Redesigning the Planet
Local Systems

The use of ecological design
& other conceptual & practical tools
to reshape the local infrastructures
of human civilizations in a wild planet

Version 6.0

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Redesigning the Planet
Local Systems

Reshaping the Constructs of Civilizations through the Use of Ecological Design & Other Conceptual & Practical Tools, such as Common Sense, Deep Ecology, Totemism, Systems Theory, Metaphor, Holistic Science, Thought Experiments, & Eutopian Strategies

Coordinated by Alan Wittbecker

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Local Systems Contents

0.0. Introduction

This work is about sharing the local (as well as global) resources and services of the planet to meet the needs of all living beings and their community patterns. It uses ecological design to create a simple method to implement and manage the sharing. First, we assess what the local place needs to develop in a stable flow, then we set aside a satisfactory area of the place to ensure the continuing operation of evolution in wild systems. Next, we measure the ranges of productivities of wild ecosystems as well as agricultural and urban systems, then use those results to determine optimum human populations for local places, regions and the planet. Within human systems, every culture would claim a share of local resources and global services not set aside for wild regeneration.

Ecological design would work on global and regional scales, as well as the local scale. For example, the Colorado river would be allocated a percentage of water to keep the river and its downstream ecosystems (including shallow ocean canyons) healthy—this may require 50% or more of all the water flow. The remaining water would be divided between resident cultures sharing the river environments upstream. This approach promises a fair way to deal with carbon emissions, toxic wastes, and energy use, also.

The equal apportionment of 'resources' to all cooperating participants in the global commons (identified with the new word 'Koinomics'—See glossary for neologisms and terms) is supported by the theory and practice of recognizing and honoring the legacy of the entire planet that hosts its legatees as tenants (identified here as 'Legatism') and is supported by the 'rule' of all beings (identified as 'Panocracy'), although in the human legal system, humans represent the interests of all other beings, much as they are starting to do now. This reapportionment is enhanced by the wisdom of harmony (identified as 'Harmosophy') and the drawing and making of ecological zones (identified as 'Zonagraphy'), which emphasizes the relative separation of wild and artificial areas. This reapportionment of 'resources' that human communities have already claimed, as well as of resources that have been badly distributed as a result of theft or violence, may cause some degree of discomfort for wealthier groups, but that is minimal compared to the suffering and death under the current system, which encourages overconsumption and large differences in the distribution of wealth.

Like metaphysics, ecological design has a vision that exceeds its bounds and a reach that exceeds its grasp. And, we have to use it to explore possibilities of local and global harmony, without having complete knowledge or experience. Ecological design requires participation and cooperation to accomplish its ambitious goals. It has to be flexible and adapt to changing environments.

This means understanding challenges and problems, as well as natural and artificial ecosystems, histories and cycles, before using a variety of physical and conceptual tools to create ecological designs on local scales, but considering the regional and global implications. This means trying to design places, ecosystems and landscapes, as well as cycles and processes. It means redesigning flows of minerals and gases, wetlands and streams, domestic and wild forests, and animal paths and reserves. It means redesigning human patterns, from transportation corridors to traditional and modern cultures. It means redesigning agriculture, cities, buildings, neighborhoods, vehicles, industries, and medicine. It means trying to redesign social traps, cultural adaptations, corporate goals and responsibilities, formal commons, styles of conflict, economic frameworks, political forms and sizes, religious applications, and even advertising. And, the purpose of all this is to restore harmony to systems that encourage health and development.

0.1. *Preliminary Thoughts on a Framework for Local Redesign*

Redesigning the ecosystems and places in the planet is a conscious effort to correct the massive 'unconscious redesign'—perhaps 'unbalanced reordering' is a more appropriate phrase—of local and global systems. The 'unconscious redesign' is an unconsidered effect of the activities of changing economic and political structures devoted to self-growth and private profit. This unbalanced reordering is rapidly changing the social and environmental orders that represent the natural capital of social and environmental evolution. The reordering is also constructing an accidental trap that leads to massive catastrophes, which will destroy that capital it needs as the basis for its renewal. Only an equally massive response of a conscious ecological design framework can lead to some form of balance.

Buckminster Fuller suggested that the appropriate tools, such as eutopian design frameworks or advanced technologies, might help human worlds to work, given the right emergency. We have been encountering the right emergencies for well over a hundred years, and we need to refine and try these tools, now. The emergencies that he considered are the human responses to a variety of catastrophes, such as fires or earthquakes. But, we are finding that not all catastrophes are fast, human-scale or visible. The effects of those large, slow, invisible, long-term changes make us uneasy, but not really adrenaline-ready. The changes are reflected in starving children, hotter summers and stronger storms, failing food supplies, and collapsing infrastructures. We must learn to recognize and respond to these other catastrophes. And, we have to do it now, before they crest and become overwhelming. We can do it. We have the evidence that things are taking a downward turn (the original meaning of the word catastrophe). We need to respond with the best tools we have.

0.1.1. *What this work is Not*

This work is not a list of emergencies. It is not catalog of losses. Many comprehensive lists and catalogs already exist. It is not a linear analysis of sudden problems and surprises. It is not a larger, more data-rich, compartmentalized model of change. It is not an abstract discussion of possible shallow changes. It is not a plan to avoid or to control catastrophes. This work does not propose solutions to stop changes or to prepare for emergencies. It does not offer a way to save the planet or our global, industrial, capitalistic, semi-democratic civilization. It is not about saving the world, or nature, or humanity. This work is not about preserving the status quos of industrial societies or of formal democracies.

This work is not about greening our civilization with more efficient cars. It is not about the continuity of market forces into private lives, or about breaking with tradition to counter market intrusion. It is not about profiting with green businesses, after certifying mild improvements. It is not about sustaining our current styles of living or levels of luxury by tweaking light bulbs, battery recycling, engine efficiency, or the color or depth of rooftops; it does not address sustainability. This work does not focus on the symptoms of a single small environmental crisis, or even several crises. This work is not about adapting to drier climates or finding immense forms of alternate energy.

This work is not about big institutions and big successes. It is not about creating spectacles or spectacular successes. It is not about creating virtual worlds in a utopian fantasy of voluntary good will to minimize exploitation and waste. It is not about the management of the planet or a detailed design for the planet. It is not about the stewardship of remaining resources or of other species, domestic or wild. It is not about a partnership or cooperation with nature—the planet is much too large, complex and dangerous for such a pretense. It is not about the invention of global cooperation or a map to achieve it.

Many recent works herald the smallness of nature, the end of nature or the death of wildness. Other books recount the themes of recent times, from the horrors of war to the triumphs of science and technology. Many authors have emphasized the urgency of responding to climate change, to extinctions, to trends of violence and victimization, and to growing inequity and financial dishonesty. Others have identified further emergencies, gender differences, border insecurities, travel dangers, and natural disasters such as hurricanes, tsunamis and earthquakes. Some have emphasized the importance of miscommunications, misinformation, violent attacks, terrorism, misuse of resources, epidemics, potential asteroid collisions, energy shortages, and desertification and ecosystem collapse. Others have recognized the momentum of short-term self-interest, self-deception, perceptual limits, overconsumption, polarization, and destabilization. And, they are all certainly right to do so—but these urgent problems are interconnected!

0.1.2. *What this work Is*

The problems are interconnected, so this work has to address everything simultaneously, because solving one problem will only offer a temporary, limited solution as other problems affect the one in the center of the focus. This work is a recognition of the problems, as well as of relentless change and radical uncertainty, that now confront many species as well as human civilizations. It is recognition that we do not have adequate understanding, knowledge or control to solve any problem once and for all.

This work is a way to adapt to ignorance, limits and chaos. It is a call for immediate action to solve significant problems to balance the whole planet, rich nations and poor nations, methane and carbon dioxide levels, and bad designs and good designs. It is a call for large kinds of public investments through the UN to avert global risks and to avoid some kinds of catastrophes. It proposes a global framework for simultaneous changes in consciousness and action, and a platform for people to self-organize and to create responses to challenges. It is a framework for personal, immediate action.

This work is a process of assembling ideas into a nonlinear narrative for the development of interacting patterns of design. It proposes creative alternatives to the business of business and the technological imperatives of progress. It is about reforming cities, agriculture, and transportation for survival. It is about reordering economics, putting constraints on businesses, but removing other restraints, such as taxes, from the goals and ends we desire. It suggests radical strategies to confront disruptive environmental and climatic changes. It urges preparations for the immediate future, using ways to survive and prosper that are exciting, adventurous, imaginative, and joyful, but that also may be hard, painful and demanding.

This work is about creating meaningful images and goals. It presents strategies to implement the images and goals. It attempts to create a framework for details, because we cannot know those details in advance or plan for them. It is about replacing the idea of sustainability with that of flexible creative fitness. It is about understanding the underlying causes and reactions to ecosystem stresses. It offers sketches of possible directions for ecological and cultural development.

This work is a thought experiment for a design framework to contain the creative coevolution of wild nature and human culture. It is an experiment on how to invent a new approach, given the immense body of knowledge that humanity already has, from the present and the long-term past. It is about recreating civilization from the bottom, by reducing our impacts and reducing our vulnerability to catastrophes. It is about managing and constraining humanity at a local (and global) level.

This work asks neglected questions about big problems, about the long, deep, wet history of life, about how many wild ecosystems we need, as well as what humans really need—about our history with its images and goals. It asks questions about our cultures and our interference with natural systems and cycles. It urges people to act heroically and exuberantly to live joyful, meaningful lives under stressful conditions. It is about respect and engagement with the planet, so that we can accommodate changes. This work is a call to imagine, participate and then to act through a common global design project.

0.1.3. *What we Need & Why it would Work*

Our assumptions have to be made explicit. This complex situation is an emergency, requiring large-scale, multiple approaches, with new technologies, massive conservation efforts, and micro-energy solutions (which require participation), but not using old, unconscious assumptions and design traditions. There is no time to wish politicians into patterns of good behavior. There is no time to beg corporations to stop cutting forests or poisoning lakes and ecosystems; as Garrett Hardin pointed out, conservation goes against their self-interests, which are focused on profits. Tree hugging is good; orgasms for peace are also good, but we need a large-scale, coordinated approach to be effective. The economy is based on rapid destruction for commodification. We might eventually convince everyone that ecosystems are part of larger human selves and that our long-term self-interest is served by conservation and preservation, but it is necessary to demand and force people to do 'the right thing' before everything collapses. Although we can learn from the many past collapses, if some cultures or civilization collapses now, it will be too late to learn. And, recovering from any collapse is going to be more difficult with globalized cultures in a completely occupied planet.

According to Garrett Hardin, many of the ideas necessary to fitting humanity into the pattern of nature are known but not yet popular. For instance, exponential population growth (or economic growth) cannot be maintained very long. Human communities cannot grow at four percent per year without disastrous consequences to the infrastructure and to the quality of life. Growth cannot be continued because the landscape is limited, in terms of productivity, energy, and resilience. Thus, we need to fit our population into the limits of the landscape (although some limits can be expanded by technology or by lowered expectations). The carrying capacity of the area is not only a function of the limits of the community, it is equal to the number of people multiplied by the level of comfort (or quality of life style). Having more energy and space means having fewer people. What is required for dangerous times on the planet is a sense of common purpose. We need authoritative leaders, who can command. Courage and imagination are needed obviously. Intelligence and passion, rightly so. But, also we need faith in our abilities and in nature's process of regeneration. We need to accept failure and uncertainty. And, we have to have the willingness to proceed with realistic optimism, despite limits to knowledge or cooperation.

Although nature and our human nature, are not enemies to be vanquished, the current situation has similarities to war. Massive changes threaten our lifestyles. Resources are removed from our reach by thoughtless or inefficient use. Growing insect and animal populations seem to be attacking our food supplies. Species are being forced into extinction. Habitats are collapsing. Dangerous chemical wastes are accumulating. Ozone holes are growing, extreme climates pressing, and the entire planet seems to be wobbling. Changes in climate and ocean balance, as well as renewed diseases and infiltrated toxic chemicals, threaten our lives. And, it is happening everywhere, at once.

Although we want to respond with a warlike approach, we have been fooled by the fact that we cannot see an enemy—and fooled by thinking there is an enemy. We have been misled by the slowness and subtlety of the penetration of our defenses. We have been betrayed by our own desire to continue our industrial dreaming at any cost. Some people have noticed changes and have been crying alarms, but they have not been loud enough or persuasive enough. Everybody needs to be awakened; everybody needs to participate, everybody needs to sacrifice and work towards peaceful solutions. The big problems seem insurmountable, and simple actions will not save our civilization from catastrophes. Part-time participation will not be enough to reverse the degradation of ecosystems, and partial business greening will not stop the unraveling of global cycles.

What is needed is an immediate, peaceful, comprehensive approach to this situation—wise actions in a framework of intentional, reflective design. We have some experience; thousands of people have collaborated on computer operating systems or online encyclopedia. So society might benefit from a push to redesign society itself, as well as to redesign the environment and planet. We have the time: One billion people in affluent countries have 2-6 billion hours to spare every day. We have the money to do it, although the costs of change are going be relatively high, from 1 to 24 percent of the productivity of every culture. The cost of collapse, however, would be much higher and more painful.

We need to act on a global scale. We have acted on a large-scale before, in times of world wars. We were able to treat war as an emergency and to encourage or enforce remarkable changes, such as rationing or redefining jobs. We were able to take these actions without destroying our citizens or our cultures (or most of the planet).

Why would ecological design work? Because life has over three billion years experience with changing and adapting, because human life and cultures have over 50,0000 years of practical experience adapting and making changes, and because humans are immensely adaptable—if they can adjust to poverty and suffering, they can adjust to a few good changes. Perhaps it is already too late—limits may have been passed and the catastrophes cannot all be reversed. There may only be a small window of opportunity, between 1 and 20 years—unless it passed from 1 to 20 years ago—for changes to be effective. Otherwise, losses due to external changes will be unacceptable economically; the losses are already unacceptable ecologically, especially with extinctions and habitat collapses. Fast changes are needed, requiring fast investments, mobile capital and social capability. We do not know, and may never know, if our actions are in time, but we can still act as if we were wise, as if doing the right thing makes a difference. And, we can work together to help others, to improve things and to make good places. If we act now, this month, this week, this day.

0.1.4. *What can you Do?*

Read this work. Correct it and supplement it. Extend it. Apply it. Grow up, mature. Lose your fear of speaking and acting, or of losing time or everything. Prepare to fight for ideas and actions that you know will benefit the complex forms of life and cultures. We are trapped in an industrial megaculture that is embedded with us in an ecological network of trillions of interdependent living beings that are being destroyed by industrial processes and financial practices. You—we—have the power to walk out of the trap and to commit our considerable energies to redesigning and rebuilding our places in the planet.

Is this work complete or original? No. Certainly hundreds of people have had ideas that are more original. Sometimes however, originality is aided by having many ready-made pieces to put together—for instance, Charles Darwin needed the works of Thomas Malthus and Adam Smith for his ideas. And, these were put into a new pattern. Earlier design work is almost always useful in later work and has value for later design. All revolutions have to do with recombining ideas into new patterns rather than discovering a new, independent idea.

Is this work an adequate response to the pressing emergencies? Can it be effective? Maybe it could be, as a frame of ideas or as a matrix that could guide action. What's wrong with this work? It was written in a hurry. It is sloppy and unfinished. Why should you read it, then? Because it has many good ideas and it attempts to put them into a very large synthesis. People sometimes object to one person delivering finished material and ideas to a larger number of readers. That cannot be the case here. That is why this work is a crude outline. It is constructed as a frame that others, like you, can add to. In fact, think of this as a workbook to which anyone can contribute, as a sketchbook where you can fill the sketches, or as a dynamic corrective exercise that can be corrected, improved, and expanded.

The attempt at local ecological design means accepting the opinions of everyone, regardless of their motives or level of understanding. The attempt therefore becomes the beginning of reeducation, which may be a long process, longer than single human lifetimes. This work should aim to be an extensive community of cocreation, like the Grameen bank or Wikipedia. This work is an open framework that addresses and limits local designs within regional and global designs. The work is a participatory process. That may be the only way it is useful. So, please think about it, but then become part of it and contribute to it. Otherwise, it will just be another impoverished, unread book, with a snazzy title.

0.2. *Redesigning Local Ecosystems?*

How can we redesign local ecosystems with ecological design? What is ecological design? How can it be defined, much less applied to ecosystems? The title and subject of this book refer to the intentional design of the emergent local aspects of the planetary system, especially living forms and more especially human forms, which are becoming a growing regional and global influence. Of course, some people have been considering it for decades and a few people are practicing and promoting it regularly.

We have not designed patterns or structures for ecosystems so far, possibly because of the challenges of scale and complexity, or possibly because we have trouble thinking about large, slow, long-term processes. Local systems are connected with and have interactive histories with other systems. Every system has unique properties and limits that have to be addressed in any design. Every system exhibits very-long term trends (called gigatrends) compared to a human lifetime.

0.2.1. *Starting Successful Designs*

The vernacular designs of many cultures are superb adaptations to their local environments. Many early cities were planned and built as a response to difficult conditions. Many of our modern buildings are models of beauty and efficiency. However, our modern cities are generally examples of wild, stochastic growth. Very few people, other than Paolo Soleri, are designing cities. Our habitations, fields and transportation seem completely haphazard. Instead of placing cities on mountains or barren ground, we are filling fertile grasslands and swamps. Instead of placing roads around vital breeding grounds, we are bisecting and fragmenting ecosystems. Instead of integrating our food areas with wilderness, we are simply converting productive ecosystems to temporarily subsidized monocrops, which we then convert to roads and city squares, without regard to place.

One way to play with design is through ecological thought experiments. The design itself must be considered with regional and global factors, including the biogeochemical spheres of the planet, cycles, forests, and animals. Other factors, such as wilderness and the extent of human cultures, must be an integral part of any design. Wilderness areas, of many kinds from autopoetic to neopoetic, have to survive in appropriate sizes and shapes to thrive and provide services to all living beings.

Human cultures have adapted to different environmental conditions over tens of thousands of years. These cultures need to operate within local and global processes, as well as within human structures. Cultures become critical design factors since their adaptive patterns, such as agriculture and technology, create opportunities and problems on local, regional and global levels. Human populations have a significant impact on the planet, especially through conversion of ecosystems and the addition of exotic elements.

In fact, culture and nature are converging in a new pattern that can be referred to as 'domiture.' Domiture is concerned with local, regional and global designs that have to begin with a foundation of wild species in wild systems and continue to the common and artificial places that human cultures create and maintain. This new pattern is supported by ecological design and ecosystem medicine. Design operates on many levels and works upwards and downwards, as well as inwards and outwards. It has to incorporate numerous other factors relating to religion and urban shapes, as well as to economic and political forms. Corporations and the growth of inequality must be addressed in any designs, due to their negative characteristics, which can distort actions.

Creating designs has to be done in a large political framework, complete with new political and corporate structures. Cultural solutions to local and regional problems have to be applied, but global problems resulting from conflict and inequity have to be addressed in every culture and especially through a larger framework. Local designs have to fit global patterns and limits.

Local ecological design rests on a foundation of ecological knowledge, as well as on an appreciation of historical problems and philosophical ideals. This work outlines how to create local designs consciously, using our knowledge of how things work, but being aware of our ignorance, and by being careful and respectful. A local design process has to address many problems, from problems of scale to political inappropriateness.

0.2.2. *A Snapshot of Local Ecological Design*

Local ecological design can create appropriate images for ecosystems to replace the harmful image of the machine. We can build on archaic cultures, with the image of a Turtle, or expand a mythic image scientifically, as with the Greek Goddess of the earth, Gaia (James Lovelock's theory). We must create an image of a whole living planet as a context for the local designs we want.

Local design can formulate specific goals to be associated with a common image. These might begin with working towards a civilized human existence on a dynamic planet, characterized by interhuman and interspecies equities. They might include the reservation of the wild, to keep the minimum conditions and processes of the planet in motion. They might include the definition of optimum human populations based on normal ecosystem productivities and the limits of geochemical cycles. They might include a plan for the independence and degreed isolation of independent cultures. They might include new kinds of cities and immense areas of common lands for domestication.

Local design could also develop strategies to discuss, refine and work towards these and other popular goals. Some of these goals would increase our ability to anticipate and respond to new catastrophes. Others would work towards equity of human societies, within important ecological limits. And, still others would reduce our impacts and disruptions on wild ecosystems and cycles. A eutopian approach would encourage compartmentalization of cultures as regards food and shelter. Other strategies could be coordinated to accomplish further common goals. A few of these would include:

- Create a steady state (in Herman Daly's term) framework of local economies that are self-reliant.
- Limit the use of fossil fuels to strategic uses, not for cars, burning or fertilizers. Limit human use of everything to within ecosystem limits.
- Manage impacts to avoid large-scale technological fixes that require constant monitoring and control.
- Preserve small scales of everything, from cities and farms, to roadways and air transport. Deindustrialize agriculture. Make it more labor intensive.
- Keep options open. Keep flexibility high. Flexibility is crucial for dealing with changes. Equally important is creative co-constraint.
- Compartmentalize systems more by following an ecological model, reducing connections and overintegration. Increase diversity and redundancy at multiple levels.
- Require a diversity of sources of materials and services for all kinds of manufacturing, always favoring local ones.
- Restructure financial institutions from interest and profits to fees and community donations. The reasons for profits are gone; this time needs enoughness and equity.
- Create massive stores and vaults for food, seeds and genetic information. Create seven-year food banks of cereals. Create long-term banks of needed tools and materials.
- Accept all of the effects of living on a dynamic planet: Extinctions, death, suffering, destruction, life, accomplishment, beauty, and joy. It has always been a wild ride and it will continue to be. The music is wild, the dance is wild.

These and many other strategies will be expanded throughout the work. Some of the strategies will be constant and permanent, while others will be temporary suggestions for transiting to desired states.

This could be done now, and it might feel similar to some times during World War II for some people in some nations. People could react in days. The economy could shift in months. Some things would be limited or rationed. Most spirits would be high because people would sharing the losses and risks, the challenges and stresses—and they would be doing it for the common good, to avoid catastrophes that could affect everyone and to save their part of civilization. The world would not suddenly become peaceful and utopian; there would still be conflict and crime, cheating and violence. But, these problems would occur within a smaller scale, within the context of redesigning human structures to be in tune with the natural processes and scales of the planet.

We do *not* want a uniform—and likely boring—industrial culture. What we do want is a framework to insure the development of local cultures. An analogy might be the atmosphere of the earth, which is essentially the same, but allows many kinds of life to develop in many different places. Designing systems is a process of assembling ideas, a narrative for the development of interacting patterns. It is not a comprehensive model, but a sketch of possible directions and developments. It is, in John Thackera's words, an incomplete score, because the composer, player, audience, site, all vary with every performance. What is important is the framework for action, with its understood constraints, so that the work is coadaptive with the participants.

0.3. *Design Science as Poetic Production (Conversation with R.B. Fuller)*

Buckminster Fuller dedicated his life to solving problems. The problems were big then, as they are now. And, what daunting problems they are now: Humans deaths on an unimaginable scale, perhaps over 200 million people in the last 100 years, from shortages and distribution failures to wars and diseases, as well as the conversion of vast areas of vital ecosystems to agricultural fields and deserts, resulting in the deaths of animals, species, habitats and ecosystems. All of these problems interact, so that it becomes difficult to isolate separate problems. These long-standing problems result from long-standing challenges to human health and happiness: Disruptions in distribution, violence, stupidity, greed, forgetfulness—not just personal forgetfulness but larger forms of cultural amnesia—old diseases and new, lust for power, and the lust to consume. Some of these problems are the result of detachment. Corporations, a trademark form of our industrial civilization, contribute to this detachment. Fuller named an imaginary corporation, 'Obnoxico,' as a foil for his ideas on addressing these problems. Fuller dismissed the flatscapes that resulted from uninformed design and recommended a form of eutopian design—Eutopias is from the Greek word meaning 'good places.' This word, with Outopias meaning 'no places,' was the source of Thomas More's pun 'Utopias,' which was also the title of his fictional account of human development to the beginning of the industrial era. This work is an extension of eutopian design to deal with long-standing problems.

We tend to think of problems as unwanted 'side-effects' of the wanted main-effects, but all effects are equal, as Fuller noted, and must be addressed as equal. A problem (from the Greek words 'to throw forward,' which is what we tend to do with them) can be considered as a question proposed for solution. Most things identified as problems are embedded in a network. Nothing is simple; there is not one problem, there is not one solution. Problems could be considered also as challenges that we must respond to continuously, in the process of living, not as puzzles that have to be solved once for all time. A challenge is a calling into question or a demanding task (a challenge is defined as 'a call to take part in'). It is about consciously choosing to see what can be done, rather than dismissing a conflict as terrible and unsolvable. When challenged by some situation, we react by habit, although this may be disconnected from other habits. Habits protect us from many problems. Addressing a problem often has to do with a power struggle, which becomes part of the problem. If problems are regarded as challenges that require a social response, then the conflict might be avoided.

The problems of cultures, of natural ecosystems, and of modern, industrial, corporate, urban civilization, have been documented quite thoroughly. We have identified most of the problems in the problematique, from erosion, pests, and fertility loss, to population migration and diseases, and we have addressed them separately, using technological innovations or political adjustments. But, we have not dealt with them in a whole pattern. We have not understood them as equal parts of complex large dynamic systems.

Sometimes we forget, moreover, that the decisions of our ancestors saddled us with losses, just as our losses will encumber our heirs with deforested landscapes on depleted soils, despoiled by exotic chemicals and hazardous wastes, in a network of impoverished habitats with an unstable climate, and of course, compounded by large intergenerational financial debts. This network of problems can be grouped under large categories, each of which contains a multitude of related problems. Each category also extends numerous threads to the other categories. The loss of nature and the wild, that is, the loss of the whole and the pieces, ecosystems, habitat, species, and individuals, may be devastating to all self-renewing systems.

The remaining losses, such as the loss of place and the loss of design, are fundamentally human losses. These losses, especially of uniqueness and diversity, tend to flatten our image of the planet even more than economic connections.

0.3.1. *Allowing Flatscapes of Design*

Places have been allowed to degrade to deserts, ruined landscapes or placeless flatscapes without the qualities of place. Placelessness begins with the adoption of a modern attitude, an abstract and a geometric view. Using this inauthentic technique, places are treated as interchangeable and unremarkable, where nothing is significant. Cutting historical roots and eroding symbols contribute to an awful placelessness, an alienation to place, and an inability, finally, to have a home and to live there. This becomes the fate of millions, and it increases.

After shaping ourselves to technology and necessity, we have lost the knowledge of how to care. We have learned to be dispassionate (uncaring), objective (uninvolved), and unattached (placeless). Other animals have used languages and tools, so it is not those things alone that account for the lost knowledge. We 'not-care' because we are confused. Our confusion results from being out of place and not having an identity.

People used to identify with place. The gain of monoplaces or flat spaces has led to a loss of identity for many. The commonness of industrial culture, at a low common denominator, has led to fewer identities to choose from. The mass production of homes, as well as of music and art, has led to fewer creations.

A number of scholars have noticed that we are creating flatscapes, devoid of depth and providing only mediocre possibilities. Flatscapes, C. Norberg-Schulz's appropriate term, have allowed landscapes and places to become monotonous and dull, displaying fewer unique qualities and fostering weaker attachments. Edward Relph outlined the disappearance of variety that results in placelessness. Places become homogenous and interchangeable, as people everywhere share limited ideas and limited ways of relating to others.

David Brower urges that the human sense of place needs to be revived. Places cannot be preserved, however, without cutting their vital connections and making them lifeless. Places cannot be restored to some Arcadian fantasy, without severely limiting their movement and development. Places cannot be created using a machine metaphor that boasts the substitution of anything for anything.

There have been attempts to define and design places. Christopher Alexander decomposed environmental objects and activities into their constitutive elements, to be reconstructed into designs that could fit local places. These formal solutions can improve strategies for design and can provide a matrix for the making of places. But, they should not assume that human variables can be manipulated to achieve a predicted response. And, they cannot ignore specific psychological or cultural patterns.

There must be a way to define places, using an ecological approach, and considering cultural modifications and adaptations to places. The approach has to be tradition-based and partially self-conscious. It has to be responsive to the genius of place, as well as to human meaning derived from the existential and phenomenological significance of the place. The concept of place incorporates physical, biological, and cultural dimensions. The solutions cannot, and do not, need to be precise; they can be unfinished and ambiguous. They can be fuzzy. The design does not need to guarantee rootedness or workability, but it can identify limits. It can provide possibilities through a matrix that allows tradition and richness. It can provide direction from the understanding of the parts. It can understand how to make a fertile kind of soil, as a metaphor, where things can live in and develop. Living beings synthesize the parts and find meaning in living there, and in doing so revitalize a place.

0.3.2. *Designing Real Living Places: A Eutopian Thought Experiment*

Perhaps the problem lies in our images; we use old images of 'frontiers' or simple, inadequate images, like the 'machine' metaphor for nature. Perhaps the problem is in a failure of imagination. Ideal images of the world have been offered as schemes for social and political development, but are dismissed as being unrealistic and flighty. On the other hand, adopting these images would require too much change—rejecting the past or refusing the cultural present, before creating new institutions from nothing. Some of them are thoughtful and imaginative, but most of them are rejected as irrelevant dreams and self-indulgent imaginings. Yet, as Pierre Dansereau has said, the failures of pollution, poverty, and urban decay are failures of imagination. Rejecting the solutions of imagination, therefore, can only make the suite of crises worse. Dreams and imagination are needed to describe desirable futures, to support plans, and to outline goals.

These rejected utopian designs can be replaced by realistic and achievable ones, based on a new image of the earth and humanity, that use an ecological perspective, to ease human societies into partnership models, to restore wilderness and common places we have destroyed, and to change international relationships into a poetic framework capable of limiting war and permitting the unique human expansion of cultural expressions.

This work outlines how to create places consciously, by using our knowledge of how things work, by aware of our ignorance, and by being careful and respectful. Certainly this seems less radical than continuing to surround ourselves with nuclear weapons and habitat destruction in the name of an isolated political reality. A eutopian process, different from the utopian, would solve many problems, from problems of scale to political inappropriateness.

Buckminster Fuller was one of the first to consider this other meaning of utopias, as good places. In the 1920s, Fuller began work on a Dymaxion Air-Ocean World Map, as an alternative eutopia that sought to define civic and ecological order through maps of known areas (Dymaxion is a word formed from the words dynamic, maximum and ion—an ion is an atom or molecule that has lost or gained one or more electrons). On this map, the North Pole is the neutral center around which land mass and ocean unfold; this deemphasizes Europe, China or America as centers. In the dymaxion series of maps, Fuller superimposed a spherical icosahedron grid onto the earth's surface to limit the distortion of the relative size and shape of its components, so his projection represents all areas with equal weight.

Later, he sketched the World Town Plan, a map that preceded and directly influenced his subsequent maps. The map, in its projection method and form, highlights the connectivity of the "one world island." Fuller saw his map as an operational tool to be used by the members of the global citizenry. He intended to establish a map that does not prioritize cardinal direction, political entities, or hemispheric organization. Instead, the Dymaxion map provides a base for presenting larger global themes such as human migration, natural resources, and population distribution. Temperature replaces politics as an organizing feature. World climate is shown in a range of coloration from warm reds to cool greens and blues. Even with these specific theme, Fuller's map emphasizes wholeness across the global surface.

The proposed framework of *local ecological designs* is based on eutopian design, an ecological and cultural framework for making good places on local, regional and global levels. Eutopian design is a way to preserve what is good and useful in human cultures and sciences, and to reserve what is necessary for nature to keep regenerating itself, while addressing the cascading problems of the modern expansion and development with an emergency approach. Eutopian design is a practical framework for allowing the creative anarchy of traditional-size cultures to be able to implement appropriate technology to deal with their resources and with other cultures through a revitalized and empowered international body that has the power of taxing global resources and properties for its own support, as well as the power to disarm and neutralize the unhealthy influences of large nations and corporations. This framework limits human expansion to domestic and artificial areas, by specifying responsibilities and duties, while permitting the free operation of nature on the majority of the planet. It saves neopoetic areas and reserves wilderness, and encourages respect for natural and cultural capital. It recommends recognizing limits and planning for them using an ecological perspective and a metaphorical approach—it is the framework for local, regional and global ecological design.

Eutopias can integrate tools and designs. Tools and designs are important extensions of the human mind. Their purpose is to foster and assist survival, not to make it more difficult. Tools and designs can be made appropriate to environmental limits and cultural preferences, both of which are often ignored by industrial approaches. Eutopias can suspend the designing of noplaces or flatscapes by promoting the understanding of the inadequacies of bad characteristics and bad designs; it can stop the plague of uniformity and paucity. Through an understanding of the consequences of human ambitions and actions, eutopias can avoid many of the evils that result from a civilization set on technical autopilot. Design can be used to reduce impacts from catastrophic events; for instance, by denying building permits on floodplains. The losses from some events, such as droughts resulting from El Nino, can be ameliorated by design and planning, e.g., by having surplus food and supplies stockpiled.

A single utopia would not work for the whole globe. That is why many local patterns, eutopias, are necessary. Most utopias expect a perfectly rational humanity in a stable, ordered nature. Eutopias accept the imperfect nature of humanity and the changing ambiguity of nature. Most utopias have a finished, closed, completely planned society. Eutopias would encourage building an open, progressive, partially planned society. Utopias are the dreams of reason, while eutopias are dreams of small traditions and cultures, reasonable or not. Where an imagined utopia offers revelations promising a desired future, eutopias offer references from selves and cultures for producing good places on earth now.

The first strategy would be to create a eutopian structure for human societies that emphasizes self-reliance and international cooperation on local resources and cycles. Eutopias would be less vulnerable to downward drift or collapses than modern nations because of its new approach to values and limits. Through the United Nations (UN), the framework would allow for global coordination and planning of local associations of communities.

The eutopian structure would create new goals and images that would be applied to priority approaches, starting with survivability and protection of the wild. Eutopias would offer redesigns of our cultural and economic systems so that they would become smaller and more independent and flexible, in order to respond better and faster to new environmental uncertainties and changes. Eutopias would provide a repository for the diversity of human knowledge (cultural knowledge) as well as the diversity of crops and animals—and of course the genetics of wild beings. It could catalog cultural legacies from archaic cultures, similar to what is being done for some indigenous peoples and cultural heritage, for example the Foxfire books on Appalachian folk knowledge, to preserve it from being lost from the transition to cities. Archaic societies have experience adapting to local conditions or catastrophes. A data base from a variety of cultures, each adapted to different environments, would provide resiliency and functional redundancy to human survival.

There is no mechanical prescription for designing and making good places, nor is there a blueprint or timetable. The current institutions cannot create good places; the market has not been able to create health and equity; even scientists and humanitarians have not been able to create a way—Eutopias is a fourth way. It is not an institution that benefits only the rich; nor is it a schedule of temporary handouts. It is a plan for a framework for local self-reliance and exchange, which is respectful of traditional cultures and ecological networks.

Eutopias has a low—but not too low—political feasibility. The benefits must be worthwhile to justify the costs. Benefits cannot be vague and unsatisfying when the costs are immediate and painful. Poetry and education must show the existence of benefits, so that the eutopian alternative can begin. This code emphasizes its flexibility. This strategy would avoid eventual hardening of the choices, but it must be instituted at once. The crisis caused by exponential growth and destruction cannot be solved just after some final limit is passed and a great catastrophe has begun. The crisis of ignorance cannot be solved by hurrying and creating more problems.

Eutopias can reduce the losses of nature and culture by creating a framework to protect them. Eutopias can reduce the losses of health, fitness and accord, by emphasizing them and creating circumstances for their continuity. Eutopias can reduce the losses of equity, renewal and design by offering new designs that allow for a normalization of equity and for the normal processes of renewal. Losses from accidents and diseases can be reduced by preparedness. Losses from earth and climate changes can be reduced, also, with preparedness for 'normal' regular events, such as hurricanes, earthquakes, and droughts.

Eutopias can show how to preserve and restore, design and plan. Eutopias can provide an ecological planning process that offers a structure of limits and divisions for the planetary systems that would permit the preservation and restoration of natural cycles and places. An ecological design process would be applied to ecosystems as well as to cities and fields.

0.3.3. *How can we Redesign the Experiment?*

For his commitment to a design science revolution, Fuller made "Ten Proposals" (from Earth Inc.) that addressed the problems of our civilization. One of the most important is to learn the mathematical coordinate system of the universe. In fact, an educational revolution, based on synergy, should be the highest priority. It would start with an inventory of all known principles, using Fuller's world game for theoretical exploration. To inventory the resources of the planet, we would convert general accounting systems to a planetary ecological accounting system, intergenerational and cosmic rather than annual and agricultural. Wealth would be refined from a scarcity model to an energy model. By making ownership onerous, excess property could be eliminated, and we would be liberated from our slavery to 'thingness.' World sovereignties, with their suite of barriers, would be modified. Humans would apply their unique skills as problem solvers by realizing our competence at design science.

Fuller made many brilliant suggestions, and applied many ideas in brilliant inventions. His technical focus, however, allowed him to overlook many of the needs of people and cultures. One sovereignty, replacing many hundreds, would make things worse, for example. As Leopold Kohr noted, bigness is the source of most problems, such as misery and conflict, and smallness is the simplest and most elegant solution.

For Fuller, the discipline of design science proceeds from a subjective search through experimentation and feedback to generalization, then development, including practice and regeneration, to evaluation and back to the subjective search in a loop. Fuller notes than humans have evolved from the local 'rejuvenation' of agrarian farming to a collective nonlocal rejuvenation of industrialization. However, industrialization has proved to be nonrejuvenating, as it has been stuck too long in a flow-through pattern of production, where everything is treated as commodity. Something that is capable of self-renewal is needed.

Fuller also argued that we have displaced ourselves as specialists and must again become generalists and 'comprehensivists.' We need greater degrees of freedom to increase the probability of cross-fertilization to solve design problems. We need new skills in design that can come from considering the local systems within a regional context. We need to try new approaches and correct the inevitable mistakes. And, we need to ask questions about the global systems, before we can try to answer them.

Fuller emphasized the importance of global communications, through radio signals, and global transport, complete with a computerized global transport system and traveling cartridges that would be assembled at local stations or loaded onto planes or ships. Fuller also proposed a global energy grid (the Global Energy Network International), which would connect all areas, although we would have to be careful not to create connections that are too rigid. The dymaxion house was to be a global dwelling service, which would optimize performance and efficiency.

A design science revolution, using a comprehensive anticipatory design science, would reform the environment. But, Fuller thought we could reform the environment without reforming people. This focus on technical solutions has resulted in more damage to the environment, instead of less. Therefore, design cannot be limited to simple mechanics, but has to extend to human cultures and behaviors, to ecology, economics and politics.

Fuller does suggest that a design scientist has to take the initiative rather than being retained by a client to carry out a limited design. The design scientist has to perform the fundamental invention, underwriting, development, and experimental proof of a project. Design science has to provide effective anticipatory strategies for formulating and managing the regeneration of industrial organisms in the same way that the medical profession deals with human metabolic regeneration, according to Fuller (WDSD No. 5, 1962). Design has to be holistic. Fuller states "the design scientist would not be concerned exclusively with the seat of a tractor but with the whole concept and distribution of food." For the field of local ecological design, this means fitting the total human industry within the context of the local, regional and global system.

0.3.4. *Poetic Production of Ecosystems & Places*

According to Aristotle, productive science or poetic knowledge, has a product as its end, not knowledge or action. It is the least exact of all science, yet, in a sense, poetic science is more basic than the others, since it has product for an end. Poetic knowledge is inseparable from the power to make. Poetic science is a making, a fashioning of random information into a whole. The whole is structurally unified into a complex thing. This unity is based on organic themes, for Aristotle. Art is a mimesis of nature, but it does not copy nature's products. It presents unified wholes, in the manner of nature. Works of art are structured like unified living things; when things exhibit unity, then they have order, and when things have a definite size and order, then they are beautiful, in art and in nature. Fuller once said: "When I am working on a problem I never think about beauty. I only think about how to solve the problem. But, when I have finished, if the solution is not beautiful, I know it is wrong." In fact, only by being organically structured can art be mimetic; and only by being mimetic to life can art works be organisms. Art, design and poetry imitate, not fragmentary reality, but the essential whole.

Our local designs of ecosystems, of wildernesses, of cultural forms need to be poetic productions. By following the principles of ecology and applying them to the characteristics of good places, we can make local designs. According to David Orr, certain design principles work with ecosystems and nations: Small units dispersed in space, redundancy, short linkages between modules, simplicity, diversity of components, self-reliance, decentralized control, large margins, and immediate feedback. A megaframe like Eutopias would allow this scaling of design from the local to the global.

Ecological design, for instance, is the design of whole communities. We can design places as organic wholes to promote the well being of individuals and the common good. But, we can only really do so as participants of ecosystems (and this takes us back to the fundamental lessons of physics: that we cannot not be part of an experiment, that disorder creates order which creates disorder, and so on). Humans need to recognize that they automatically participate in everything. Furthermore, due to the uncertainty in dealing with large, long-lived systems, we have to learn to accept that the system needs most of its own productivity and to limit our use of the systems to well below critical limits, that is, within the flexibility of the system.

Local ecological design is the design of human impacts on unique places in the planet. It may require patterns of constraint more than specific technological applications for that level. It requires the participation of everyone, dealing with small actions and very large cycles. But, the designs and actions, and certainly, our awareness, have to extend to the region and perhaps beyond the planet.

Figure 474-0. Balkan Park rangers train for wolf tracking
(Photo by P.M. Woulfe 2002)

0.4. *Deep Ecology and the Potters in Our Planet*

By Arne Naess

Yes, I mean "in." The atmosphere is over us and also part of the Earth. So we are inside, rather than on, the Earth. We are mobile, too mobile, fragments and units of life, busy using and misusing whatever we find at hand for our many, sometimes admittedly queer, purposes. Potters, as so many others, contribute to the fight against the resulting degradation of life conditions on Earth. If an example is needed, you have North River Pottery, situated in one of the ecological deserts (practically no biodiversity) teeming with humans: Brooklyn, New York. The term "desert" is not quite appropriate, though. It is a centre of human activity that, in a not-too-distant future, may be an area with sustainably rich and diverse life forms. (Let us say, in the twenty-second century.) In a pottery, in one city, one may now listen to more sounds and music literally "in the Earth" than ever before.

Asked to tell something about deep ecology for the periodical *Studio Potter,* I can only say what I would say to a hundred other occupational groups in our—from the point of view of history, of humans—astronomically rich in the material and technological sense societies (I am reminded of the saying of Mother Teresa: "We are poor in Calcutta? No, you are poor!").

From the 1960s until today there are, roughly, two main kinds of reaction to the ecological crisis. First, there are some people who admit that a new set of global problems are at hand that requires a less polluting industry, recycling, a less steep population curve, preferably a stabilization, and more respect for nature. But in the main: business as usual. This group considers those who ask for deep changes in the rich countries to be alarmists who underestimate the chances and effects of technological revolutions—if the crisis turns out to be more severe than scientific research today estimates it to be. They regard those who introduce philosophical or religious issues as soft-headed, and "ecosabotage" as a form of terrorism with no good effects in democracy.

A minority reacts very differently. The way of life in the rich countries is devastating the conditions of life on Earth if it continues in the present direction, they say. And that way of life is not conducive to the fulfillment of the basic goals and ideals of a good human life. So nothing essential is lost if societies change their main aspect: not only economically and technologically, but also the social texture. Nothing less is required in order to significantly change ecologically relevant policies and general political priorities.

In the long run, life quality will not decrease, but rather increase. Humans will use a little more wisdom and will be able to realize a rich life with simple means. The point of view of this minority is based on diverse philosophical or religious premises, even if these are articulated only rather fragmentarily or not at all. They may be said to have or manifest, however vaguely, a philosophy of life or even a view of the whole, a total view.

Within both groups there are many who use some of their energy to overcome the crisis, even if they clearly see that their personal contribution has to be small. The former I call supporters of the "shallow" or the "reform" ecology movement; the latter, the supporters of the "deep" ecology movement.

I italicize the two words because they are often neglected where they are important. Thus, there is a widely used term "deep ecologist," in my view an unfortunate designation. It makes it natural to add a somewhat ridiculous term "shallow ecologist." Most supporters of the shallow movement do necessary and excellent jobs. It is only a waste of time when they oppose the deep movement in general. Instead of the term "deep ecologist," one may use "deep ecology theorists." There are hundreds of articles and books by authors, philosophers and others, who discuss important questions of principles, and who sometimes add complicated, sometimes unclear discussions. The rank and file supporters, the backbone, need not bother to read the theorists. They need not know the terminology.

It is of importance that groups who otherwise have different opinions and belong to different cultures find each other and encourage each other. To help, however modestly, to reach this situation is the main function of the common terminology. It is important to feel that thousands and thousands are working for the same goals. It is also good to feel that it is not only people from the rich countries, but also people in materially poor areas who eagerly and under adverse circumstances work along the lines of the deep ecology movement. My presentation here is one adapted to people in the rich countries with high formal education relative to the global average.

One general way of explaining how deep ecology movement has come to being is to note the expansion of care. More than ever, it is seen that nonhuman living beings also need care, whether they are considered useful or not from a narrow human point of view. People who always have found it meaningful to do things for their own sake, whatever the beauty or ugliness of these beings, find that there is a frightful lack of care, locally, regionally, and globally. Therefore, most supporters tend to agree that every living being has intrinsic or inherent value or worth. And that there is a right, if rights exist at all, that belongs to every living being.

Considering the consequences of the population explosion in the last centuries, the opinion exists that it would be good for the fulfilment of human basic goals in life to be fewer, and very good for other living beings if there were fewer humans. The fulfilment is more likely if there are significantly different human cultures, but that requires space. Perhaps, in the twenty-second century, a slow decrease of the population will take place. But ethical consideration suggests that this is a process that requires many centuries of wise policy.

It is plain that respect for non-industrial cultures must prevail among the supporters as part of their concern for future richness and diversity of life forms on Earth. What is called ecological sustainability requires sustainability of human life forms, but the importance of the peace movement derives largely from the tendency within some cultures to coerce or even destroy others. A good sign of increasing awareness of past destruction is furnished by the mixed feelings about the "discovery" of America in 1492. The resulting destruction both of human cultures and life conditions in general have been of gigantic proportions. But we can only smile at the idea that it might have been postponed until the appearance of greater human maturity, say in the twenty-second century?

How would future societies look? How would the requirement of not violating deep ecology principles affect the structure of human societies? Interestingly enough, it seems that a wide variety of cultures, including their social aspects, may fully take care of those principles. But some should be disregarded because of inadequate satisfaction of two additional sets of requirements, those laid down by two mighty old movements: the peace movement and the social justice movement. The basic emphasis on increasing care within the deep ecology movement largely insures a broad cooperation with the two other movements. The unecological aspects of armaments and wars are too obvious to dwell on. But clearly some long range ecological goals must be ignored today in order to be of material help to very poor countries starting development toward economic progress, but this, of course, does not imply support for a development in the same direction as the so-called "developed" countries. That must be avoided at all costs, even if it will elicit serious hostility on the part of the power elites in so many poor countries.

My vision: A manifold of green, or better, colourful, societies, and few or no power pyramids like the USA or EEC. It cannot, of course, be part of the function of deep ecology theorists to work out blueprints of ecologically fully responsible societies, but to use both their creative imagination and full power in criticism. The green movement at its best learns from all the three movements requiring grassroots support and activism.

Ecological sustainability requires full richness and diversity of life forms on Earth. The term "richness" is meant to convey the idea of local, regional, and global abundance, not only absence of extinctions. The scary diminishing of biodiversity practically everywhere in the suburbs has only recently been investigated thoroughly. A change towards richness and diversity requires profound change of city and regional planning. It is difficult to see how this will happen if the "business as usual" attitude prevails. The supporters of the deep ecology movement have a formidable task to accomplish, and the frontier is long. Don't press people active in one sector to move to a different one. Victory means an immense contribution to life quality of humans, and relief to countless other beings.

Figure 04-1. Arne Naess with Kit-Fai Naess & Marcella Woulfe in Oslo 2002.

1.0. Preparing Tools for Challenges to Design

Human consciousness of our effects on the planet and on each other has gradually increased, as shown by recycling programs and by celebrations such as Earth Day, which has been getting larger every year—as a celebration. But, celebrations do not seem to have lasting effects. Environmental deterioration has worsened in most places. Levels of consumption have increased; populations have increased. Wastes and pollutions cannot be controlled. Death and destruction are not even counted, just estimated. The estimated deaths during the Twentieth Century is a story of big death: 250 million people from democides and violence; 32 million from famines, once the greatest producer of deaths in agricultural societies for thousands of years; 58 million from diseases including influenza and AIDS; 21 million as a result of natural disasters, such a droughts and floods; 25 million, as a result of poverty and lack of shelter and clean water—386 million people is a mean estimate not a high one. The fate of habitats, species and individual organisms is worse. We just estimate species or percentages of the planet: 400 species a year become extinct prematurely, or 50% of the wetlands in the planet are modified or destroyed, or 50% of coral reefs have been damaged or destroyed. If we were to personify the damage, we would have to say that Gaia is being raped and slowly murdered.

The earth does not need to be saved or healed, as if we could do either. The ways of life that we remember and prefer, the places that depend on other species and natural processes—these can be saved. Our own divided minds, that let the poor be enslaved by the wealthy, that let 'good' animals be domesticated and 'bad' animals be eradicated, can be healed. The sacrifices will have to be great; the changes will have to be radical. But, only then will the congratulations and celebrations be meaningful.

Some of the catastrophes we face are very slow, very large, long-term and invisible (to us). The challenges, losses and catastrophes are expanded in Volume 1, *Redesigning the Planet: Foundations*). We need to propose and execute local policies to steer change. We do not have time to look at all the information that we have collected, or to convert it to knowledge. We never have had time. We cannot connect with all the information flows. So, we will have to act as if the information we have is enough for wise decisions.

We have many tools that we can use to respond to challenges. Tools play a central role in the thought world of a culture; They are not simply integrated into culture; they actively reorder the culture. Many tools, such as language and myth, are general and often used. Metaphors and are useful for understanding complex systems. Other tools include questioning, identifying gigatrends, and making scenarios. A few are presented in more detail: Thought experiments, Synthesis, and Ecological education.

1.1. *Naming & Modeling with Metaphors*

Many words began as metaphors, useful for extending the understanding of something by calling it something else. The concept of metaphor has been defined and used for over twenty-five centuries. Metaphor is used in all advanced languages. For Aristotle, metaphor was a trope, the 'turning of a phrase' (The word metaphor comes from the Greek word that means 'carrying beyond'). Aristotle was one of the first to say what it represented in words: The process of transferring a word from one object of reference to another.

There are two principles governing the creation of a metaphor, according to Max Black: First, the just disclosed phenomenon is given the name of a previously identified one that resembles it, and second, this resemblance is discovered in the most 'essential' aspect of the new phenomenon, which calls forth a direct perceptual experience, already named. That is, a metaphor furnishes a label and emphasizes similarities between a known thing and an unknown one. It not only defines and extends new meanings, but also redescribes domains seen already through one metaphoric frame.

Not only are the two concepts altered, but also the meaning of the concepts is altered. And this 'halo' meaning, in its unique reducibility, permits things to be said that could not be said otherwise. In the secondary and primary systems—for example Karl Popper's phrase "the brain is a computer"—opposites interpenetrate and are unified even though the metaphor is initially and cognitively perceived as absurd. Metaphors emphasize likenesses between things, living things, languages, or human constructs. A visual representation of a metaphor can be a model. Modeling can be done with metaphors as well as with shapes and numbers.

1.1.1. *Metaphorical Models: Traps & Filters*

Karl Marx contended that we live in cages, part natural and part made, although human actions could modify them. The word cage is a metaphor; it implies being trapped. It is, however, a metaphor that can be expanded with a description in space as a four-dimensional box. Perhaps there is a better metaphor, since we depend on nature and society as a foundation for life, that of a trap. The word 'trap' is from the Old English 'to step.' A trap is a device for catching and holding animals or a stratagem for catching people. The idea of a trap can be related to the idea of closeness to limits or to the overconnection of links.

Taken in four dimensions, a trap can be a serial trap: The use of resources by a people, where the replenishment rate is constant and the rate of use exceeds it. This trap results in ecosystem degradation that is less reversible.

A filter is an interesting metaphor. For organisms, the environment is a filter that allows some characteristics to continue, by providing opportunities and challenges. Selection operates as a survival filter that passes any structure than has sufficient integrity to persist. Organisms put together structures based on historical patterns, and move through a filter of limits like minnows through a fish net. Perhaps, the idea of a filter is too passive. Perhaps a better model might be a kind of dynamic mutual sorting filter, a mutual filtering of organisms and environments. Organisms and an environment co-order each other, sorting things out in a mutual process of activities and adjustments. In the next largest system, ecosystems are also filtered or interactively sorted. That may be a very basic filter.

These mechanisms are only parts of a culture. There are some parallels with biological evolution, especially if we use memes as the unit of transmission. The structure of cultural filters is a meme construction that is robust. Memes are still filtered by the mental environment for fitness to that environment, although in this case the filters are partly due to memes. The scale of replication is related to positive feedback, as when a work of art fetches great sums of money or is popularized from controversy. The information that is transmitted is in form. Culture is more than a simple filtering or sorting process. It is more than a formation process. Because it occurs with physical, living, conscious, and social systems, culture is more like a 'novation' process, that is, it recombines things into new orders. The models of trap, filter, and sorter are used in subsequent discussions.

1.1.2. *Conceptual Models & Scenarios*

Models can be constructed with a series of verbal statements or with a combination of statements and mathematical equations, using data. There have been many such models of the world system recently. Each model gathered data, analyzed it, and made a set of predictions based on the data and analysis. Each of the models also recognized having very general problems. We have separate kinds of models related to plant productivity, human population, and world games. We can try to generate models dealing, not only with the more constant of natural and human characteristics, but also with the limits of certainty and the vagaries of change.

Instead of describing models and thought experiments, perhaps, we should be creating 'scenarios,' a word associated with plots and summaries. In trying to redesign local systems, we need to incorporate stories and social understanding with the sciences and designs. A scenario could let us explore plausible approaches to complex patterns. It would let us incorporate the perspectives of other cultures as well as quantify common requirements. A shared scenario would emphasize the transformation and construction of healthy future states and then allow everyone to participate in the creation and make sure that their perspectives and values are represented.

An important first part of scenario construction is the process of imagining alternatives and then filling in the principles related to transformation and management. Another part is to create strategies to describe the course of action through specific practices. In *Our Common Future*, from the United Nations world commission on environment and development (the Brundtland report), the authors concluded that the positive effects of technological adjustments, such as recycling and energy efficiency, were insufficient to realize any kind of sustainable basis.

Scenarios have been used before, traditionally in threes, beginning with the "business as usual" scenario, probably ending in overshoot and catastrophic collapse, and the "streamlining the existing system" one, also most likely ending in some form of collapse. Usually the third scenario presented is "transformational utopian change," which involves completely regimenting society and then preserving the environment in one form. Usually this is recognized as idealistic and unrealistic. The alternatives range from capitalistic individuals or a new tribalism to technological utopias or sustainable empires. However, by basing redesign on current cultural standards within a global cultural framework, we can avoid having to engineer human existence. We can modify world-images and behaviors, within a frame of standards and practices.

Scenarios have to consider all the factors determining the future, including change (the speed and rate of change), the momentum of the present (masses of people, habits and investments), and conscious adjustments to environment and society. Scenarios have to recognize the complexity of civilization and technology, as well as the increasing costs of the maintenance of the complexity. Scenarios have to address risks from external environments well as from technological change. They have to anticipate surprises from trends and catastrophes. Many of these factors can be ameliorated by design. Some can be avoided by design.

1.2. *Questioning Things*

Questioning has a long history in human experience. The Greek philosopher Socrates was one of the more renowned questioners. He approached teaching through a disciplined, rigorous dialogue with people he met on the street, sometimes by accident or often by design. Socrates tried to get others to recognize the contradictions in their ideas; he assumed that incomplete or inaccurate ideas would be corrected during the process of questioning, and hence would lead to progressively greater truths. He never seemed to reach an end to questioning, however, perhaps because there was no end, that is, the process of questioning could refine any kind of knowledge or ignorance, indefinitely, or perhaps because by itself questioning could only do so much with definitions and concepts. His method was a common search, through conversation, for the goal of truth.

1.2.1. *The Socratic Method*

Socrates asked questions as part of a conversation with others. He seemed concerned with discovering what the opinions of others were based on, an invisible truth that could be made visible with questioning. The questioning forced the other participants in the conversation to try to agree on the truths beneath the opinions. Socrates professed ignorance of the truth himself, in fact or in pretense, ignorance being the first step in the pursuit of knowledge. He expressed skepticism that the other conversationalists actually had real knowledge. The process of questioning subjected opinions to real examples from real experiences—an empirical method—leading to a more general concept—this is the process of induction used in a scientific, homogenistic logic—and then the consequences of the definition were drawn out, through deduction. These definitions were refined by further questioning until all members of the conversation had a better grasp of the concepts. Through thorough questioning Socrates demonstrated that knowledge was quite often uncertain. There was no absolutely certain knowledge. Questions were also meant to examine life as well as belief and truth, and to show that often people were ignorant of their ignorance. Socrates held that disciplined questioning enabled the other to examine ideas logically and to be able to determine the validity of those ideas.

1.2.2. Hardin's Extension

For Socrates the goal of knowledge was the acquisition of concepts, such as justice, courage or wisdom. He thought that the truth could be contained in a correct definition. And, he was groping for more abstract definitions. This became a problem, as abstraction became removed from the specifics of living. Socrates was most concerned with examining concepts, but concepts are a small part of reality. Of course, constant questioning of concepts can expose the psychological basis of concepts, and perhaps that is what Socrates meant to do.

But, questioning concepts often reaches limits fairly quickly. Socrates never offered any answers, although he assumed that an absolute certain knowledge was possible to become established eventually.

The ecologist Garrett Hardin used questioning to illuminate partial knowledge and to track connections between things. Questions establish the limits of assumptions and perspectives. They can clarify the focus of a problem and test evidence related to any problem. Questioning can be used as a device to focus on a specific problem, not only the extent of the problem, but its aspects. Questioning can also be used to explore specific aspects of the dimensions of thought. Of course, questions can refine the process of critical thinking and can allow refocusing in a wider or narrower context. This type of questioning arrives at answers as workable hypotheses or guidelines for making decisions about operating in the world. Without certain knowledge, however, we can make adaptive decisions, based on partial knowledge. His questioning took on the form of asking what happened then, after an answer was arrived at. "And then what?" Hardin asks. Questioning works in a conversational way by weaving ideas. Konrad Lorenz decided that humanity would indeed have destroyed itself by its first inventions, were it not for the very wonderful fact that inventions and responsibility are both the achievements of the same specifically human faculty of asking questions.

More than an annoying part of a conversation, questions are legitimate ways to approach a known or unknown situation. More than just a way to turn around a conversation, questions are tools that allow you to surround a topic and define it more completely. More than simply an admission of ignorance, questions can form a phenomenological spiral that allows you to return to a subject from different perspectives with different levels of understanding.

1.2.3. *Maslow's Questioning of the Norms of a Society*

Before designing a good society, certain normative questions must be answered. These tentative answers are based on those questions first suggested by the psychologist Abraham Maslow. The questions have been slightly modified before being answered briefly. Is the norm to be universal, national, subcultural, familial, or individual? The norm could have universal elements, not only for humans but also for all species impacted by humans. Maslow assumes that different norms must be on different levels, depending on the context. For example, there would be some universal human behavioral standards, but special local expectations, to conform to various cultures.

Should society be selective or unselective? The society should be unselected. It must account for all human variability; and accept it when possible and treat it when necessary. It would have to account for prisoners and misfits. The society should be pluralistic, and accept and use individual differences in constitution and character. Humans are not interchangeable; the insane and aged must be considered. It must integrate all people into a society or work in that direction.

Should society be pro-something or anti-something else? Society could be proindustrial and pro-scientific, within the set limits of the society and the planet. But, industry must be properly scaled; and science must be cautious. The size of community cultures could be limited by function.

Should it be centralized or decentralized? The global unit could be centralized, electronically, at least, and socially planned; but individual cultures could be autarchistic, based on self-reliance and interdependence. Both should be flexible. Regions could be centralized for some functions.

Should society be tolerant? Society must tolerate all cultures in the nations. Each culture would determine styles and complexity for its individuals. It could aim for taoistic noninterference, but be available for help. What should be done about injustices? Biological injustices exist and can be ameliorated; social injustices can be rectified, but the society would have to have the apparatus in place.

Should society determine family attitudes? Family or sexual attitudes can be institutionalized by the culture. All group adaptations would be determined by culture. Should society be open to more than one religion? Society can tolerate any institutionalized religion, so long as it does not impinge on other groups. The spiritual life is a necessary part of a society.

How should leaders be chosen? Leaders within a culture could be chosen by traditional means, within the limits of human laws. Leaders of the international framework could be chosen by global referendum from the ranks of cultural leaders. The leaders would determine the relation of truth to people—who shall know how much about what and when.

For what is an individual responsible? The individual is responsible for the style and simplicity of their life and for its effects on nature and society. The individual is responsible for being tolerant of others, and is free to make many kinds of choices.

How these questions, and many others, are answered partly determines the shape of this project.

1.2.4. *Questioning Ourselves*

Things seem so confusing and contradictory, we have to keep asking questions about how things are done, for instance about old standards for the sizes of pipes or the lifetime of a tool. We have to question lifeboat politics, with its implications of gender, class and race values and inequities. What are the full effects of plastic wastes in the ocean or on ocean species? Behavior is determined by immediate personal consequences (short-term egoism), regardless of long-term consequences in modern and ecological systems. How stable is poverty in the midst of wealth? Why are we not trying radical designs like arcologies? Some of these questions can be answered by further questions. Will the technology harm the environment? Will the process waste energy? Does it use exotic, composite, dangerous materials? Does it really contribute to our welfare? How can land and people be used well, or what is a good use? What is good knowledge of good work? How can one be honorably native to one place? When will we learn that neither art nor science that can be neutral? What are the risks of consuming now? Losing self-respect, seeing the collapse happen? There is an implicit larger question, once asked by Arne Naess: What is the role of humanity in the destiny of the planet? Then again, what are the risks of acting in unpopular ways? Being ignored? Losing status or being assassinated?

One serious question is what to do with those nonindustrial cultures that choose to continue to be nonindustrial. Should we make a park for them? Should we isolate them in some way or have some kind of boundaries that sort the technology that they can use? Maybe the word Park is not the best way the best word since they are not zoological specimens and maybe we cannot save them that way, but what we could do is allow them to create the boundaries they want.

Urban intensification leads to the question: Is there a limit to human numbers? Perhaps space, but is there a psychological limit? People in cities seem to do well with high-contact, high-proximity living. What happens when people are crowded or feel crowded? Physical complaints, emotional complaints, sexual dysfunction, or feelings of fear, seem to be expressed often. There may be limits of crowding. Are there social limits, in terms of the number of people one can tolerate? We may have a requirements for personal space, home space, and wild space.

So one question is why do we consume so much? Why do we consume some things and not others? Overconsumption is a very destructive pattern and the pattern is his defined by deception and lies. Our entire society now focuses on spending. For psychological reasons as well as economic ones. The banks do not help either with their campaigns to push second mortgages that higher interest rates. Tim O'Reilly suggests that more than real estate bubble we need to be concerned with the reality bubble.

As Speth notes, the fundamental question is how can the operating instructions for the modern world economy be changed so that economic activity protects and restores the natural world. He uses modern capitalism in the broad sense as the actual existing system of political economy as it stands, not as an idealized model.

Maybe, we need a big, formal program for questioning. Clarke suggests that we parallel David Hilbert's program for advancement and mathematics—the list of 23 problems to be solved by the mathematics community. We should have our own Hilbertian program for the Earth system. This includes analytical questions, normative questions, operational questions, and strategic questions. For example, a first analytical question is: what are the vital organs of the ecosphere? Another analytical question is: what are the characteristic regimes and time scales of dietary variability?

A normative question would be: what are the general criteria for distinguishing non-sustainable paths? Or, what kind of nature to modern societies want? An operational question is: What is the optimal mix of adaptation and mitigation measures to respond to global change? A strategic question is: What are the optimal goals for dividing the planetary surface into natural reserves and managed areas? What might be the most effective global strategy for generating and integrating and data sets? A final example of a strategic question is: What is the structure of an effective and efficient system of global development institutions?

We want the conventional system, with its 'humans first!' motto to lose its hold on our minds. To get to the heart of it, to weaken its grip, we have to attack the weakest point. And that is the questions of meaning and value. How meaningful is it to shop? Where is the value in eating Kobe beef? Is this radical enough? Ecological enough? Perhaps we have become trapped by too much cheap energy to question things. We have benefited too much from cheap materials and cheap labor. We have benefited too much from too cheap food. This lets us break our faith with places. So how do we establish standards for places? Instead of profitability we should have health; instead of professional excellence we might have the durability of the community. Along with Wes Jackson, the idea of homecoming must include homemaking, especially now, dealing with remnants in ruins.

Can we design our way out? How can we act if we are ignorant? So far, we have not reduced problems and dangers by gathering more data, creating more theories, or by being cautious about industrial production. Ignorance is a problem. Another is that we cannot live without acting. We have to act on the basis of what we know, which is incomplete. So the question of how to act in ignorance is very important. We can act on the basis of incomplete knowledge when our culture has an effective way of telling us that the knowledge is incomplete and how we should act in the state of ignorance. Unfortunately it is also possible for incomplete knowledge to become the basis of arrogant behavior and dangerous actions. The standards of our behavior should be derived from understanding of our place and communities before incomplete technological knowledge. One conclusion we could make especially regarding uncertainty is that we could reduce the number of problems if we simply live that levels slightly below the lowest level of uncertainty, or the lowest absolute level productivity, of ecosystems.

Design cannot be separated from social and political questions. Designs, as Winston Churchill recognized, especially buildings, steer our experiences and actions. According to Langdon Winner, design includes the deliberately chosen, enduring forms of both material and intangible entities that affect human relations. Ecological design is a field that aims to recalibrate what humans do in the world according to how the world works as a biophysical system and a cultural entity. Design in this sense is a large concept having to do as much with politics and ethics as with buildings and technology.

Design has to be about more than making things, it has to deal with systems in context. Or poses questions for design: does society have to be organized differently to be capable of doing ecological design? What would this society look like? Do we need to did redesign institutions to be capable of doing ecological design?

Perhaps there is a model of questioning that could serve a large movement. In terms of procedures for management, the U.S. Navy has a workable program for questioning. Because the officers and enlisted men serve for a very limited time, the Navy system seems to be chaotic, but it has been tested and it has evolved over generations the system manufactures safety and efficiency even though there are numerous mistakes under new circumstances and there is a wide range of skills among the crew. Having a crew participate in questioning the actions of officers serves several purposes. One of them is to keep everyone in touch with the activity, providing redundant checks on actions. This increases safety, so that errors can get detected before they become much larger. But newer crew have a lot to learn in these discussions and criticisms of service training exercises. New crew also do not have the experience of older ones. They are not as efficient, and they are not always knowledgeable about what to do, Since they need guidance, this process is quite sensible. It minimizes accidents. Considering that the Navy operations are often dangerous, at a fast pace and under high stress, there are relatively few fatal errors. If the Navy were to follow formal procedure in a strict hierarchy that accident rate would probably rise. One of the problems for society is that we do not have similar procedures for normal situations, so we seem to feel that we can make errors, and in the end we will not have a high price.

Some people will want to decide boundaries through culture, watershed, or political power. These questions can be answered in meetings. This outline seeks to improve people's circumstances by enlisting them to save their own environment and their own way of life. Democracy itself is kind of like a thought experiment, where questioning and conversing about disagreements and disasters allows us to experiment with them, and our responses to them, before there is real conflict and real suffering. Even if the real disasters are not prevented at least they have been addressed. Dissent occurs within the context of loyalty. Freedom is expressed within a context of law that limits it and protects it. The democratic system can avoid runaway feedback. Anthony Barnett asks if there is a fourth kind of democracy now, reflexive, direct and large scale, made so by rapid news and easy communication.

Questions widen a narrow field. Hardin points out that concerns about narrow issues, such as pollution, can cause a deep examination of the process, such as distribution theory, that cause or contribute to the issue. Human activity simply produces things that we want and things that we do not want, such as pollution. As we ask questions about who pays and who benefits, we are able to think or rethink about these things.

Questioning can get to the basis of any conversation. But, questioning can also frame and direct the conversation. Questioning also provides feedback for any answers. Therefore, questions will be a critical part of the approach to design. In terms of stimulating learning and creativity, questions are sometimes more powerful than answers.

1.3. *Performing Local Thought Experiments*

Humanity is engaged in a great experiment with the planet. We are replacing large, old, complex ecosystems with young, simple fragments, in which fires are suppressed, large predators are removed, large herbivore populations are encouraged, exotic species are introduced, soil is compacted, and excessive biomass is removed—all for the purposes of increasing the amount that can be harvested for human use. Our radical cultural experiment to dominate the planet comes from strengths that allowed us to survive rapid climactic changes during and after the ice ages. The ideas that are guiding us, the strategies we are using now, however, are obsolete; they worked effectively under less complex conditions, at lower population levels, but not at high populations on a global scale, where domination leads to ecosystem interference. This is the making of tragedy—applying strength in an inappropriate context.

We are also burning massive quantities of fossil fuels; this is a one-time, large-scale geophysical experiment that could not have happened in the past and can never be reproduced in the future (according to R. Revelle and H.E. Suess, 1957). Our actions are experiments, whether we want them to be or not. Unfortunately the experiment is not only bad science—there is no control planet—it is ill-considered. This experimental course, which may be global and irreversible, cannot be unmade, not by planning or science, much less by our standard methods of ignorance, cupidity, or denial. This section suggests the kinds of thought experiments that might guide large-scale, long-term designs, which could alter the direction of the great experiment.

There must be a way to refine the experiments, to minimize our impacts, to be less reckless, and to anticipate the outcome of our experiments before we finish performing them. Not all experiments must be physically implemented. Albert Einstein and Leopold Infield suggest that knowledge of laws can be gained through the contemplation of idealized experiments created by thought, *Gedanke-Experiment*. For example, to address the equality of inertial and gravitational masses, that is, how the problem of general relativity is connected with gravitation, Einstein imagined an elevator at the top of an incredibly high building, and then imagined what research could be done in this local environment. Such experiments might seem “fantastic” in his words, but they might help us understand things.

Although ecosystems and political orders are orders of magnitude more complex than physical systems, perhaps we could imagine and use such experiments to help us understand what is happening with our complex planet that is composed of many interlocking ecological systems. Thought experiments can give us clues about what can happen and what is the likelihood of that happening. ”And then what?” asks Garrett Hardin again. Unlike medical doctors or scientists, we cannot either wait or directly experiment within a realistic time frame or scale. We cannot experiment at all in a traditional sense, where we hold most variables fixed, while changing one or two variables in experimental runs. Ecosystems operate over very long time spans; furthermore, their historical nature means that they cannot be restarted for tests.

1.3.1. *A Sample Small Thought Experiment*

We can outline a few kinds of thought experiments. The first, on roads, is for the nation of Bulgaria, but could be extended to the Balkans. The next experiment calculates the services and the number of arcologies needed to house the human population of one local place. The thought experiments presented below are incomplete, but suggestive of the kinds that we could be creating and manipulating to guide our plans and models.

An experiment can start with a question: What if we limited the number of roads in Bulgaria? Bulgaria has many roads, although politicians, as well as business people and drivers, are asking for more, wider, smoother, and direct roads. Cities want better roads leading to their centers. Forestry managers want more roads into forests. Resort areas want more roads leading to the sea or mountains. Economically, roads can stimulate income, at first. But, there are other ways of looking at roads.

We can look at roads with an ecological perspective. As a science, ecology describes the interrelationships of organisms and environments, that is, the experience of living together in the biosphere. But, ecology is also a way of 'seeing' that human beings are participants in nature, as part of the food chain, for example. People, like most mammals, use roads (or paths) to get from one place to another, to get supplies, to visit others, or just to look around.

This is a fine use of our technology. It allows us to increase our horizons and better our lives. Better roads make traveling more efficient. There is less waste of oil and gas, and less wear on vehicles and their occupants. But, every technological innovation in vehicles either requires or makes roads. And, roads have effects that go far beyond the movement of people.

New roads lead more people to new places, thus changing the characteristics that often make those places attractive (e.g., being off the road). Roads increase the flow of things between points. But, too much flow (of matter, energy or form) can destroy biological relationships and diversity. Roads are a major force in fragmenting the habitats of plants and animals. Many animals cannot live near roads or noise or human activity. Many animals and plants need large areas to roam and roads cut into their areas (although, highway routes and underpasses can be modified; for instance Britain builds underpasses for frogs). Roads directly affect natural and human communities in many ways, causing:

- Changes in populations of animals or plants that cannot cross them (isolation)
- The spread of organisms that use roads to colonize new areas with plant or insect or animal pests (that is, things that are out of place)
- Problems with erosion
- Problems with spreading trash (other things out of place)
- Changes in hydrology and wetlands
- Changes in social circumstances. For instance, private cars changed public morality in America. Many kinds of crime are increased, for instance, bank robberies, if there are fast roads nearby with easy access.
- Changes in economies, as new roads bypass old routes.

Many countries answered the demands of their citizens, business people, and politicians (and ignored the environment) by building bigger, faster roads. Then as people crowded on the roads, they get more crowded and slower, and the demand for bigger roads rose again. Many countries have found that building more and larger roads does not solve the problems of congestion, accidents, and danger. These problems have a lot to do with the kind of transportation on the roads, that is, cars, trucks or buses.

Maybe Bulgaria should have a new autobahn and maybe all the roads should be upgraded. But, it would be better if it were part of a plan for the entire country that considered population movement, the needs of all the people, and the best forms of transportation. Buses and trains are far more efficient than private cars, and many countries are rebuilding their train and bus routes, from Brazil to France and Japan. By concentrating on a good public transportation system, and limiting the influence of private cars, Bulgaria could become a good model for them to follow.

1.3.2. *A Larger Experiment: What If One Locale Was an Arcology?*

Using the locale of Sarasota County in the US State of Florida as an example, the entire population could be put in one small arcology, and this move would have serious consequences for all dimensions of the locale. One would be to reverse the trend of simplifying wild ecosystems. Another would be to concentrate human activities. It might also limit human impacts. And, it is possible that homelessness would be reduced.

Historically, human hunting altered ecosystems, then human gathering and planting converted forest, grassland, and wetland ecosystems to agroecosystems that had to be managed. Now, the expansion of urban areas with roads, power grids, and other infrastructure, is interfering with the basic functioning of many ecosystems. Modification, conversion and destruction of ecosystems disrupts the complex interactions within and between ecosystems, the hydrology, soil structure, topography, and the predominant vegetation; it changes the complement of species, and it causes a loss of diversity. The new replacement systems are simpler, less mature, and less diverse.

We have achieved great horizontal growth, much like a gigantic fungus. However, if we want to be like a smarter fungus, slime molds for instance, we need to learn to cooperate to grow up and be more dense and vertical. The larger metropolitan regions are covering wild ecosystems and agricultural fields with single-family houses, malls, building, recreational areas, and roads—all of which are car-centric or auto-morphic. This means that energy and goods are also spread thin. Such systems of things are hard to control, hard to keep safe, and hard to remain interesting. In fact, it might be worthwhile to compare human systems to mature ecosystems; we are creating pioneer individuals that do not live well in concentrations. We are creating edge individuals and not those who can live in interiors and share resources, or can develop new resources with cleverness and intelligence. City designs do exist, however, which incorporate the properties of mature systems and ecological thinking.

An arcology, as defined by Paolo Soleri, is a city which embodies the fusion of architecture with ecology. The arcology concept proposes a highly integrated and compact three-dimensional urban form that enables radical conservation of land, energy and resources. Arcology eliminates the automobile from within the city, and with it, the fifty percent of land devoted to automotive needs. The multi-use nature of arcology design would put living, working and public spaces within easy reach of each other and walking, supplemented by elevators and airport things, would become the main form of transportation within the city. An arcology would use passive solar architectural techniques such as the apse effect, greenhouse architecture and garment architecture to reduce the energy usage of the city, especially in terms of heating, lighting and cooling.

The small footprint of an arcology, combined with many built-in gardens, would allow rural space and agricultural fields to be closer to the city, and a part of the immediate urban environment. Wilderness, also, would be much closer to population centers in arcologies. Psychologically, the intelligent design would be more conducive to inspired living, the kind found in traditional culturally-significant cities that characterize certain times. The proximity of agriculture and wilderness would allow people to participate more in them, with the full range of benefits that comes from growing and cultivating plants, as well as being able to immerse in the otherness of wild ecosystems.

The sizes of proposed arcologies range from 250,000 to almost a million people, although smaller or larger ones are possible. Paolo Soleri's proposed Novanoah was designed for 400,000 people. One arcology of that size would hold the entire Sarasota County population of 393,000 (2012). It could be located at one of the three large cities in the county, Sarasota, Northport or Venice. Some agriculture would be practiced in and on the arcology; other fields would be east of the arcology. Some recreation and all golf courses would be near to the arcology. A large part of the rest of the County could be restored to native ecosystems. Some smaller towns might continue in their current form, for special economic or cultural reasons.

Assuming that the area under the arcology is about 5 square kilometers (almost two square miles), the surface area taken up by the arcology would be only 0.0028 percent of the land area of the county—that is under 3 thousandths of one percent of the land area and about 1 tenth of one percent currently under concrete and asphalt. The number of roads would be significantly reduced. Over 2 percent of the land is under road surfaces in the United States, with a smaller percentage in Europe, by comparison. Land under agricultural production would also be reduced, partly due to improved practices, partly due to the integration of many kinds of agriculture into the city, and partly due to the carefully limited use of wild populations, without domestication or containment.

However, due to historical settlement patterns, residents may vote to have 3 smaller arcologies at Northport, Sarasota, and Venice (See the example of the Floating City of Venice Arcology in this book). That might decrease the total area under concrete, although it might increase human impacts on the County. The shapes of arcologies could be diverse. Many of Soleri's shapes are geometric. They could be large pyramids, filled with living and working spaces, connected by transits and illuminated by light wells. The traditional ziggurat modernized would offer a good ratio of sunlight and truck gardens to size. Arcologies could be empty tubular pyramids with modular dymaxion attachments that could be moved between arcologies or new sites. Or, they could fit the shape of the landscape.

What would such a change mean to most people? Probably, few people would have the need for private cars. A typical day, for most workers, whether administrating, grading papers, policing, or making steel, would start with a walk to work, past local stores and businesses, playgrounds, and microfactories. Work would involve fewer layers of hierarchy; the pay range would only be from 1 to 7 times the minimum salary.

Since Soleri's heroic designs, arcologies have been confined to computer games and have become elements in science fiction and cyberpunk films. With more prototypes being designed, one may be built in the next twenty to thirty years. A proposed project for Tokyo Bay, the Shimizu TRY 2004 Mega-City Pyramid, if constructed, would become the largest artificial structure on the planet; it would be 2004 meters tall and house 750,000 people. The external structure of the pyramid would be an open network of megatrusses, carbon nanotubes to allow the pyramid to withstand environmental stresses. The trusses would be coated with photovoltaic film to convert sunlight into electricity and help power the city. Separate buildings for housing and offices would be suspended from the supporting structure with nanotube cables. Transportation would be provided by accelerating walkways, inclined elevators, and a Personal Rapid Transit system inside the trusses with individual driverless pods.

The Sarasota Arcology(s) would be part of a whole package of changes, brought about by ecological planning on every scale from local to global. The experiment would not require that arcologies replace archaic populations living in human-modified ecosystems, or even all low-density habitations or traditional cities. But, they could be new cities situated in infertile areas to release good soils and sites to wild ecosystems or agriculture.

Heroic design and extravagance in life is needed in general. It is not contradictory or antithetical to frugal lifestyles or to restoring a healthy environment. Life is exuberant; energy is used, lives are lived and used, not wasted or saved. Life is the accumulation of individual experiences that cannot be saved, stored, or owned. The heroic things in life are often those most admired or remembered by subsequent generations.

1.3.3. *Conclusions: And Then What?*

Thought experiments can give us clues about what can happen—"And then what?" as Garrett Hardin always asks—and what is the likelihood of it happening. Unlike medical doctors or scientists, we cannot either wait or directly experiment within a realistic time frame or scale. We cannot experiment at all in a traditional sense, where we hold most variables fixed, while changing one or two in experimental runs. Ecosystems operate over very long time spans; furthermore, their historical nature means that they cannot be restarted.

Large-scale, long-term experiments are expensive and relatively few. Most experiments are short-range, small-scale, isolated, and detail dense. They do not present the hypotheses required for the management of ecosystems. Ecosystem management, because of uncertainties, lack of controls, age, and uniqueness, is an uncontrolled, large-scale experiment. Thought experiments can refine the design of our larger experiments by suggesting better hypotheses.

Thought experiments can help us avoid being overwhelmed by details. Thought experiments can help formulate goals and interpret information appropriate to scale. The idea of science is to manage our experiences with generalities. Once the thought experiments are started they can be refined with conceptual or mathematical models, which can simulate the changes and evolution of changes. Computer-based models can permit complex explorations, as well as suggest new patterns and further hypotheses. Through thought experiments and models, many of the dangers and expenses of our activities can be avoided.

Thought experiments are vital to understanding the complexity of ecosystems and global cycles. In practice, erring on the side of preservation—the prudent and conservative course—means minimizing the influence of human activities on the land. It means experimenting cautiously with new approaches to forestry and being properly skeptical about claims for sustainability. It means drastically reducing our demand for natural products, through conservation, reuse, recycling, and human population control, so that the greatest number of ecosystems can be left wild and degraded lands have time to be restored to health.

Thought experiments can also be used to examine possible scenarios of the future based on our actions. For example, if we continue the current trend of inequity, how might things play out? For example if the rich keep getting richer, how will they have to protect their wealth from the poor? Will laws be enough? Will they need ever-larger armies of security personnel? Will the poor collapse, leaving rich enclaves that have to grow their own food? At what point will the gap be wide enough that the poor try to harvest the wealth of the rich by force? Will the poor prey on each other first? At what point will the environment be used entirely for a few more years of life for rich or poor humans, before it collapses?

Will local groups, such as the northern hemisphere, form alliances to keep going, after writing off other regions or the southern hemisphere? Will this block be able to defend its resources? Will that extend the time of any collapse? Or accelerate it? Will the United Nations be able to coordinate some kind of peaceful reorganization? Can a revitalized UN guarantee a rational economic and political strategy for all nations? Is it utopian to think of such reorganization or redistribution for equity? Is this less naïve than allowing the market to sort out entire cultures and regions and consign them to poverty and violence?

Thought experiments will be suggested throughout this work. Some of the chapters on wilderness, population and design are, in fact, thought experiments. Most of the suggestions for designs are thought experiments. The best response to a question about what would happen as a result of some actions under some circumstances may be a thought experiment. Through that, you can create explanations and discover answers in a dialogue with others.

1.4. *Systems Synthesis & Other Tools*

1.4.1. *Systems*

A system is a set of things—such as people, cells, molecules, or elements—according to Donella Meadows, interconnected in such a way that they produce their own pattern of behavior over time. The system may be buffeted, constricted, triggered, or driven by outside forces, but the response is characteristic of the system. A system is not just a collection of things. It is an interconnected set of elements that is coherently organized to survive. Systems can be distinguished into three parts: Elements, connections, and function (purpose). Functions are harder to see than connections, and connections are harder to see than elements. A system is a way to explain part of the universe and to deal with complex behavior. Mario Bunge defines a system as a complex object, every part of which is connected with other parts of the object in such a way that the whole possesses emergent properties that the parts lack. The parts of the unit keep its structure and function stable, despite changes and disturbances in its surroundings. Intrasystem bonds are stronger than intersystem bonds. If they were not, the system would fall apart.

In biological systems such as organisms, ecosystems, or the biosphere, most parameters must stay under control within a narrow range around a certain optimal level under certain environmental conditions. The deviation of the optimal value of the controlled parameter can result from the changes in internal and external environments. A change of some of the environmental conditions may also require change of that range to change for the system to function. The value of the parameter to maintain is recorded by a reception system and conveyed to a regulation module by an information channel.

Biological systems contain many types of regulatory circuits, both positive and negative. As in other contexts, positive and negative do not imply that consequences of the feedback have good or bad final effects. A negative feedback loop is one that tends to slow down a process, while the positive feedback loop tends to accelerate it.

Material processes can produce conceptual objects, which are embedded in the processes embedded in webs of processes. Processes encounter each other in a functioning web of an ecosystem (with tangible and diffuse surfaces). Lynn Margulis qualifies her definition of an ecosystem as 'the smallest unit capable of recycling the elements of its membership.' For example, organic carbon can be expired, fixed, reacted, or transformed. This is done through the physiological activities of the members of the system, through breathing, enzymes, or some other way. Margulis adds that elements recycle faster within ecosystems than between them.

Global (or emergent) properties are possessed by wholes, regardless of components, as in "the territory of the wolf pack is eighty thousand hectares." This property emerges with the system and disappears if the system breaks down. It is an emergent property if no component of the system has it individually. History, structure and stability are emergent properties of an ecosystem. Role and scarcity are not. An ecosystem has emergent properties that are different from the sum of community interactions. They also affect biogeochemical cycles.

Any large system, such as an ecosystem or culture, is a high-order, multiple-loop, non-linear, feedback system. In such a system, feedback loops are the basic structural elements. Each loop is a circular path of interaction between several elements. Like many systems, cultural systems need energy for their maintenance. Social systems have all sizes and degrees of complexity. Governments are more complex than families. Systems can also be constituents of larger systems, like nations are part of the United Nations (UN).

The systems approach to culture allows us to consider specific dimensions of culture, from kinship to intellectual, economic and political culture. Cultural systems have all sizes and degrees of complexity. Governments are more complex than families. Systems can also be constituents of systems, like the United Nations (UN). Culture evolves. Cultural evolution depends on two things: How fast useful changes arise and how fast they spread.

1.4.1.1. Systems Models

The system has been used as a model of a field. As models, systems are useful. There are two theories of systems. General systems theory is a holistic description of the hierarchical order of nature as a complex of open systems of increasing complexity. J. C. Smuts described holism as the "whole is more than the sum of the parts." Ludwig von Bertalanffy, Arthur Koestler, Ervin Laszlo developed the foundations of systems philosophy and applied it to numerous spheres of inquiry. And, the second, cybernetics is a theory of self-regulation of those systems through deviation counteracting (negative) and deviation-amplifying (positive) feedback cycles. Norbert Wiener generalized cybernetics, feedback, and information beyond computer technology. Shannon and Weaver's information theory and John von Neumann's game theory are also fundamental contributions. Systems can be concrete or artificial, according to Irvin Laszlo. Systems can be described as physical, biological, ecological, and cultural. In fact, systems can serve as models of a field, ecological groupings (ecosystems), and human complexes.

1.4.1.2. Several Properties of Systems

Systems have properties, in fact, much the same as fields: Process (speed, flow), Autopoesis (self-making, wholeness participation form shape boundary), Differentiation, Integration, Constancy, and Development. Systems can also be analyzed in terms of operation, using the special terms of systems theory, such as feedback, connectivity (coupling or linking), and triggers (energy amplification). Some of these properties are critical when trying to design large ecological or cultural systems, especially limits, feedback and connectivity.

1.4.1.2.1. Limits

The word limit comes from the Latin word for boundary or frontier. It means at least three things: Boundary, utmost extent, either the largest or the smallest, and restriction. Thus, a limit is a point or line where something must end, or a boundary beyond which something ceases to be or to be possible. A limit may be unknown or invisible. Motion results in limitation. Limit is the essence of forms and patterns, which are defined by their limits.

Mathematically, the concept of a limit is fairly simple: It is something that is approached, but not reached, as some value descends to zero. In specific applications the limit is usually a number, that is, the rate of photosynthesis or the carrying capacity. Every finite system has limits. Systems have a limit in size, which may be determined by structure or the speed of turnover of components. Systems may have limits in terms of the number of connections that can be maintained with other systems. Any physical system, with multiple inputs and outputs, is surrounded by layers of limits. There are always limits to growth. A limit can be a threshold to a new system that may be less stable. If not system imposed, limits may be self-imposed or culturally imposed. Systems rarely have real definite linear boundaries. Connections ruin the neatness. The lesson of boundaries is hard for systems thinkers. There is no single legitimate boundary to draw around a system. We artificially create boundaries to simplify our problems and insulate our sanity. We need to be flexible to find appropriate boundaries to think about new problems and make models for understanding new problems.

1.4.1.2.1.1. *Local Physical Limits* (Freedom & Order). We have learned that there are physical limits to many physical phenomena. We cannot measure light going faster than a maximum speed. We cannot reach, even in theory, a lowest temperature of absolute zero. We see that certain masses of hydrogen cannot exist without exhibiting qualitative changes in form or temperature. The limits of the universe, like the speed of light or the quantum of a field, put limits on freedom; freedom is defined here as the absence of restraint or confinement, or the state of being free from rules or patterns. But, limits cannot be complete, any more than freedom can. The predictability of particular events within a larger aggregate of events is referred to as redundancy in information theory.

Random order is open; it has many degrees of freedom. Differences can be related to degrees of freedom. An order with more differences has more degrees of freedom. The macroorder limits the degrees of freedom in underlying orders. This implies that the universe is partially ordered and partially disordered. The distinction between order and disorder disappears when the domain of both is the universe. Freedom, as meant by social or political, also applies (see later discussion). Life and art require a balance of rules and freedom.

Systems are considered to be wholes where the internal connections are stronger than the external connections. There is no whole system without an interconnection of its parts, and there is no whole system without an environment. Everything is connected in a system; removal of any part alters the dynamics of the system.

1.4.1.2.1.2. *Local Biological Limits.* When it comes to biological phenomena, we notice that groupings of individuals cannot exceed a certain number before the group fissions. With human beings, we almost never have a permanent family group over 150 individuals. Individuals themselves rarely remember over 9 items at one time. These limits have to do with the characteristics of patterns that make up groups. The limits can be described in terms of the number and strengths of connections, as well as of limits of freedom.

Living consists of complex behaviors whose limits are defined by rules of order that can be empirically described. Biological order is built on physical and chemical orders. That is why life is limited to such a narrow range of conditions, as regards temperature, pressure and the composition of air or water. And, that is why the most complex orders are vulnerable to changes in their substrates; energetic radiation can alter and destroy an individual, a small change in climate can destroy crops and human civilizations. Complex orders always depend on simple orders.

Ecosystems and organisms depend on a complex set of conditions, which can be limiting factors. Organisms are affected by the quantity and variability of materials, if they require a minimum of them. Organisms are also affected by their own limits of tolerance to those materials. They are limited by elements and physical factors, such as light or water; it is limited by too little of an element, such as phosphorus—this is Liebig's law, or by too much of an element, such as salt—this is Shelford's law of tolerance. Every tree species has a lower and upper critical temperature, which limits their growth. Low temperatures prevent trees from absorbing the moisture needed for transpiration. High temperatures result in excessive losses of moisture.

Competition limits the number of species in a niche. Garrett Hardin states the competitive exclusion principle as: Complete competitors cannot coexist. Niches must be different for species. Krebs states that the fundamental niche of a species has an "infinite number of dimensions," making a complete determination impossible. Territory can limit breeding percentage. In some birds, less that 30% may breed. In wolves, only 60 percent.

Whenever there are too many replicating units for space and resources, whether genes, organelles, individuals, families, cultures, or species, some persist and some fail. Self-organization and co-construction of the organisms and environments allow selection to act on various levels at different time scales. More than one unit is selected. No one unit is the key. System complexity is a limit for rogue species, since all have the same building blocks.

1.4.1.2.1.3. *System Limits: Carrying Capacity.* The system itself has limits. It has a maximum biological load that can be carried indefinitely; this is the carrying capacity. This carrying capacity is usually considered to be the maximum population sustainable on a long-term basis of renewable and nonrenewable resources. Calculating a carrying capacity for many mammals is relatively simple. For instance, the number of caribou that could be supported on the North Slope of Alaska is basically determined by a long-term average of primary productivity, that is, food for browse, according to David Klein. Calculating an optimum population for human beings, based on caribou as a food source, is also relatively simple.

Carrying capacity can be defined basically in terms of energy. For instance, an adult human requires 2300 kilocalories just in food. For heat and clothing, more calories would be required; for transportation and shelter still more; and, for luxuries, many more. By 1990 the average American was using 2,300,000 kilocalories per day, 1000 times the minimum.

For humans, this carrying capacity must include domesticates, as human equivalents, since many domesticates compete for protein consumption. Carrying capacity calculations often just consider food energy, but all needs—clothing, shelter, transportation, information generation, aesthetic satisfaction—must be included. This introduces cultural elements into consideration, so human carrying capacity must be considered as cultural carrying capacity.

Cultural carrying capacity involves many more variables, such as luxuries, aesthetic space, the use of technology, the implications of images of place, and the idea of an optimum. Since an optimum is always less than a maximum, according to Eugene Odum, the carrying capacity would be reduced by as much as half. Many mammals adjust their numbers below a maximum capacity, especially when the variability of the system is considered. Wolves underutilize their resources, as do most mammalian predators, perhaps since the same level of resources are not always available every year. Because people use culture to adapt, a figure for carrying capacity has to be variable to reflect the changes in productivity.

Furthermore, the optimum carrying capacity decreases as the per capita use of energy and resources increases. Technology could expand the carrying capacity to some extent, with more efficient use and resource substitution, but it could reduce the capacity with unforeseen effects, from the use of pesticides for example. The optimum could be reduced more to reflect the possibilities of catastrophes; perhaps it has to be the lowest possible number to meet the worst conditions in a satisfactory way.

1.4.1.2.2. Feedback

Feedback is part of the science of cybernetics. When Norbert Wiener, Arturo Rosenblueth, and Julian Bigelow needed a name for their new discipline, they adapted a Greek word cybernetics, meaning 'the art of steering' to evoke the rich interaction of goals, predictions, actions, feedback, and response in systems of all kinds (the term 'governor' derives from the same root, after N. Wiener 1948). Early applications in the control of physical systems, such as aiming artillery, designing electrical circuits, and maneuvering simple robots, clarified the fundamental roles of these concepts in engineering.

A control system usually has input and output to the system; when the output of the system is fed back into the system as part of its input, it is called the 'feedback.' In cybernetics and control theory, feedback is a process whereby some proportion of the output signal of a system is passed (fed back) to the input. This is often used to control the dynamic behavior of the system.

There are two kinds of feedback, positive and negative. With positive feedback a system responds to the perturbation in the same direction as the perturbation (or deviation-amplifying, or error-amplifying, or cumulative causation, or destabilizing, or centrifugal). In contrast, a system that responds to the perturbation in the opposite direction is called a negative feedback system (or deviation-reducing, or stabilizing, or centripetal). A system in which there is positive feedback to any change in its current state is said to be in an unstable equilibrium, whereas one with negative feedback is said to be in a stable equilibrium.

The end result of positive feedback is often amplifying and 'explosive,' that is, a small perturbation will result in big changes. The feedback is deviation-amplifying (sometimes referred to as error-amplifying). This feedback, in turn, will drive the system even further away from its own original set point, thus amplifying the original perturbation signal, and eventually become explosive because the amplification often grows exponentially (with the first order positive feedback), or even hyperbolically (with the second order positive feedback). Indeed, chemical and nuclear fission based explosives offer an excellent physical demonstration of positive feedback.

Feedback is usually bipolar—that is, positive and negative—in natural environments, which, in their diversity, furnish synergic and antagonistic responses to the output of any system. Bipolar feedback is present in many natural and human systems.

Feedback is information directed back into system that causes a change. If there is too much positive feedback, then the system can overshoot an equilibrium. The concept of overshoot allows human consumption to increase at the same time that ecological capacity is shrinking. There is no contradiction, just a form of madness. Both are happening currently. There is no direct, immediate feedback to counter or correct overshoot apparently. The wastes become global, that is CO_2 can leave auto exhausts despite the concentration in the atmosphere. There is feedback, but it is delayed for a long time by the size, flexibility and redundancy of the system. Meadows notes that a person who makes a decision based on feedback cannot change the behavior of the system that drove that feedback. Decisions only affect future behavior. And, there will always be delays, since nothing can react instantaneously.

1.4.1.2.3. Connection

A system is defined as a complex object, every part of which is connected with other parts of the object in such a way that the whole possesses emergent properties that the parts lack. Systems are considered to be wholes where the internal connections are stronger than the external connections. There is no whole system without an interconnection of its parts, and there is no whole system without an environment. Everything is connected in a system; removal of any part alters the dynamics of the system. Connectivity is related to the size and density of a system.

Connectivity is related to the size and density of a system. To connect means to bind together, from the Latin words, or to link or couple. A connection is the relationship or association. A complete connection is regarded as a circuit, which becomes required for certain patterns and their continuation. A cycle is movement through a circuit.

The organization of an ecosystem is described by diversity and connectivity, among other characteristics. Every local system is connected to others some degree, but usually the degrees are very weak, through gravity, global chemical cycles, or just through patterns. Too little connection between parts and the system may fall apart. Too strong a connection between parts, and the system may not be able to renew itself through processes like metalysis, which requires that connections be broken and reformed. Too little connectivity and species are too independent; they can die (no food or prey). Too much connectivity and each species has to compete with all species; there is little flexibility to change. So it seems that connectivity must have regions of operation. Overconnection can be compared to power grid connections and failures. If overconnected, all can fail; if underconnected, many local areas fail; at a mid-range there can be power transfers.

In an ecosystem, individuals and species are connected in terms of quality and quantity of connections. The connectivity of a component of a system is a measure of the number of direct connections between it and the rest of the system. Connectance is a percentage of the number of connections through predation or exploitation as a percentage of the total number of possible interconnections. A system is more connected if the absolute number increases and the percentage and strength increases.

Functional connectivity is measured by the potential for movement, dispersal and interchange between populations of species, especially those subject to fragmentation. Connectivity in an ecosystem is a function of the mobility of a species, that is, its dispersal characteristics, its autecological characteristics, such as food or shelter requirements, the structural characteristics of the landscape, such as spatial patterns, the distance between patches, the presence of barriers to movement, such as highways or rivers, predation patterns, and disturbance patterns, including human interference.

The organization of an ecosystem is described by diversity and connectivity, among other characteristics. Every local system is connected to some degree, but usually the degrees are very weak, through gravity, global chemical cycles, or just thought patterns. By being overconnected a system can lose stability. Overconnectedness creates a lag in signals. Agricultural fields are good examples of overconnectedness. This is even more true with corn than with wheat due to the changes in the species from domestication. Overconnection causes greater lag times. But, in a city, food supplies damp food variations so the lag is less important. Under-connection can also create instability. Parts go their own way and there is no communication between them. If a system is underconnected, it may become unstable or lose resilience, because there is no pathway to allow a signal between significant parts.

The concept of diversity does not take into consideration the connectedness of the subsystems or systems. In addition, for each direct species to species relationship, additional bundles or sequences of indirect interconnected relationships spiral outwards logarithmically into the ecosystem and the biosphere as a whole. Indigenous peoples have names for many of these relationships, usually in verb form, such as pollinating, germinating, and shading. They understand and respect the importance and intelligence of species connectedness.

An ecosystem also has to be connected to global cycles, such as phosphorus. To preserve connectivity under uncertain conditions, it is necessary to maintain large areas of natural habitat in a larger matrix, as well as maintain natural connections and to minimize artificial connections, such as roads.

The connectedness of the subsystems or systems is necessary to understand some concepts, such as diversity. In addition, for each direct species to species relationship, additional bundles or sequences of indirect interconnected relationships spiral outwards logarithmically into the ecosystem and the biosphere as a whole.

At a critical point of connection, there is a phase change from a disconnected phase to a connected phase. This allows nodes to interact or communicate. That is, one location has the potential to affect another. Otherwise local events would only be felt locally. Global connectivity arrives in a sudden jump. Experience is local, in a neighborhood. But, there may be global connections. Disconnected networks can prevent global cascades. What is the trade-off between local stability and global connectivity? A global connection can be overwhelmed if it replaces local to local connections.

1.4.1.2.4. Triggers

A trigger is a mechanism that activates an immediate change in scale or a release of information or energy. A trigger can have connections to a global system. A trigger often creates positive feedback. A signal is a sign that may be recognized or transmitted, often to initiate some action, such as communication. A triggering signal can cause dramatic amplification.

1.4.2. *Ecological Synthesis*

Traditional science attempts to control a situation by thought or experiment. An experiment limits degrees of freedom in a formal manner; it screens out quality. The gain from an experiment is an 'if/then' structure, resulting in mathematically specific functions. Portions of the universe are placed behind glass in a laboratory world. As science cuts the connection to direct observation, it becomes blind to outer world. The formality of science makes statements about the outer world tautological. This is a problem with quanta, species fitness and psychological needs. Colloquially, trying to control ecosystems is like trying to control a spouse in marriage or machines in a factory; they will not be controlled well or completely.

There was a paradigm change in metaphor from machine to organic system that undermined atomism and the old animism alike in developmental biology. The modern notion of organicism can be traced to the foundation of Taoism. Things are what they are and act upon one another by virtue of their position within a system of patterns. The tao was the great pattern, a field of force in the physical and spiritual world. This organic conception was carried to Europe by the Jesuits in the eighteenth century and had a profound influence on the philosopher G.W. von Leibnitz. Leibnitz influenced Morgan, Smuts, Whitehead, Needham, and Bertalanffy. For Bertalanffy organicism was necessary to accomplish three specific jobs in biology: Appreciation of wholeness (regulation), organization (hierarchy and level laws), and dynamics (process, behavior of open systems). Certain psychologists (e.g., A. Maslow) and philosophers (e.g., M. Merleau-Ponty) have preferred qualitative description to quantitative analysis in their work. The blending of scientific objectivity with the sensuous and intuitive capacities of the mind is called hierarchical integration by Maslow (1968), who suggested science should strive for comprehension above clarity.

Sciences could use synthetic as well as analytic approaches to their subjects. Synthetic branches would be concerned with providing coherent pictures of the realms of study, as exemplified by the application of General Systems Theory to agriculture and farm animal welfare (M. W. Fox, 1983). Ecology could become a unifying science, including the whole of human experience, and permitting science an ethical dimension.

1.4.2.1. Ecological Science & Perspective

Ecology is one of the oldest disciplines. Early in their development, human beings realized the value of recognizing edible plants and animals and their interrelationships, and they built up traditions of knowledge. This practical ecology has been obvious for a long time, but because it is subtle and complex, it is not easy to quantify, and its development as a science is recent. This practical ecology enabled some cultures to achieve long-term stability in a natural environment; it also embodied teleological and holistic concepts expressed in qualitative terms rather than in mathematical forms. As a young science, these practical concepts were formulated as various principles: Wholeness, the relationship of complexity and stability, succession and climax states, and the balance of nature. As ecology became more quantitative, that is, mathematical and reductionistic, its methods and topics more reflected the old physics, but now it is developing a new paradigm.

Assumptions of a new paradigm (based on Ho and Fox 1988) are that form and variation are not arbitrary or random. Processes that generate form and variation at every level occur before natural selection is said to act; evolution can be understood in terms of this process, more than in terms of maximum fitness (exemplified in protobiotic evolution, molecular genetics). The emphasis is on integration, transcending disciplinary boundaries. In protobiotic evolution, physical and chemical processes are responsible for molecular selection and for the fitness of the environment for life. In the generation of organic forms, physical and chemical processes provide organizational principles that coordinate detailed biological mechanisms, including viscoelastic changes of the cytoskeleton and expression of different genes. The new paradigm will have new metaphors (Table 1421-1):

Table 1421-1. New Paradigms for the New Old Ecology

A process view (A. N. Whitehead 1920, M-W. Ho 1988)
Holism (J.C. Smuts 1926, A. Koestler 1958)
A field concept (C. H. Waddington 1962, S. Goodwin 1988)
Self-organization and constructionism (Francisco Varela 1982, S.W. Fox 1988)
Reciprocally constrained construction (Russell D. Gray, 1988)

In a process view, organisms are dynamic structures that are immanent and simultaneous with the process, rather than a consequence of natural selection of past random mutations. Like quantum physics, in ecology, the observer is within the theory in a very fundamental way. By the act of observing the observer influences the outcome of a phenomenon, taking part in the construction of physical reality.

In trying to synthesize the evolutionary theory of Darwin and relativistic physics of Einstein in a frame of holism, J. C. Smuts presented the whole as a powerful organizing principle inherent in nature. Koestler extended this to a system theoretical model of self-regulating, open hierarchical order (SOHO); he proposed the term holon to designate the Janus-faced entities on intermediate levels of any hierarchy, which can be described either as wholes or parts, depending on the frame of reference above or below. A holarchy of holons replaces the notion of a hierarchy of parts in a whole.

The field concept for development emphasized dynamic transformation (form as organized spatiotemporal domain), in contrast with the particulate concept of an organism. The field is understood in terms of group dynamics rather than selective advantage or cost.

Self-organization replaces the idea of natural selection. Any organisms or system is the history of the maintenance of its identity through continuous self-making, or autopoesis. The system develops through a continuous dance of autonomy and control; autonomy represents generation, internal definition, internal regulation, and self-assertion, whereas control represents consumption, instruction, assertion of other identity, and external definition.

Reciprocally-constrained construction replaces the concept of adaptation. The organism and environment are co-implicative, co-defining, and co-constructing. A process of self-assembly, where the self is the organism/environment system.

A holon is any stable subwhole in a hierarchy that displays rule-governed behavior and structural Gestalt constancy, to paraphrase Koestler. The rules lend order and stability, as well as flexibility, to a system. Wholes are mutually defining, but also self-making.

Nature is a self-making system; species and organisms are self-making. The ontology of any living system is the history of the maintenance of its identity through continuous self-making, or autopoesis. The evolutionary stability of the subassemblies—organs, organisms, species—is reflected by the degree of autonomy (self-government) each has, according to F. Varela. The system develops through a continuous dance of autonomy and control; autonomy represents generation, internal definition, internal regulation, and self-assertion, whereas control represents consumption, instruction, assertion of other identity, and external definition. Furthermore, the holistic nature of the STEM field eliminates the unsatisfactory notion of the priority of relationships to beings or of wholes to components.

Ecology deals with the relationships of organisms to environments. It is not a reductive discipline, and not readily amenable to quantification. Even scientific ecology is an integrative discipline that extends beyond the bounds of science. In a way, ecology is an amphibious discipline, with the authority of science and the force of moral knowledge. Ecology, studied through its components and relations, is a perspective, a way of 'seeing,' according to Paul Shepard. It is a perspective of the human situation held in a web of interconnections. For Paul Sears, ecology is a 'subversive subject.' Ecology is normative and sensible. Ecology also offers a 'sacramental vision' of nature. Ecology is radical—from the Latin word meaning "rooted"—and forms part of a new metaphor that is more appropriate to the unity and interrelatedness of the earth.

Ecology is part of a movement of consciousness, concerned with equality, diversity, health, with humane methods, and with a holopoetic cosmology, and ecology affects them simultaneously. Radical ecology offers a new perspective of humanity in the total field of nature and defines balanced relationships with ultrahuman beings and species.

1.4.2.2. *Patient Practice*

There are ways of dealing with the earth that are not scientific or technological; they are aesthetic or ethical. They are not incompatible with a whole science. Goethe's natural philosophy incorporates a world view described as organic dialectics; its method is described by contemplative nonintervention and the primacy of the qualitative. The two methods are described as follows.

1.2.2.1. *Contemplative Nonintervention*: An observerless and valueless science may be contrasted with the Goethean ideal of contemplative nonintervention. Eddington had asked if advanced equipment does not tell us how nature can be made to behave. Goethe felt that the human being was the best apparatus (perhaps to a foolish extreme). Later Eddington raised the same issue, that experiment might only tell us how nature can be made to behave. And Heisenberg expressed the exasperation from scientific investigation that showed us nature exposed to our methods of inquiry. Goethe rejected domineering analysis; his radically different approach was passive attentiveness. An observer tried to get into the flow of phenomena; by observing patiently and receptively, insights could cap years of patient watching. This was the attitude of relaxed attention, a receptive state of creation.

1.2.2.2. *Primacy of the Qualitative*: An exact sensory imagination is needed to midwife the deep-down phenomenon. Qualities must be evaluated; a script of qualities to be read for meaning. Sensory data were qualities savored, not measurements taken. Starting with qualities, the "exact sensory imagination" could midwife the deep phenomenon.

Goethe attempted to use his method to produce an organic and morphological world-history. This methodology is part of nature; it reflects nature. Rilke wondered whether or not all the dynamics of nature, including those of human society, are hieroglyphics of the methodology of thinking. Early science saw the world as mechanism; modern biology is seeing it as resembling an organism; perhaps it will be seen as spirit or as a composite of all.

To examine organisms, and nature in general, we must shift to a taoistic approach:

Asking rather than telling; observing rather than manipulating; receptive and passive, not active and forceful; 'nonintruding,' and noncontrolling. It stresses noninterfering observation rather than controlling manipulation; it is receptive rather than forceful. Classical objectivity may be contrasted with a taoist, which is another path to objectivity with greater perception. Loving perception provides kinds of knowledge not available to nonlovers; this is especially true in ethological literature. Maslow cites his own work with monkeys. Lorenz, Tinbergen, Schaller, Goodall, and Fox have found it to be true. This is the way a good psychotherapist, teacher, scientist, parent, or friend functions.

1.4.2.3. *Soul Science*

Science sometimes undercuts its neutral, objective approach, and allows conclusions to be reversed. For instance, one result of Elton's food chain was the realization that the bottom link—plants—is the most important part. The use of energy flows in ecosystems resembles descriptions of yogic meditations (compare the idea of enantiodromia). Nature is an extremely sensitive nexus of means and ends. Nature is a feeling system. We need a new animism to approach nature. This animism would allow us to behave "as if" nature was intelligent and sensitive.

What is necessary is not a primitive animism or a single-vision science, but a scientific animism, to replace scientific humanism and to understand our animalistic nature and use it as the foundation for a sound human ecology, philosophy and psychology. Anima is from the Latin word for soul. Animism could be an inquiry that would carefully and appreciatively consider the animal aspects of ourselves and how we understand and empathize with other living organisms. A scientific animism would consider the relations of humans to vegetation and the human attitudes toward ecotypes, like open plains and dense forests; it would consider the need for sacred places, and open, quiet or wild landscapes; and, it would consider territoriality, aggression, and the aesthetic reaction to the wonder and beauty of life.

A scientific animism would be concerned with far more than the anatomy and taxonomy of animals; it would be concerned with the mutual training between human and nonhuman animals (with an emotive bond); and, it would be concerned with the need for touch and phylogenetic possibilities of animal empathy—dogs, for instance, exhibit strong physiological changes when they are petted and human blood pressure drops. It feels good to be touched. A scientific animism also needs to understand the meaning of being human, to go below cultural or social explanations of love and alienation. It may, as a genuine science, forget the analysis and lose itself in the ecstasy of the phenomenon that it seeks to explain. Science functions best when we understand so well that we no longer need it.

The human mind shares nature's intent—producing experience—since the mind fits nature. The whole ecology is related to furthering the greater pattern of the universe itself. The universe is a regenerative system, of which we are a part. Theodore Roszak asked if ecology could approach the sacramental vision of nature. He characterized ecology for its sensibility; it is holistic, receptive, trustful, aesthetic, and intuitive. Ecology must be capable of assimilating moral principle and visionary experience to be a science of the whole planet.

1.4.2.4. *Being an Other: Animism and Conservation Totemism*

Deep ecology and its source, ecosophy, could make a basis for a new animism. The new animism could be expressed in specific societies for plants and animals. Totemism could be used for protection and conservation of nonhuman species.

Enlightened modern hunters often form associations, such as Ducks Unlimited, to protect animals and their habitats from the accidental threats of modern civilization. A good hunter learns to think like her prey and to recognize its signs and requirements. Hunting traditions have taboos against taking too many prey or vulnerable individuals.

In the past, hunters revered their prey. Reverence for life is an ancient attitude, recently revived as a principle by Albert Schweitzer, who distilled it from his examination of religions. Most philosophies are not adequate to deal with nature and ecological relationships; many religions are too narrow to consider nature as more than a dominion. Ethical thought had been developing since prehuman history, Schweitzer said, and it culminated in the principle of reverence for life. When humanity extends its concern to relationships with all life, and intelligence operates on the will to live, then the reverence for life arises. True reverence for life makes no distinction between higher and lower forms. If we were to act so, distinguishing between pests and pets, we must do so in the sorrow of the recognition that we are killing. True reverence for life entails reverence for death, since life and death are inseparable. No pattern can survive death, when death is the destruction of individual patterns. No one would mourn the content, which is even more evanescent. All life is sacred, but this can never be a reason for not killing, because that is how lives are sustained. Since life is of the utmost importance to the living, it should only be taken in sorrow, used and shaped with respect, and experienced with awe, for underneath it is still unfathomable mystery. Lao Tse and Confucius taught universal reverence and nonviolence as well. These ideas also have been stressed in modern times by Vivekananda, Tagore and Gandhi, and by St. Francis and St. Thomas, R. W. Emerson, J. Maritain, and Paul Tillich.

People have identified with animals for thousands of years, tracing their own ancestral lineages from them. In totemic religions, typical of foraging groups, each group is symbolized by a particular plant, animal, object or phenomena (the word 'totem' is from the Algonquin word meaning relative). Clans are descent groups from these chosen or fictional ancestors. The first totem often came in a vision; it was used to coordinate out-marriages between groups. A totem, as defined by J.G. Frazer, identifies an intimate and special relation between humans and every member of the class.

For instance, the Arunta tribe in Australia is divided into totemic bands. The "witchetty grubs" had about forty people living near Alice Springs. These bands owned territory, for example, the hare wallaby and carpet boa clans owned part of Ayers Rock. Traditionally, the bands went from one favored locality to the next, and at a central gathering place, had sacred ceremonies. All people, totems and natural phenomena are assigned to moieties. Moieties divided people into two groups within an estate group: Half of society might be black, kangaroo, acacia tree, and goanna lizard, and the other half, white, emu, gum tree, and rainbow serpent. Such divisions made it simpler for marriage and unions. Spouses would be drawn from opposite moieties. The rules of a totem also constituted good conservation practices: No hunting in sacred sites; prohibitions against hurting totemic animals; and, compassion to animals. Totem animals (or objects or phenomena) could be contacted in Dreamtime (everywhen) when the invisible side of life was made visible.

In another instance, the Kwakwaka'wakw people in the Pacific Northwest of North America shared their ancestry with each other on a crest pole (sometimes called totem or princess poles). They believed that each person had a special totem or guardian spirit, who bestowed some of her powers. The totem could be an animal, plant, substance, or event, such as lightning or cloud. These poles were commissioned by the head of the family to display status and created by artists working within traditional styles of representation; The poles were cut and carved with axes, adzes and chisels, then colored with dyes from hemlock, cedar, alder, and other sources. Their completion was often celebrated by a potlatch ceremony. Animal ancestors included wolves, bears, whales, seals, sea slugs, barnacles, as well as mythical beings such as Thunderbird or Seamonster. At first, poles were kept exclusively inside houses, but later outside poles intrigued visiting sailors and businessmen, who sometimes took them from seasonal villages.

The poles were not worshiped, but embodied beliefs about social realities, including descent, inheritance, power, privilege, and social worth. The poles were meaningful because they were the chosen visible expression of the history of the family, which had to be publicly recounted and witnessed. The construction of the poles was accompanied by the appropriate rituals, since each pole was owned by a supernatural being. The artist presented the faces of beings only, so the stories had to be retold by the owners. The poles, especially later model poles, were also used for funerals and as teaching devices, as children and spouses had to be trained in the totem. Totems, more than being good to eat or use, were chosen because they were good to think with, according to Claude Levi-Strauss. They were metaphors for people and things, as well as for trees, which conveyed history, strength, growth, and longevity. The chief of the tribe was the post of the world, as his ancestors were the root of the tribe. Honors, an important form of wealth with goods, were displayed in a totem.

Totemism is a good way to have animals be represented in human society and law. It is more selective than pantheism or animism, and the totemist provides a commitment to preserve the subject through the bond of brotherhood. Totemism teaches an invisible whatness about the self, since it is an analogy between a social system and the natural world, in a religious context. People are parts of society, while people, animals and plants are parts of ecological system. In this way, empathy is accentuated.

Paul Shepard, and independently Michael W. Fox, proposed a human association devoted to each species of wild animal, so that every creature on earth would have a human constituency. Groups of people would form voluntary leagues dedicated to single species and their habitats and ecosystems, which are crucial parts. A feeling for participation in ecosystems is necessary. Leagues would have the ability to foster concern for nature, with a tendency to preserve it. A totemic disposition would increase a "primitive" awareness of the earth. There may be secondary or tertiary totems that overlap with other groups or leagues. Social networks could be extended into the ultrahuman world by imagining that life and obligations were shared. Kinship could be reflected in totems.

Is there a way to replace cultures, economic systems, or bioregions with the alliances of totems? I myself am aligned with black bears, lichen and lightning and ask you to join me in the Black Bear spirit clan founded in Coeur d'Alene. This is not just a duty, it is a fun!

Figure 63-1. Mountain Grove meeting, with Dean Apostel, Twila Jacobsen, David Parker, Paul Libby, and others

1.5. *Threading Systems Through Fields*

The universe at large, with its clusters of galaxies, clouds, stars, and planets, extends itself through space and time. Parmenides held that space was a plenum. On the other hand, Leukippus conceived of space as emptiness. The physicist David Bohm combines both ideas in the concept of a field. He describes the universe as a field with waves of infinite size. The universe is permeated by septillions of waves at all times. A wave is an integral pattern of the physical continuity of a particle. Waves shape the field, that is, they excite the field. The field is an invisible, nondetectible source from which elementary particles draw order and energy. There is no place for both field and matter, "field being the only reality," according to Einstein. The field here and now depends on the field in the immediate neighborhood at a time just past. Excitement is generated with a temporal dimension. Humans generate their own waves that are added to the infinite variety coursing the universe.

The field concept was originally introduced by Michael Faraday into studies of electricity and magnetism, and was expanded by Clifford. The field concept is central to the unification of theories of light, electricity, and magnetism. Einstein extended Clifford's ideas of the field in his theories of relativity. In large systems, time acquires a new meaning associated with irreversibility. The classical mechanical concept of time results from simplifications. Einstein induced that time is relative to the frame of reference. Space-time is an ensemble of occasions and places, held together by duration. The future and past are tied together by duration. To the largest duration—the universe—all time is present. Time is not empty or abstract. According to Einstein, every change of coordinate systems mixes space and time in a mathematically defined way.

In his Special Theory of Relativity, Einstein included gravity in the picture, making space-time curved. But as massive bodies have greater gravities and mass can be converted to energy, all four perspectives form a field that can alter each component. Through the principle of equivalence of gravitation and acceleration and through the use of a symbol that mathematically described the local rate of 'turning' of the curvilinear coordinates, Einstein was able to relate curvilinear order and measure to the gravitational field. Both the electromagnetic field and the gravitational field can be understood as aspects of curvature. Einstein's 1907 principle of the local equivalence of gravitational and propulsive accelerations (geometrodynamic law) linked the two currents of thought from Riemann ("geometry is part of physics") and Mach ("inertia is influenced by mass elsewhere").

The physicist John Wheeler regards curved geometry itself as the building material of the universe. Gravity can be regarded as slow curvature; the electromagnetic field is rippled with different curvatures, and the particle is a knotted up region. Wheeler hypothesizes that a pregeometry is necessary because geometry fails to explain some events such as gravitational collapse. If one regards geometry as an abstraction from a moving Space-Time-Energy-Mass field (STEM), the pregeometry is the STEM field, the ground of being. The STEM matrix is a cosmic, transformable field. The STEM field is primary. Time and space are secondary to the field that contains them. No one component is ontologically subordinate to another. The STEM field is a meso-field in the universe; it vanishes at both ends as a knot dissolves into the identity of rope after being analyzed. Particles dissolve into identity with the universe. The field is a paradox; localities are part of it but do not communicate instantaneously, by light. The speed of light is still a limit for most communication, but not for the behavior of the field as a whole. Space is filled with local relationships. The limits of the array are nondefinable. The STEM field has general properties, such as motion and autopoesis (self-making).

1.5.1. *Properties of the Field*

A property is an attribute proper to a thing or characteristic quality common to all members of a class. The properties of a field are shaped by the historical operation of the field itself. This means that these properties are reflected in different levels of organization. Mario Bunge distinguishes three kinds of collective properties: Aggregate, structural, and global. Aggregate properties are often statistical, as in the average age of the wolf pack is 3.9 years. Structural properties can be possessed by individuals or groups on the basis of their relations to others, e.g., high-tail is the daughter of nick-ear. And global (or emergent) properties are possessed by wholes, regardless of components, as in "the territory of the wolf pack is eighty thousand hectares." This property emerges with the system and disappears if the system breaks down. It is an emergent property if no component of the system has it individually. History, structure and stability are emergent properties of an ecosystem. Role and scarcity are not. The basic properties of a field, any field, are: Motion (process), autopoesis (self-making), differentiation, integration, constancy, and development.

1.5.1.1. Motion as a Property of a Field

Nature, for Alfred North Whitehead, consists of patterns whose movement is essential to their being. These patterns are analyzed into events (or occasions). An event is a change of state. An event is described by two points, an initial and final state. A process is a sequence of states (also called history). Process is the dynamic change in an unfolding flow. Process is a fundamental feature of nature. A process creates a path, described by a trajectory of states.

A process is described as evolutionary if it involves emergence and the creation of new things (general speciation; to be a species, however, the novelty has to reproduce itself or multiply or diffuse). In complex systems the past contributes to or constrains the state (from the magnetic hysteresis of ferromagnets to organisms, which have memory).

The activities and movements of an organism are united into the being of the organism. The organism is a dynamic structure that is immanent and simultaneous with the process, rather than just a consequence of the selection of individuals modified by mutation. Beyond being merely relations of relations, organisms are pulsations of process, natural units of fact. For example, since subatomic particles are part of a field, and they are internally related within the field; they cannot exist without the field. The field provides the order required for producing individual actual occasions. The coming-to-be of organisms, i.e., process, is a fundamental feature of reality. The organism undergoes a process of evolution in which it produces new forms in itself.

1.5.1.2. Autopoesis as a Property of a Field

The field is autopoetic, that is, self-making (from the Greek words), according to Francisco Varela and his colleagues. Autopoesis refers to the dynamic self-producing and self-maintaining activities of living beings. The tenets of autopoesis are presented in six principles: (1) Identity: Identifiable components are organized internally with structural boundaries; (2) Integrity: The self is a single, whole, dynamic functional system; (3) Self-boundedness: The boundary is produced by the system; (4) Self-maintenance: The boundary and components are produced by the functioning of system; (5) External supply of materials: Elements, such as carbon or water, are obtained beyond the boundary; and (6) External energy supply: Light or chemical energy from beyond the boundary is converted into organic bond energy.

In an autopoetic framework, every being is embedded in a world and observed by an embedded observer. The material components of life move through physiological processes.

Autotrophs, such as bacteria, algae, and green plants, convert energy into organic compounds; heterotrophs reconvert autotrophs into heterotroph flesh. The unit of evolution at any level is a network capable of a rich repertoire of self-organizing configurations. Reactions at the chemical, organism, or ecosystem level, when combined, produce unexpected positive results from the sum of single reactions. An ecosystem has emergent properties that are different from the sum of community interactions. They also affect biogeochemical cycles.

1.5.1.3. Differentiation as a Property of a Field

The field universe is a vast order of individual events, discrete unfoldings within limits, following certain laws, but in unique patterns. Patterns of complexity shade and grade into one another endlessly. A large family of similar unstable particles can been classified phenomenologically in a complex set of interrelated orders. It appears to many physicists as if the beginnings of new orders of natural laws are being revealed, in which particles would be like flower designs on a carpet pattern, while something unknown corresponds to the structure of the cords of the carpet. In fact, orders reform in the 'carpet,' as John Wheeler suggests.

Analyzing the world as if it were made of particles would be similar to analyzing the carpet as if it were made of flowers: it would give some results and have some predictability, but the metaphor would limit better understanding. Wheeler states that patterns in the 'foam' are seen as subnuclear particles. The foam can be seen as a metaphor for the self-reconstruction of the universe from standard parts to novel structures, through a process of metalysis, that is, the break-down of parts to form new structures.

Order is measured through relationships. David Bohm himself states that order is basically a set of similar differences. Differences can be related to degrees of freedom. An order with more differences has more degrees of freedom. The macro-order limits degrees of freedom in underlying orders. Bohm contends that order is more fundamental than relationships and classes; order is logically prior to relationships. But this seems to be a misconception. Order is measured through relationships. The brain registers differences and similarities, leading to perception of order, and this is related to other orders stored in memories (perhaps in a holographic manner). Nature is often ordered only by our understanding. Bohm sees that there are two kinds of differences: Constitutive determine the essence of order; distinctive determine how one order is distinguished from another.

1.5.1.4. Integration (& Participation) as a Property of a Field

John Wheeler believes that since law, field and substance all exist after the theoretical big bang, the universe owes its existence to trillions of acts of registration. The phenomenon comes through elementary acts of participation by different observers. Wheeler asks if the universe might not be brought into being by the participation. Quantum mechanics strikes down the concept of the neutral observer; participation is vital. Wheeler noted "To observe the electron even, the experimenter must shatter the glass—must reach in with instruments."

The quantum principle destroys the observer behind glass (*in vitro*). The universe is not the same after measurement; the observer becomes a participator. Einstein said that no event can be postulated without the presence of an observer; but no observer can see the whole system; and anything can be an observer or participant. A world without participants is impossible. The observer is part of a natural or social community. No system can exist without observers. Fortunately, nature contains many eyes. There are no lone observers. The autonomy of our social system goes beyond our individual autonomy; the knower is the observer-community. Humanity participates in the natural world, so human history is part of natural history. All beings participate in relationships that make up their worlds. Full participation removes the barriers of language or thought; "otherness" pours through.

In fact, particles are connected by the field, not by superluminal signals or any other kind. In a holonomic field, the resolution of any one perspective of the whole is so weak that it has no predictive value. Information is not transferred because the field is in-form-ed. An adequate model must provide for unified understanding of all of nature.

1.5.1.5. Constancy as a Property of a Field

Bishop Berkeley proposed a bootstrap principle when he argued that the inertia of any body is determined by the distribution and masses of all other bodies in universe. Ernst Mach's principle repeated the same idea, demanding the closure of the universe, to make it finite and bounded. The mechanical properties of space are determined completely by matter only in a space-bounded universe. In the bootstrap principle, the universe is what it is because it is consistent with itself; we are not free to sort out accidental properties and distribute them with various values among different universes. No properties of the universe, however, are fundamental; they follow from other properties in a web of interrelationships. Geoffrey Chew's bootstrap model considers hadrons as temporarily stable configurations that result from an interaction of processes. They may transform themselves into other particles. The bootstrap relation takes the form: "Universe=subatomic-particles," where '=' means 'equivalent to.' Each particle represents a facet of the universe and not just a small part. All electrons have the same charge because they represent a single aspect or perspective of the universe. Each particle is only an abstraction of a relatively invariant form of movement in the whole field of the universe. Specificity can be a property of the particle's path, what Whitehead a 'concrescence,' and what Waddington calls a 'chreod.' Yet, if the universe is open-ended, then the consistency of the whole can never be proved logically.

1.5.1.6. Development as a Property of a Field

The loss from motion creates a sediment, which is history. Sedimenting is irreversible and gives direction to time. The sediment of the past is a given and different for each present. The ceaseless activity of being in history creates newness. Novelty is born from the womb ('hystera') of change. History is the result of this hysteresis process. The universe restructures itself constantly at a more complex level. The evolution of the universe is a history of the unfolding of differentiated order or complexity. Building up emphasizes structure and levels of hierarchy by joining systems from the bottom up. David Bohm states that we have been conditioned to the belief that higher orders of nature are determined by the lower order of the mechanical motion of particles. It is impossible to exclude the contrary assumption that high order features of natural laws are as fundamental as those referring to atomic movements.

By comparison, unfolding implies an interweaving of processes structured at different levels. Evolution acts in sense of simultaneous and interdependent structuration of micro-worlds and macro-worlds. Complexity emerges from the interpenetration of the processes of differentiation and integration, processes running simultaneously from top and bottom and shaping the hierarchy from both sides. Patterns of complexity shade and grade into one another endlessly. Reciprocal causal processes can increase structure, differentiation and complexity in natural systems, according to M. Maruyama.

1.5.1.7. Properties Across Levels

The properties of the field are modified by the operation of the field. Different properties emerge at different levels. For instance, stability at the ecosystem level is replaced by loyalty at the social and psychological level. It is possible to trace the changes in characteristics from the field to the ecosystem and then to place and society. All levels can be addressed as systems.

Table 1517-1. Contrasted Properties of Different Levels of Patterns

— Nature —		— Culture —		— Design —	
Field	*Ecosystems*	*Place*	*Culture*	*Good Places*	*Good Societies*
Process	Course	Dynamicism	Conduct	Action	Method
Autopoesis	Self-making	Identity	Wholeness	Individuality	Extension
Differentiation	Diversity	Uniqueness	Flexibility	Richness	Variety
Integration	Construction	Investment	Adaptation	Conviviality	Cooperation
Constancy	Stability	Regularity	Endurance	Consistency	Loyalty
Development	Productivity	Renewal	Vitality	Health	Harmony

Animation and ecological value changes the differentiation of the field to the openness of the ecosystem. The addition of communication and cultural values to that characteristic of the ecosystem results in the richness of place. And, the addition of social values and awareness of a place leads to variety in that society. These six properties of a field can be related to equivalent properties in different aspects of the field, from ecosystems to human societies.

1.5.2. *Field Changes*

Field changes result from the operation of the field. Some relevant changes include growth, breakdown, emergence, patterns, trigger, scale, and history.

1.5.2.1. Growth (Anabolic Change)

To grow is to come into being or to increase in size or in some other quantity such as mass or energy. The universe and its field grow from some unknown impulse. We have observed that the universe has been growing, as has our local solar system. Everything seems to grow. Gravity encourages accumulation of mass and energy in black holes. Everything tries to expand, to survive within serious constraints or limits or to exceed them. Growth seems to be a primary thing, yet limited, from aggregation to organic size. A living body, for instance, produces many more cells than are needed, and then it corrects the excess by signaling some cells to die. A body also produces many more sperms or eggs than are ever used. In some cases, many more offspring are produced than ever can mature to reproduce themselves. Life seems geared to cycles of overproduction and correction.

In the organic world, growth is healthy only when the rate of change is decelerative in the long run; cancer and population are constant or accelerative. Some economists once assumed that growth is limited to one of two kinds of growth, steady or logarithmic (arithmetic or geometric), but that is palpably untrue. Three particular causes of growth can be distinguished: Additive, an accumulation of more; replicative, an accumulation of more through reproduction; and mutualistic, where all agents change structure, as in meiosis.

1.5.2.2. Breakdown (Catabolic Change)

John Wheeler states that patterns in the foam are seen as subnuclear particles. The foam is more like the fabric of a dream. Wheeler states that patterns in the foam are seen as subnuclear particles. The foam is a metaphor for the self-reconstruction of the universe from standard parts to novel structures, through a process of metalysis, that is, the break-down of discrete units to form new structures. The process of renewal can be called metalysis (the neologism means ‘loosening change,’ from the Greek roots). Living order can also be defined in terms of the influence of whole over the parts. Disorder at the level of a molecule can reflect the higher level of the order of a cell. The machinery of a cell is not a permanent fixture, but is disassembled and rebuilt periodically, according to specific patterns and in harmony with the functioning of the cell in its environment. Weiss shows that parts of a cell are constantly changing, growing, dying, breaking up and recombining, but under control at a cellular level. This is metalysis. Metalysis is a technical term for the process of dedifferentiation in biology. It can also be used to describe physical processes like quantum foam or social processes like institutional revolution. It is used to describe biological processes, such as metamorphosis, where changes are often so extreme that the organism constructs many specialized parts of the adult from cells set aside in the embryo and that are nonfunctional in the juvenile (imaginal disks). These rules work well with natural processes that operate in ecosystems. There is an operation of metalysis with nations as well. Through isolation and identity, people divide into cultures and nations. Nations have unified and disunified. The process of dedifferentiation is also forwarded by catastrophes.

1.5.2.3. Development (Complex Change)

Development means the introduction of an innovation. The evolution of matter, for instance, proceeds through a spiral process, as exemplified in the carbon cycle in stars, where a carbon nucleus captures four protons and emits them as an alpha particle at the end of the process. In some cases physical behavior depends on past history. Magnetic hysteresis is one case. Hysteresis is not confined to magnetism—structural deformation and colloidal behavior also may depend on past history. Louis de Broglie, and later David Bohm, think that the Heisenberg indeterminacy may be the result of not taking into account the past history of an elementary particle in predicting its behavior. Perhaps some of the problems attendant in scientific inquiry arise from the inability to take into consideration the complex history of a particle. Nature is unpredictable. Its fuzziness is due to indeterminate states—indeterminate at the human level, where we have limited perspectives in a local system.

The development of life since the Cambrian era displays a diversity of forms in an expansion of life into places that can only be described as self-realization, since it is far more active than the passive adaptation of self-preservation. This development is reciprocally constrained construction. The organism and environment are co-implicative, co-defining, and co-constructing. They engage in a process of self-assembly, where the self is the organism/environment system. A biological organism grows to maturity, which is a stopping point for size. The organism continues to develop, however, experiencing and learning the environmental complexities through mating and then to the end of life. Development may include growth at early stages, but it refers to the continued change after growth has stopped.

1.5.2.4. Emergence (Novel Change)

Complex adaptive systems display emergent behavior. As an example of emergence, slime molds can form a community without a pacemaker cell that determines when the cells need to combine. It seems that self organization is bottoms-up. Emergent systems are rule-governed, though; slime molds explore by adhering to low level rules. Individuals coordinate work, even if they cannot assess the global situation. Emergent systems are local; individual molds “think” locally and act locally. Random action serves to explore local space. Individuals pay attention to their neighbors, and patterns emerge from local activity. Simple behavior seems to work, with local feedback, and more sophisticated behavior “trickles up” to approximate a global perception. Mathematical analysis measures those behaviors with standards and converts them to numbers in an abstract space.

Emergent properties (or global properties) are possessed by a whole, regardless of its components, as in "the territory of the wolf pack is eighty thousand hectares." This property emerges with the system. It is an emergent property if no component of the system has it individually. History, structure and stability are emergent properties of an ecosystem. Role and scarcity are not. The emergent properties of organisms include discreteness (physical), genetic homogeneity, recognizable subsystems, the coordination of parts, irritability (response to a stimulus), and reproduction (genetic consistency). Of course ecological design should consider these properties as well.

1.5.2.5. Pattern (Constant Change)

A pattern is an arrangement of form of elements. Process applied to components yields pattern. Nature is composed of patterns. Patterns are not still. A circular pattern through time can be recognized as a spiral (the earth's orbit for example). The pattern should allow for surprises and discontinuities; it can do this if it is flexible. Regularities in systems are patterns. Patterns can be seen in things or even cultures. For instance, laws of genetics are natural patterns; human customs are artificial patterns. Where the natural ratios of females to males are altered by female infanticide or other action, the pattern is artificial.

Paul Shepard describes living natural "objects" in terms of events that constitute a "field pattern." Relations are not prior to objects; they arise together. The wasp and the yucca coevolve; they are not co-linked by prior relations. Furthermore, a specimen is more than the sum of its species' relationships to an environment; it is an intentional being that, with other members of the species, can create niches, as well as adapt to them. Because the stem field produces life, the qualities of life cannot be separated from its physical qualities. While it is true that living subjects are at a different level of description than events in field patterns, they should not be treated as ontologically subordinate. All of the aspects of the field have equal status. Ecology placed living "objects" in a field. This field determines the limits of any ecological field of activity, and no field of ecological activity can be described without taking the physical field into account. The field is living and intentional, as well as physical, and an ecosystem model must address intention or other emergent properties.

1.5.2.6. Triggering (Explosive Change)

Mario Bunge distinguishes two types of causal mechanisms in systems: Energy transfer, and a triggering signal, where the energy is far disproportionate to its effect. The triggering signals are small changes in energy that cause large changes in the physical or cultural output of energy. With a trigger, information guides energy use. The trigger mechanism applies to simple phenomena, such as explosives, or to complex biological and cultural phenomena. For instance, there does not seem to be a single trigger for El Nino. One trigger has to do with water overflow and then back flow from the western pacific. Others may have to do with sunspots, which would reduce radiation, or volcanic eruptions. Many of these atmospheric, oceanic and geophysical triggers may converge. Nineteenth-century famines may be correlated with ENSO events that influenced China, Indonesia, Brazil, and southeast Africa.

Culture is like a trigger. It allows less information to activate the system. And, this is the only way to increase information handling, when the system is larger and more complex—of course, this is what stereotypes and metaphors do. Leaders or chiefs can give signals that channel energy into large projects. Population density was controlled by the traditional approaches to resources. In archaic societies, cooperation and consensus, as opposed to competition and individual exaltation, permitted planning to remain informal. Population growth triggered competition and conflict, which lead to positive feedback of the thing that caused the stress, that is population growth and conflict. Art can be a trigger for change (or explosive decompression, to continue the weapon metaphor). The metaphor itself is compressed information that can be uncompressed by the receiver.

1.5.2.7. History (Irreversible Change)

History is a sequence of states. In complex systems, the earlier state, also called the 'past,' contributes to or constrains a subsequent state, such as the magnetic hysteresis of ferromagnets or the behavior of organisms having a form of memory. The ceaseless activity of being in history creates newness. Novelty is born from the womb (*hystera*) of change. History is the result of this hysteresis process. The motion of the field creates a turning, which leaves a history, out of which patterns arise. Scension is a precession of motions, resulting in directional change—evolution. The transformation is a historical expression.

The evolution of matter, for instance, proceeds through a spiral process, as exemplified in the carbon cycle in stars, where a carbon nucleus captures four protons and emits them as an alpha particle at the end of the process. In some cases physical behavior depends on past history. Magnetic hysteresis is one case. Hysteresis is not confined to magnetism—structural deformation and colloidal behavior also may depend on past history. Louis de Broglie, and later Bohm, think that the Heisenberg indeterminacy may be the result of not taking into account the past history of an elementary particle in predicting its behavior. Perhaps some of the problems attendant in scientific inquiry arise from the inability to take into consideration the complex history of a particle (compare Heisenberg's uncertainty principle). Nature is unpredictable. Its fuzziness is due to indeterminate states—indeterminate to us, who have limited perspectives in a local system.

1.5.3. *Living Fields*

Charles Sherrington developed a field theory of subjective space. He distinguished between exteroceptive, interoceptive and proprioceptive fields; the exteroceptive receptive field was coextensive with the body surface and richer in receptors. These elements comprise a biological explanation of subjectivity. The subjective field is characterized by a broadening of lived time. This extension includes the lengthening of responses. The subjective field of self is parallel to Kurt Lewin's concept. The self is a creature committed to a specific association, a genome plus place; the fitting of self to setting is partially definitive of both. Place/person/act are as indivisible as the physical STEM field. Lewin thought that the psychological fields joining the personality to its life-space, the immediate environment, and life-space to a larger environment, were strong enough to alter objective facts, that is, to make them normative.

Lewin was willing to study the objective factors that were potential determinants of life-space. The organism's own world is usually left out of consideration by Psychology. Lewin's life space combines the *umwelt* (of J. Von Uexkull) and the life-world (of Edmund Husserl). Topology provides the mathematical model for Lewin's representation of psychological processes. Topology is a geometry in which spatial relationships are represented in a strictly nonmetrical manner. Since topology had no directional concepts, Lewin invented a qualitative geometry called hodological space, represented by vectors. He used two-dimensional planar maps to represent life spaces (recent researchers use a linear graph, on which an indefinite number of points can be mutually interconnected in asymmetrical relationships).

Lived space requires a three-dimensional representation. New mathematical treatments of fields tend to be three-dimensional. Rene Thom's catastrophe theory and Conrad Waddington's epigenetic landscape are two such theories. The epigenetic landscape field can be used to explain why chickens rarely walk around a fence to get food. The chicken's need chreod is deeper than the path of a cognitive chreod around the fence. So the chicken can only go toward the food. If the need chreod is too deep, it cannot explore first with its cognitive chreod, where a less hungry chicken could. In humans, this explains why necessity cannot be the mother of invention; the landscape of leisure is needed.

1.5.3.1. Field of Person

Although we can intuit the interdependence of nature, we sometimes mistakenly conclude that our skin is the boundary to ourselves. We extend tentacles of personality to other things and people. As Whitehead pointed out, everything prehends everything else. The human skin is a delicate interpenetration, like a pond surface, according to Paul Shepard. The skin's interpenetration links a living field to a larger field.

What is impaired in the absence of a rich ecology is the individual's knowledge of herself, not only as a person, but as a member of a species. Harold Searle's thesis is that the environment constitutes one of the most important ingredients of human psychological existence. There is within the individual a sense of relatedness to total environment or field.

A deep relationship with a place is as necessary as one with other people. Without such a relationship, existence loses much of its significance. A range of experiences can spring from a place, from depression to the peak experiences described by Maslow. Even drudgery is part of a commitment to place; it is acceptance of restrictions. The word nostalgia was coined by Johannis Hofer (1678) to describe an illness characterized by insomnia, palpitations, stupor, fever, and persistent thought of home. The disease could result in death. Thus far, the sense of place cannot be gleaned from an analysis of the nervous system. Yet a place shapes the nervous system, somehow, until it becomes a necessary part of health.

1.5.3.2. Field of Place

The making of places from undifferentiated wilderness is the living ordering of the world into places. A place changes qualitatively; it becomes structured. Natural complexity decreases as the human increases, although the two are not mutually exclusive. Places are ecosystems intimately associated with living beings. Fitness is achieved after progressive reciprocal adaptations; it requires a stability of relationships between societies and the place. The specificity of place is important. The spirit of each place may remain to influence successive generations.

Ecology relates to at-homeness; a dwelling in neighborhood of its source. Adolf Portmann observed that insects and animals displayed a powerful attachment to places; that it was best understood as home. The attachment to a place is rootedness. The fundamental ambiguity of existence is that humans have different capacities for feelings and awareness. Some feel strongly about a place or home; others never do. Home is also an enclosure, a place for protection and privacy.

A place is a part of the environment claimed by feeling. Emotion binds together motion and perception. Emotion can transcend distance. Emotion creates an 'in-place'. A place must be found and made; it does not exist independently. Home requires rootedness, at-easeness, and regeneration. Von Uexkull described the importance of rootedness in his concept of lived-world (*umwelt*). Feeling at home is a state of awareness; losing the feeling may cause crises. Being inside is knowing where; it is safety, cosmos, enclosure. Inside and outside, like a dialectic, can always be reversed. Empathy is willingness to be open to significance, to know and respect symbols of place. A house is a place that provides shelter; it answers social needs; it is a repository of memories, a field of care. For the private self, the house is a world; for public selves, the world is a city or civic center.

1.6. *Education: Fun with Words Numbers Links & Images*

An effective education need not be bound by the conceptual and economic limits assumed by most institutions. A minimum education may train students for an economic role in society, but a good education teaches them how to enjoy living among other human beings in an ultrahuman nature and to perpetuate a good society. Poets like Wordsworth and Auden recommended that broad training in science and technology was necessary for poetic knowledge, which is part of a good education. Novalis considered that the study of the external world, through science, was only the first, half-way, step to full human consciousness. The second step was introspection, the contemplation of the self. Subject areas in traditional institutions concentrate on one step or the other. Any student can achieve both steps, leading to a complete education, with time and inclination. A complete education requires intense effort, discipline, patience, and a tolerance for failure. Elite institutions, with their richness of culture, can offer more potential than the pedestrian paper mills, but are often limited by social fashions and finances. An ecological education could offer greater benefits, with a teacher "leading" a pupil to an education (which is derived from the Latin word meaning 'to lead'). In his educational theory, Plotinus went still further and laid down a triple organization of education, requiring a social education, a personal and self-revealing education, and a synergetic one that would permit a perspective of the whole of human existence. Only institutions that integrate education within a balanced society can achieve this triple objective. By encouraging students who are already working outside academic walls, ecological institutions can foster this necessary kind of synergetic education.

The most valuable qualities of an ecological education are personal contact, which allows noncompetitive constructive criticism, and flexibility, which allows the educational process to fit an established and meaningful life-style. Ecological education lets one learn how to feel and live, as well as to think. As Aristotle recognized long ago, experience is necessary for thinking. The very cloisteredness of traditional university education works against it in this respect. The university fails to teach communal responsibility, self-reliance, and physical work—those qualities most dear to R. W. Emerson. Education must embrace three concepts, according to Schiller: liberation, play, and community. Liberation is freedom from the limits of identity; play is imaginative experience; and community is the supporting matrix of life. This ideal is most closely approached in already established communities (not the artificial and involuted, temporary university dormitories) and when play and freedom are not limited by arbitrary rules and economic goals.

Ecological institutions provide for education within the larger community, in the larger context of work and recreation. Perhaps this attention to context accounts for the success of business training institutions, such as hamburger university or insurance college. Relevant institutions stand a better chance of surviving social changes than those built on self-perpetuating administrative interests and alumni sports empires, whose vast buildings and grounds might better be turned into shelters for the poor or enclaves of employment, to produce real goods for society as part of their programs.

All human beings need a life that is protected and ordered, loving companions and contact with the wild universe. But, one cannot pretend that this little world is not part of a larger one riddled with hunger and fear—one which everyone's actions affect. The beliefs people hold are worthwhile only if they enact them in a larger world, ethically (which comes from the Sanskrit word meaning 'doing together'). Very few institutions concern themselves with the scope of ethics; that is left to the employee or student.

Although it is pretentious to assume the responsibility for a class or culture, sincere action begins with personal responsibility and responsiveness within a smaller system. Unpopular questions, ethical expressions, and confrontations all have a price. It may be only silence or deprecation; it may be expulsion, imprisonment, or death. Everyone needs the courage to question society and express their beliefs and findings without worrying about the cost. For only through sincere, studied expression or example can anyone hope to influence the consciousness of others. And only by surrounding society with a new field of consciousness—not by attacking it—can any transformation occur. When human beings cooperate spontaneously, because they understand what it means to be human, because they understand how to treat their places on earth, only then can education be considered successful and, perhaps, lead to a more peaceful and humane world.

Garret Hardin points out that education is not just literacy, and that literacy, the ability to understand what words really mean, is not enough anyway. It needs to be supplemented by "numeracy," the ability to quantify information and interpret it intelligently— computers, remember, use numbers for everything—and, on another level, by "ecolacy," the ability to take into account the effects of complex interactions of systems over time, for understanding of the complexity of the world, that things are interconnected and affect one another. Together, these are three major filters against folly that citizens can use against the blindness, short sightedness, and sheer idiocy that experts disguise as eloquence or expertise.

1.6.1. *Literacy* (Words)

Literacy is the quality of being literate. Specifically, it is the ability to read a short passage and answer questions about what was read. The word comes from the Latin word meaning letter or later 'writing.' Being literate is being characterized by learning, cultured, educated. A person who is educated has been "lead" from ignorance, out of the self in other words, by fostering the growth and expansion of knowledge through a course of formal study. Knowledge is a condition of knowing, an acquaintance with theoretical or practical understanding. There are no limits on what can be known. But, most knowledge is concerned with survival first. It is important to know what plants to eat, where to find shelter, how to make clothing. This was, and still is, the most basic level of literacy.

But, literacy occurs on more than one level. Beyond familiarity with the terminology and applications, computer literacy is competence at solving problems using a computer, or even the professional design of new machines. Complete computer literacy is the knowledge of how the computer operates, as well as its design, manufacture, and programming—few have that complete kind of literacy. Classical literacy can survive the collapse of printers and newspapers. But, could computer literacy survive the collapse of computers? Perhaps this question hinges on the definition of literacy.

Gandhi put literacy in a similar perspective, "Literacy is not the end of education, not even the beginning, it is only one of the means." Certainly, computers can be valuable for certain aspects of education, but we must not forget what function the computer is assisting. In other words, computer use should not displace the skills themselves. Education should include a core of mathematics as a liberal education always has. And poetry and narratives should still be memorized, as well as written or examined on a computer.

Literacy, as the skill in the written and spoken language, enables readers to draw on the wisdom (and foolishness) of human beings distant in space and time. Hardin notes, in a discussion of the sins of the literate, that language has two functions beyond communication: "To promote thought and to prevent it." The second function is why literacy has to be accompanied by the ability to think critically.

1.6.2. *Numeracy* (Numbers)

Numeracy involves the ability to measure and to interpret quantities, proportions and rates. Hardin warns that human beings have learned how to use literacy to hide numbers and the need for numerate analysis. He draws attention to the problems created by always thinking solely in terms of dichotomies, e.g., safe vs. unsafe or pure vs. impure, rather than in terms of relative risks and benefits. James Lovelock has also noted our inability to assess risks mathematically. The quantitative analysis that is so important in science, technology, business, and government is dismissed with indifference. In a complex, rapidly changing society, understanding quantities, ratios, rates and duration of time is crucial. Numeracy has limitations, also—the conclusions of an accurate mathematical analysis are only as good as its premises.

We have already had fun with words in section 1.3.2. We can have fun with links and connections throughout the remainder of this project. There are many interesting numbers that play a part in the design of the planet. The Universe has 100 billion galaxies in the universe; there are 100 billion stars per galaxy. The Sun is a fusion reactor; its mass is 330,000 times earth, and the volume is 1.3 million times earth. Its core density is 300 billion earth atmospheres and central temperature is 15 million degrees C. The surface temperature is 5500 degrees C. Hydrogen gets converted to helium at 600 million tons per second. The size of the sun (864,000 miles diameter) is a balance between gravity and gas pressure. The sun has increased its output by 25% in the past several billion years.

The sun is orbited by eight planets, including earth. Earth it is part of double planet system with the moon. Its diameter is 8000 miles. Its elliptical orbit is off 8 degrees from a circular orbit of sun. It tilts on its axis, but the moon stabilizes the tilt. The surface is 197 million square miles, 29% of which is land (and 11% of that is arable). Temperatures range from –127F to 136F. Mountains are limited in height by the thickness of the crust (not a problem with Hawaii, which rests below the crust).

At the beginning of the last ice age, 100,000 years ago, human numbers may have dropped to 10,000 adults or merely 600 adults. In the Upper Paleolithic, human numbers rose to 500,000, then 10,000 years ago (before agriculture) to 6,000,000, and now 6,600,000,000. The changes in density were also dramatic: 100,000 YBP, there was 1 person/12,500 km^2 or 0.00001 person per square kilometer. In the Upper Paleolithic, the numbers were 1/255 km^2 or 0.08. At 10,000 YBP 1/25 km^2 and at 5,000 8/25 km^2 and at 2,000 YBP 42/km^2 and 300 years ago 160/km^2 and now 1013 people per square kilometer.

Human populations changed the character of many ecosystems. In 1979, rainforest was disappearing at a rate of 300 acres per hour. In 2000, 1500 acres an hour became desert. Brazil lost 25,000 square kilometers of jungle in 2002. Indonesia loses almost as much. Forest worldwide is lost at 0.4 hectares per second (= 1 acre). M. Williams calculates that over 7 x 10^6 km^2 of dense forest and 3.13. x 10^6 km^2 of open forest have been eliminated since post-glacial times. In 1986 Peter Vitousek calculated 40% of all plant energy was used or wasted or destroyed. Around 1980, human demands for plant materials was equal to the regenerative capacity of the earth. In 1999, it exceeded it by 20 percent

For the first time in human history, in the year 2000, as many people lived in large communities (over 20,000) as in small communities (under 20,000). By 2001, the number of people living in cities reached 56 percent. Sixty percent of Earth's inhabitants are expected to live in cities by 2030, according to the United Nations—the same year global carbon dioxide emissions are expected to increase by almost two-thirds of what they are today. Intense interactions of people in larger concentrations also produce more information. Information in the entire world is estimated at 2000 petabytes (petabyte = billion megabytes or a quadrillion books of 170 pages) by K. Kelly. What was it in 12,000 BC or 0 BC or 1400 by the way? The econosphere may be as big as the biosphere, according to Kelly. In 1998 dollars he estimated the global infrastructure is worth 4 quadrillion dollars—perhaps an overestimate. Mary Daily estimated ecosystem services of the earth at 33 trillion. This is doubtless an underestimate. If you include the worth of the capital that is producing those services, at some nominal interest, such as 5 percent, then the value of the living earth is over 3 quadrillion dollars, which still might be an underestimate.

1.6.3. *Ecolacy* (Links)
Ecolacy was once achieved by studying natural history, the plants and animals that surrounded every human group. Ecolacy is the ability to ask and answer the question: 'And then what?' This would allow the effects of the interactions of systems to be taken into account.

Scientists have been extremely successful using reductionistic methodology on every problem, breaking problems down into their components and studying the properties of these components and their interactions. This has led to the ascendancy of mechanical science—thinking that one can do just one thing. Garrett Hardin stated the important ecological understanding of ecolacy as: 'We can never do merely one thing." This statement is now known as Hardin's Law, and it means that there are always wanted and unwanted effects, products and wastes.

Reality is composed of causal chains of events rather than single effects. Events are embedded in causal networks and are produced by multiple causes and have multiple effects, each of which triggers a causal chain of future events. Hardin contends that since we cannot do just one thing we must always ask and answer that question: "And then what?" We have to try to ascertain the benefits and costs of proposed courses of action on both the individual, social, and ecological levels. The ecological systems way of thinking employs scientific theories and knowledge to study the interlocking processes characterized by many reciprocal cause effect pathways. The ecological systems way of thinking must become an integral part of the thinking of the well educated person if we are to adequately control technology and human actions.

1.6.4. *Discussion of Filters*
David Hargreaves judges that our current educational institutions resemble a curious mix of a factory, an asylum and a prison. This command and control model creates pressure on overloaded people. Ivan Illich's proposal to deschool society means creating learning webs by using existing technologies and spaces, such as town halls. Learners would connect with their peers in new contexts to learn. Learning would not be funneled through one teacher.

The world is too complex for our minds, suggested G. P. Marsh and many later thinkers. So, our minds have to filter out what is less important. We filter data, arguments, emotions, and information. The filter allows a total picture of the whole with relatively little information. Of course that picture might be wrong. But, it is clear, as a result of filtering and thinking. Other human activities act as filters, also, especially culture.

In education and communication, noise is a problem. We are flooded with information, and much of that noise. We have to filter out as much noise as possible and much of the information. But, many cultural filtering systems—William Thackera mentions peer reviews—are collapsing.

The industrial system developed like a jigsaw puzzle with an unknown design. With only a few pieces the pattern is unknown, notes Charles Taylor. Partly, however, that is because we are making the pattern, generating it, as we go along, with bricolage. Our efforts at aggregation and filtering result in a form. As we generate it, more of the pieces fill in and a pattern emerges. But, if the pattern does not fit the environment, it has to change.

Garrett Hardin contends that most of the major controversies of our time can be understood as the result of the participants relying too much on any single one of these three filters. No one filter by itself is adequate for understanding reality and predicting the consequences of our actions. There is, however, a filter that has gone unmentioned, in its ability to concentrate or distort human perception. That filter is the image.

1.6.5. *Imagacy* (Images)

When a hierarchical order cannot adapt its function to an actual situation, then there is a synchronous change in the vertical order. The change in order is discontinuous, although the function is continuous. Since the details are not abstracted to a higher level, one cannot predict when the revolutionary change will take place. In general, revolution is discontinuous and synchronous, whereas evolution first appears to be continuous and diachronous. In the synchronic mode, form is complete as soon as it appears; in the diachronic, the form is slowly elaborated. It would appear that complex processes, like evolution, actually use both modes.

Hierarchical thinking is limited in cybernetics. The concept of control might better be stated as kind of reciprocity or mutual causality. Furthermore, in an open system, the environment, structure, program, and feedback all govern the system in concert. Hazel Henderson states that only the system can model or manage the system, but this is not entirely true. Images can model the system in miniature.

An image is an imitation or representation of something. It can also be a symbol or type, a metaphor or concept. An image can stand for something else, for instance the image of a dove is often used as a symbol for peace. In the etymological sense a symbol is something 'thrown together,' as a problem is something 'thrown forward.' Unlike an image, a symbol often represents some other thing, process or quality. Symbols can be processed by 'Analytical Engines' or computers. These machines have been used for metaphors of the brain, which also processes symbols, that is, the operation of both parts of the metaphor, brain=computer, can be described in terms of algorithms, or mathematical rules for manipulating symbols.

An image of course can be used in a variety of ways. It can reference similarity, correlation or a formal linkage, according to the categories of association developed by C.S. Peirce: icon, index, or symbol. Icons have a similarity with an object, as when a landscape painting depicts a landscape. An index is when an image is causally linked with something else, as when a wolf's howl is related to location or emotion. A symbol has a social convention that establishes the relationship linking an image and a thing, as the Coat of Arms of the Woulfe family symbolizes the family line. Physical connection is not necessary for any of these modes. Peirce suggested that the difference between the modes of reference could be understood in terms of hierarchical levels of interpretation. Symbolic relationships are composed of relationships between sets of indices, and indices are composed of iconic relationships between sets of icons. Understanding a higher level means decomposing it to a lower-order form. Understanding the logic of images, as well as their power, is important to their use in communicating and design.

An image, especially a cosmology or an image of the world, models the system in miniature. From the image, which can be a paradigm or mind-set, a whole system can arise, with unique goals, rules, parameters, and structures. A cosmology includes a mythology constructed as a poetic system. Joseph Campbell states "Mythology—and therefore civilization—is a poetic, supernormal image." Mythologies and religions can be understood as great poems. When recognized as such, they point through individual things and events to the ubiquity of a presence that is whole in each. This is what P.B. Shelley meant when he wrote that poets are the ‘unacknowledged legislators of the world’—not that they pass laws or prophesize the future, but that they generate images for the future, and these images can be articulated into goals to influence our actions. Bad images, from indifferent poets, can relate to severe cultural problems, as when popular Italian poets romanticized the violence and hatred of Fascism. The mechanistic images of science, from Shelley to the Fascists, determined much of the violent conquest of nature.

Kenneth Bounding notes that the image as a cognitive construct of the world has several aspects: Spatial, temporal, personal, relational, value, and affection (emotional) for each individual. The total sum of individual images is a world of interrelated constructs. This parallels the experiences of other living beings. Using its senses, each participant creates an image of nature, or world—umwelt, life-world, is the term used by Jakob von Uexkull)—from the sensations that are meaningful to it, and which limit it. Simple beings, such as bacteria, make a relatively simple image, whereas more complex beings, such as apes and humans, forge more complex images.

In fact, human beings design complex images for a variety of purposes, including to make a profit or to persuade others to join a group. In this, design reflects the economic and political bents of humans. In a hyperactive marketplace, design responds with sophisticated images and crass intentions. In the city, design responds with an architectural icon, the skyscraper, for expressing power, status, success, and victory over limits and the environment—however temporarily.

In the discussions of design, the importances and weaknesses of images will be explored. Images will be added to the complex ecology of people, projects, tools, and social structures in an open living system. William Thackera wondered if such an ecology could be designed. Perhaps it can.

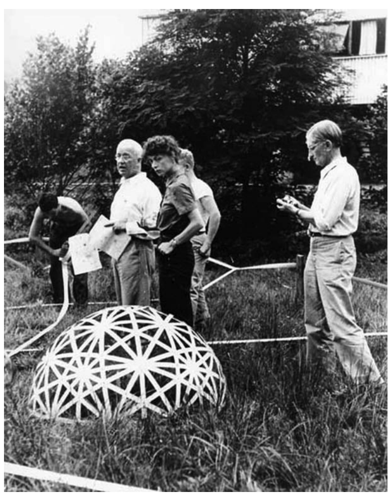

Figure 165-1. R.B. Fuller class on the Supine Dome 1948

2.0. Approaching Local Systems with Design

How can we approach an ecosystem as a whole? Scientifically? Technologically? Aesthetically? The planet is relatively old and large, with a unique history and many dynamic ecosystems. There are ways of dealing with systems that are not scientific or technological; they are aesthetic or ethical. To examine something that is larger than our logic or perception, we need a different approach. To examine nature in general, we must shift to a taoistic approach, asking rather than telling, and observing rather than manipulating. We need to be receptive and passive, rather than active and forceful, and nonintruding and noncontrolling, instead of pushy and manipulative. A taoistic approach stresses noninterfering observation rather than controlling manipulation; it is receptive rather than forceful. This is part of the paradox of duality; it is detached yet concerned, free yet committed, and independent yet responsible. Perhaps the taoist is another path to objectivity with greater perception.

We are skilled at iconic perception and aesthetic perception, but seem unable to use a double perception. Aesthetic perception offers a reassuring vision, which interprets or identifies nature—we need a naive vision, which surprises, shocks, fascinates or seduces the senses, which awakens desire and stirs the imagination, and which furnishes a feeling of the invisible. Iconic perception offers a cognitive view of the planet that reduces the planet to the limits of logic—we need a holistic view, compounded with the unconscious and feeling.

Nature is an extremely sensitive nexus of means and ends. Nature is a feeling system. We need a new animism to approach nature, the understanding that perception is part of feeling. This animism would allow us to behave "as if" nature was intelligent and sensitive, and as if we were loving and wise. Loving perception provides kinds of knowledge not available to nonlovers; this is especially true in ethological literature. Abraham Maslow cites his own work with monkeys. K. Lorenz, N. Tinbergen, G. Schaller, J. Van Lowick-Goodall, and M. W. Fox have found it to be true. This is the way a good psychotherapist, teacher, scientist, parent, or friend functions. And that has to define our approach to the planet.

We can apply designs to ecosystems on many levels. We are doing so accidentally now. But, the designs have to consider the limits of systems, as well as limits to the human enterprises. We might start by designing ecosystems, artificial ones on a small scale, for the express response to problems caused by inappropriate scale, interference and waste disposal.

2.1. *Human Design & Ecosystems*

Humans have designed many things, from tools to trade routes. And, we have changed many different ecosystems to be more productive for us. But, we have not attempted to design humanity, human systems or ecosystem patterns.

2.1.1. *Why Design?*

Why should we need to design ecosystems? An ecosystem is self-making, self-managing, and self-renewing. What can human design add to that? As a young, exploring innovative species, we have added diversity and interest to other living forms. We became hosts for many new parasites and types of bacteria. Our feeding patterns encouraged other species, which did not taste as good to us, to compete successfully. Other animals and plants found us useful to live near. As an older, confident, successful species, we started to convert ecosystems to what we wanted. Now that we are self-satisfied and arrogant, we find that we are influencing every natural system, taking what we need from some ecosystems, enhancing a few, misusing others, and interfering with the rest; we are creating patterns that we cannot control. So, what can we do? We can control ourselves, we can control our influences, and we can abstain from trying to control every variable in a system and every system on the planet. That may be the concern of the design of human limits.

There is no guarantee that nature can provide humans with everything they want. Recognizing the lack of guarantee is simply recognizing that nature is wild and we must come to terms with nonhuman beings and processes. It is not enough to arrange trees in rows to maximize future harvests; it is not enough to preserve small areas of old-growth without natural disturbances. We must pay attention to the processes that make up the habitat, for example, the role of herbivores on trimming vegetation (and diversifying it by predation). The design of an ecosystem and its management must ensure that the processes operate to maintain a dynamic state. Furthermore, the context must be conserved. The ecosystem, however, cannot be considered outside of the context of the entire landscape, including human images and institutions.

We need good ecological designs to restore the balance between human needs and natural processes. Ecological designs focus on whole communities that work in the same self-sustaining and self-limiting ways as nature. By consciously creating meaningful order, we can develop ways of producing widespread community wealth while positioning the community for a long, sustainable future in a healthy environment.

What are we considering when we talk about the design of regions? Should we build new islands or paths? Restore species or guilds that have dropped out or become extinct? People are often discussing solutions to local problems, such as deforestation, that would entail massive planting programs in some places. These technical aspects may also be the concern of a design of physical alterations.

2.1.2. *What is the Local?*

What does the word local mean? A local system, for instance, has unique characteristics that emerge from smaller local interactions. What does it mean to be local? These terms are terms of scale, used to describe a field.

2.1.2.1. The Local Field

The concept of the field allows many things to be related internally and connected by scale. These operations of the field scale to other aspects of the field need to be addressed by designs on various levels. These properties of the field are important to design because they must be considered if the design is to be stable and useful. Local design has to address these properties to be successful as design. Local design has to consider the emergence of new characteristics and the qualities of patterns, especially those related to connectedness and scale.

Local system properties are a set of constant constraints on local systems. These differences will have important affects on local ecological design. Cultural systems develop patterns (especially as related to design): Paths, Nodes, Networks (hierarchy), Fractals (Explosions Implosions, traps), Spirals, and Cycles; and these can create problems with feedback to local design (where there is not enough feedback or none).

2.1.2.2. Local Scales

Differences in scale are often called local or global differences (in systems theory). Concepts of scale apply to physical and biological fields. Local fields or events are those separated from other fields or events and exert minimal influence on the others. That is, the internal connections inside a local field are stronger than the connections between local fields.

Local systems create regional and global systems; at the same time local systems emerge from a regional and global system, which has characteristics that emerge from the interplay of local systems. Regional and global systems have properties that no local systems have, such as an overall climate or global biogeochemical cycles. James Lovelock suggests that the interaction between hardwood forests and softwood forests may act as a global regulator of oxygen for the entire planet. Many things, such as human poverty and species extinctions, only seem global because they are happening in many local systems at the same time, and may effect regional cycles.

Local fields have characteristics that distinguish them from the regional fields. Local fields can be characterized by: Separation, limited influence, disjunctiveness (the future is not like the past), reflection of local conditions, contribution to the regional, and territoriality. Separation refers to location in the regional field (space-time), as well as having different make-up and different environment. The local is independent of other local fields. Local properties may not determine the variables in other local fields. Having a limited influence means that there is often a weak connection with other local systems, and sometimes little affect on the global. A local field has an immediate effect on only a small fraction of the totality of parts of a regional field. Ross Ashby uses the example of a chemical reaction of silver nitrate and sodium chloride, producing AgCl, but not influencing the regional system. A local system reflects local conditions. Of course, local systems develop historically. In this case local fields have similarities with regional fields.

Table 2122-1. Local Regional & Global Properties

Local	*Regional & Global*
Separation	Connection
Limited influence on other locals	Affect on all locals
Reflection of regional influence	Constraint on local
Disjunctiveness (future different)	Internal temporal organization
Contribution to regional	Independent of any local
Limited by regional & global	Emergent properties from local

Local fields can be described as: Emergent, with new properties; internally organized; constraining the local, affecting all locals, and independence from any local. In general, regional systems emerge from local systems; they have unique properties that local systems do not have. The properties are not repeated independently in local systems. Often the properties are too interconnected to be independent. Ashby uses the example of chemical and biological reactions that form protoplasm. Properties are emergent if they are not predictable from the analysis of local systems. For example, hydrogen and oxygen are gases; under certain circumstances, they combine to form a fluid, water. For another example, the tasteless gases hydrogen and oxygen can combine with carbon, in certain biological processes, and form a sweet, solid sugar. In a third example, amino acids, which can form as a result of volcanism in an early atmosphere of the earth, can be combined in living processes to make protoplasm, which is self-making; this new property is a surprise. The new emergent properties are protected from factors that could reverse or destroy them. Furthermore, they are not reversible due to historical development. The regional can organize local systems in internal relations (and have relations with an external environment). The regional puts constraints on the local; that is, it limits the action of local systems. The regional has connections to all local systems, even those that have no connections to other local systems. Regional change affects all local systems. But, a regional system is independent of any local system; the local may have minimal influence on the regional. Regional systems develop historically. As regional systems become larger, when the range of size of part to the whole is larger, the properties of the whole are more likely to be very different than the local.

The regional level has many more kinds of feedback, as it consists of many more subsystems. Furthermore, the rate of feedback is expected to be much slower. This means longer times and longer lag times or delays. Laws defining constraints on the whole cannot be derived from the laws of parts. Regional systems properties are a set of constant constraints on local systems. These differences will have important affects on regional ecological design.

Switching our attention from a focus to the larger frame usually involves a change in scale. Scale has several meanings. Basically, as it is used here, it has to do with the level of measurement in a space/time energy/mass context. For instance, in forestry the measurements of leaf litter by foresters can be made at several scales: Single tree, stand, annual measurements, or stand life measurements. Processes that are unimportant at a small scale might be vital at a large scale. Too much litter by one tree might be unimportant, but too much litter in one stand in one year, for instance, might suppress a soil cycle; too little litter over a century might interfere with several regional or global atmospheric cycles (for more forestry examples of scale in design, see the book *Good Forestry*).

2.1.3. *Why Start with the Local?*

Because an ecosystem is a unique whole, local design has to address the uniqueness of the whole, the special emergent properties of the whole. For example, it makes no sense to discuss the amount of CO_2 in the atmosphere without paying attention to the carbon, oxygen and water cycles—or in fact, any cycles, ecosystems, or organisms that impinge on carbon dioxide—or in fact the deep history of the atmosphere and planet, as well as the structure and function of the atmosphere.

All the layers and processes within the whole are subject to restraints and limits on the whole system. The whole is not equal to its levels; it is more than the sum of the levels, to sharpen an old saw, so to speak. The local system moves and develops as a whole, subject to regional and global constraints. The whole system maintains its identity through continuous self-making, or through autopoesis in the words of Francisco Varela. The system develops through a continuous dance of autonomy and control, according to Varela. By reducing the study of the planet to the chemistry and physics of a subwhole, or holon, science can lose sight of larger emergent patterns.

The framework of our thought has to be concerned with the whole idea of ecosystems bound up in living patterns. A coherent, flexible framework can provide the context for the problems of atmospheric warming or extinction pulses. The organization of our thought requires the vision of the whole. Our efforts have to be directed to the good of the whole system.

2.2. ***Holecological History of Life***

(Being edited)

2.3. *What is Natural Design?*

Poets and biologists often look at patterns and events in nature and express appreciation at how well nature designs things, from eyes to sunsets. But, we have to ask, is it design?

2.3.1. *Does Nature Design?*
Does nature design? Does life design living beings? What about self-designing systems? Does nature really design forests or streams? Perhaps we should say that nature is self-organized? The self is a scaled phenomena. The small self is organism-centered. The larger self is part of a self-organizing web. But, self-organization is not self-design. Are living beings designed? Nature obviously produces complex beings over long periods of time, and it does so in a way that has been referred to as design by people for several hundred years at least. It seems possible that motion, over time, at various scales, results in greater complexity of elements and arrangements, automatically resulting in living beings. This process takes place in a changing biophysical environment, as a form of ecological play, complete with system economies and with living values. The process of nature is described in those four categories.

More complex kinds of patterns, such as the circular pattern, suggested by the myth of eternal recurrence, depends on regular repetition, as with the seasons. It allowed disintegration to be replaced by regeneration. The helical pattern is innovatively cyclic, and the cycle is additive and seems to reach a higher stage with each repetition. Finally, there are nonlinear patterns. These seem to have more surprises due to the acceptance of complex nonequilibrium systems. They may evolve in a definite direction, but can do so by leaps and turns.

Of course perception is a large part of patterns. And, we perceive the direction as being towards more complexity and more integration, until we have a global society, coordinated on several levels, within a more complex biosphere.

2.3.2. *Natural Design*
The patterns of nature form due to characteristics. These characteristics can be grouped according to their human use, from the surrounding biophysical environment to valuing.

2.3.2.1. Characteristics of the Surrounding Biophysical Environment
There are some characteristics that we can say that nature has, as a result of its historical motions and patterns. This set ranges from patterning to interaction limiting (a kind of principle of least effort applied to physical process).

2.3.2.1.1. *Self-patterning*. A pattern is a regularly array of similar units. The units do not have to be exactly the same shape or size, and the regularity does not have to be perfect. Many of the laws of physics are nondeterministic laws (or stochastic) and they influence natural and human systems. Our ignorance of them lets us get caught by surprises. These laws create patterns in space, as well as in human history. There are simple kinds of patterns. A linear pattern tends to be interpreted as progress or regress—this is the dominant concept of unending progress in modern history. Patterns have a form, sometimes repetition, and sometimes regularity, but each of these is caused by some limiting factor. As Paul Weiss noted, the patterns of organic nature are a combination of order and diversity; order involves constraint while diversity requires freedom for difference. Some scientists describe organisms as being configured by energy through time, but organisms are material patterns in space as well. Regularities in systems are patterns. Paul Shepard describes living natural "objects" in terms of events that constitute a "field pattern."

2.3.2.1.2. *Creating forms*. History creates unique patterns, especially in ecosystems. Each ecosystem is unique in its form, information, and in its dynamics and history. In creation and recreation, things form and unform, reform and unform, then form again. Creativity is the process of recombination into forms.

2.3.2.1.3. *Self-making*. Nature is autopoetic, that is, self-making (from the Greek words), according to Francisco Varela and colleagues. Autopoesis refers to the dynamic self-producing and self-maintaining activities of living beings. That means that organisms have identity, integrity, self-boundedness, and use external supplies of energy and materials for their own maintenance.

2.3.2.1.4. *Wholeness*. Energy, information, matter, life are part of inseparable whole, with no formal theory linking them. Relativity, quantum theory, and entropy imply individual wholeness, in which the analysis of something into distinct parts is no longer relevant to understanding the whole. Relativity and quantum theory both imply the need to regard the world as an undivided whole, not as a spectral oneness, but as a diversity of the whole from many perspectives. Wholes are mutually defining, but also self-defining or self-making. Nature is a whole system, as well as a self-making system; species and organisms are self-making. Wholeness is related to health— indeed, the word 'whole' comes from the Indo-European root, which is also the root for the words health and holy.

2.3.2.1.5. *Systemic*. A system is a way to explain part of the universe and to deal with complex behavior, using the concepts of feedback and emergence. Systems theory analyzes events, processes, and patterns in the world. An event is a change of state that is described by two points, an initial and final state. A process is a sequence of states, also called a history. A process creates a path, described by a trajectory of states. A process is described as evolutionary if it involves emergence and the creation of new things, as in general speciation; to be a species, however, the novelty has to reproduce, multiply or diffuse. Systems have a limit in size that may be determined by structure or the speed of turnover of components. Systems may have limits in terms of the number of connections that can be maintained with other systems. Systems are considered to be wholes where the internal connections are stronger than the external connections. Connectivity is related to the size and density of a system. There is no whole system without an interconnection of its parts, and there is no whole system without an environment. Everything is connected in a system; removal of any part alters the dynamics of the system.

2.3.2.1.6. *Processing Patterns*. Nature, for A. N. Whitehead, consists of patterns whose movement is essential to their being. These patterns are analyzed into events or occasions. Process is dynamic change in an unfolding flow. Process is the fundamental feature of nature. Life has patterns as well, that are shaped by rules and physical limits. The first thing that every living being creates is an inside, to wall out the outside, but not completely. Living beings tend to have a few themes that can be expressed in many variations. Living beings tend to optimize their shapes and sizes, depending on the environment. Living beings are opportunistic, that is they take advantage of new resources that may result from physical or biological processes, for instance tides or other forms of life. The act of living includes errors in form and information. Living beings build from the bottom up, even complex ones repeating older patterns of development.

2.3.2.1.7. *Development/Change & Filtering/Sorting*. Patterns change and develop. Evolution can be described as an unfolding of patterns that are filtered by a changing environment. These patterns can be analyzed into events. Biological reproduction is prolific, but is limited by processes such as predation, by material and energy cycles, and by the ability to find solutions to filtering processes. Francisco Varela analyzes the evolutionary process as satisficing rather than optimizing; that is, a suboptimal solution is adequate to continue living; striving for an optimum or maximum does not pay off in terms of investment of effort. Wallace described evolution as a conservation process, similar to the centrifugal governor of a steam engine. Darwin used 'natural selection' as a metaphor for evolution. Evolution is then the changing theme of the conversation between species and environments. Evolution may be interpreted as the development of new channels for communication. A process is described as evolutionary if it involves emergence and the creation of new things. The process of evolution at all levels is the formation of varying sets, and the differential elimination of some sets and survival of others. Consequences include directional change at all levels, an increase of organized diversity in the universe, and the evolution of wholes maintained by interlevel feedback.

2.3.2.1.8. *Place generating*. A place is generated by living beings as they exist, bounded by their environment. That boundedness gives a place its identity and integrity, and allows it to maintain itself in a definite form and process. Places are patterns of things and webs of relations that can be understood by observing and participating. Like any "thing" or system, a place is extended in space and bounded, so it has an inside and outside. As part of a geographic approach, most places can be located on the earth. Like any finite thing, a place is a unique set embedded in a larger system; it is a local thing connected to other places by dynamic processes and cycles. Places have meaning for the species that have modified them by living there for generations. For humans, places have even more of a psychological dimension that reflects the personal investment of energy and emotion in a place.

2.3.2.1.9. *Place responsive*. Place can be described as a field that orders itself. The types of ordering depend on the local characteristics of place. Plants and animals respond to place by creating their own world, according to their complexity and needs. An organism is inseparably related to its habitat, the place where it lives. Individuals are related to places by basic physical factors. Place provides limits to which individuals have to adapt. Places and organisms shape each other through feedback. Insects and animals displayed a powerful attachment to places, as Adolf Portmann observed; this attachment can be best understood as home. Several metaphors have been used to describe the human place on earth: Storehouse, property, or a spaceship. But the earth is not a spaceship or storehouse; it is home.

2.3.2.1.10. *Dynamic nonequilibria*. Like any finite thing, a place is a unique set embedded in a larger system; it is a local thing connected to other places by dynamic processes and cycles. Individuals are part of complex large dynamic systems. The organism is a dynamic structure that is immanent and simultaneous with the process, rather than just a consequence of the selection of individuals modified by mutation. The organism is what it does. Dynamic change is the result of a process unfolding in an advancing flow through place. Process, the coming-to-be of organisms, is a fundamental feature of reality. The process of nature is not merely rhythmic change, but it is a creative advance, producing new forms in place.

2.3.2.1.11. *Interaction limiting*. To survive, an ecosystem depends on the interactions and balance of many variables, most of which are not well understood. In any system the possible number of interactions is limited by the specific variables of the system, with its complement of living forms and resources. While it is meaningful to speak of an optimum diversity, as the result of limits and the interaction of many factors, a maximum diversity may never be reached in any system. Maximum order would result in a static universe, whereas a maximum diversity would create a nonordering chaos. As Paul Weiss noted, the patterns of organic nature are a combination of order and diversity; order involves constraint while diversity requires freedom for difference.

2.3.2.2. Developing Ecologically

Biophysical systems develop into ecological systems, which can be described in terms from aggregating to actual existing.

2.3.2.2.1. *Nature-based*. Nature in general (certainly pre- or nonhuman nature) is nature-based, that is, it does not seem to rely on any external factors, other than physical constrains and sunlight.

2.3.2.2.2. *Aggregating*. Aggregation is usually the first step in the self-assembly of individuals, from cells, and groups, from individuals. The word 'individual' is a metaphor. As such it refers to aggregates (sand), functional units (populations), and autonomous, self-regulating beings (a wolf). The world is a sloppy place; to describe it, it is better to build a model with a high redundancy of subsystems, each of which is coarse, but the aggregate of which gives good adjustment to environmental events. Claude Levi-Strauss described such a process as bricolage, fitting the bits together, identifying impressions of life as sets and forming them into systems. This is what nature does with organisms and niches. An organism is an intentional being that, with other members of species, can create niches, that is custom places, as well as adapt to them. M. Krebs states that the fundamental niche of a species has an "infinite number of dimensions," making a complete determination impossible. Those species that enlarge their niche also enlarge the ecology as a whole. Species integrate themselves into the system over time, using previously unused productivity or waste in developing their special niche. Each ecosystem, however, sets the limits for the style and complexity of its individual species.

2.3.2.2.3. *Trial & Error process/Novelty testing*. Animals learn through a kind of empirical testing from trial and error (for humans, books are a kind of redundancy of trial and error learning, or as Buckminster Fuller said, 'trial and error error error.'). Evolution is trial and error process of learning that takes place on an immense timescale of billions of years. All learning contributes to the evolution of a larger pattern. The activities of two communicators combine to make the universe of the observer more ordered and redundant. After all, the goal of life is experience, not efficiency; and redundancy promotes experience as well as stability. Natural processes that seem destructive are cyclic and preservative. Ecosystems that seem inefficient and wasteful are many times redundant, and therefore stable and flexible.

2.3.2.2.4. *Trial generating*. Natural environments test organisms with challenges. This generates trials of the kinds of organisms and can result in success or failure if the challenges are survived or not. Nature generates trials of new forms, not only on a large time scale, but on the physical scale of the planet. Most trials result in failure. Even success applied to new conditions can result in failure. Failure from success can be tragic at the human level.

2.3.2.2.5. *Novelty generation*. Ecosystems with living beings change and turn. The sediment of the past is a given and different for each present. The ceaseless activity of being creates newness, that is, novelty is born from the womb (*hystera*) of change. History is the result of this hysteretic process. Change maintains the openness of an ecosystem, and allows novelty in the system. Individuals also use various patches and areas in one or more systems; they create paths between these areas. Their activity can change the character of these areas. The organism and environment are co-implicative, co-defining, and co-constructing. They engage in a process of self-assembly, where the complete self is the organism-environment system. The process of construction involves a self-presentation offering new symbiotic relations and novelty. Novelty always enters with environmental change, which serves to maintain the openness of the system. The "strategy" of ecosystem development is increased control of, or homeorhesis with, the physical environment and novelty—probably to protect itself from perturbations.

A process is described as evolutionary if it involves emergence and the creation of new things, as in general speciation; to be a species, however, the novelty has to reproduce, multiply or diffuse. Balance is an ideal for humans: Too much novelty is stressful, it is too new to understand, and too much of the sameness is stultifying; too much conflict is stressful, but too much peace is boring.

2.3.2.2.6. *Reciprocal interactions*. Ordering of the world makes places from wilderness. A place changes qualitatively; it becomes structured. Fitness is achieved after slow, progressive, reciprocal adaptations; it requires a stability of relationships between societies and place. The nodes in tree or net represent elements in a system. Their links suggest interconnections.

These are three general levels of interaction: Individuals, species and systems. Animals and plants, algae, bacteria, fungi, live together in ecosystems. In an ecosystem, individuals and species are connected to some degree, in terms of quality and quantity of connections. There are three basic kinds of interactions: Neutral, negative, and positive. Living together involves many kinds of interactions, from competition and conflict to cooperation and mutualism. Interactions may be reciprocal or complementary. They may dominate or control. Interactions are multidimensional. A wolf, for instance, may howl to communicate, or to restore proximity with a mate, or for simple pleasure. Many animals, such as wolves and caribou, develop together over time, adapting to each other's strategies. Paul Ehrlich and Peter Raven refer to this mutual adaptation as coevolution. Coevolving systems never completely adapt. Coevolving increases the quality of the environment.

2.3.2.2.7. *Bottom-up organization*. Complex adaptive systems display emergent behavior. As an example of emergence, slime molds can form a community without a pacemaker cell that determines when the cells need to combine. It seems that self-organization is bottoms-up. Emergent systems are rule-governed, though; slime molds explore by adhering to low level rules. Individuals coordinate work, even if they cannot assess the global situation. Emergent systems are local; individual molds "think" locally and act locally. Random action serves to explore local space. Individuals pay attention to their neighbors, however, and patterns emerge from local activity. Simple behavior seems to work, with local feedback, and more sophisticated behavior "trickles up" to approximate a global organization.

Unfolding implies the interweaving of processes of structuring at different levels. Evolution acts in the sense of a simultaneous and interdependent structuration of a micro and macro-world. Complexity emerges from the interpenetration of processes of differentiation and integration, where the processes run simultaneously from top and bottom, and shape hierarchy from both sides. The predator serves as a top-down limit for prey species, keeping them healthy by altering their behavior, removing young sick and old individuals. Of course, in the system, there are bottom-up limits also, as plants change their chemistries to attract or avoid predators of their own.

2.3.2.2.8. *Physical restraints.* The limits of the universe, like the speed of light or the quantum of a field, put limits on freedom; freedom is defined here as the absence of restraint or confinement, or the state of being free from rules or patterns. But, limits cannot be complete, any more than freedom can. Individuals adjust to the restraints of an environment, but their activities change the environment, putting new constrains on other beings or systems. The process of nature is not merely rhythmic change, it is creative play, transcending restraints and resulting in a creative advance, in A. N. Whitehead's words, producing new forms everywhere.

2.3.2.2.9. *Natural process.* The goal of processes is continuity, as living beings emerge from previous states. Species and places depend on other species and natural processes. Natural processes, such as fire, wind, or species explosions, operate freely, even as they alter the functioning of the system. Natural processes that seem destructive may preserve larger patterns. Natural processes are their own purpose and constitute their own value. Natural physical and living processes sustain each other. Natural processes take on significance of their own without reference to humanity.

2.3.2.2.10. *Actual Existing*. In fact, nothing exists by itself, that is, not in relation to other characteristics, activities, or systems. Nature takes in, or conceives, things as parts and wholes. Wholes and parts do not exist absolutely. John Wheeler's alternate worlds are really the umwelts, the existence worlds of particles. Particles choose their paths from probabilities. The universe owes its existence to trillions of acts of registration by beings, according to Wheeler. For example, since individual things or organisms are part of a field, they are are internally related within the field, and they cannot exist without the field. The field, or physical society, provides the order required for producing individuals. Individuals are connected in place by infolding movement. Each animal is a participant in a field of existence. Living beings synthesize the parts and find meaning in living there, and in doing so revitalize a place. Karl Popper conjectures that besides the theory of the hostile environment (passive Darwinism), there is a complementary theory of the friendly environment. Many organisms are active explorers, searching for new, friendly environments. Conrad Waddington said that the "general anagenesis of evolution is towards what may be crudely called richness of experience." The goal of all creatures is to come into the fullness of existence.

2.3.2.3. Economizing

Nature makes an economy of the interactions of beings in patterns. This economy can be described in terms ranging from productivity to gigatrends.

2.3.2.3.1. *Productivity* (Or creative waste or natural capital). Nature is productive, that is, plants living in ecosystems transform solar energy into food energy. Systems of forms produce the materials and energy needed for others. The amounts produced by each system are limited by temperature, moisture, and a variety of other parameters. Resources and living beings in patterns are the natural capital of systems; productivity is the interest of the system, and productivity that is not use by the system or any system is the interest that is not available (although, as creative waste, it may be used later in other systems).

2.3.2.3.2. *Interrelational*. The expression of life points the mind toward the broadest meaning. It points, not toward truth, but towards an ever-enlarging relational field. It points to the frame, in fact. That which is the frame must be ambiguous. Frames themselves must be used as metaphors. For human ecology, Arne Naess rejects the image of man-in-environment for the relational, total-field image. He characterizes organisms as knots in the biospherical net, a field with intrinsic relations. The relationship with other beings becomes part of the basic constitution of a being. Relational qualities can be understood better by a morphogenetic logic, which can be characterized as relational, qualitative, symbiotic, heterogenistic, reciprocally causal, and interactionist.

2.3.2.3.3. *Nested*. Ecosystems are scalable and can be nested within others. Every thing could be considered as a set of nested ecosystems, from a body to the planet. Each nested system acts as a subwhole at a lower level and a whole at a higher (or outer) level. This nestedness allows linkages between scales.

2.3.2.3.4. *Interdependent*. As with an organism, the various parts of nature are so interdependent that nothing can be abstracted without altering the identity of it or the whole. Whole things are mutually defining, but also self-defining. Any living system is the history of the maintenance of its identity through continuous self-making or autopoesis. By comparison, unfolding implies the interweaving of processes of structuring at different levels.

Evolution acts in the sense of a simultaneous and interdependent structuration of a micro and macro-world. The elegance of a fish pond and the delicacy of its stable disequilibrium are the outcome of a long evolution of interdependence. But, no one has ever made a complete census of even so simple a system as a pond.

Many local patterns flow together through time interdependently, sharing materials. The death of one pattern sometimes leads to the death of other patterns. None of the bodies or systems are completely independent or completely bounded; they are interdependent and open systems. A body or system is only maintained by a flow of energy and materials from its surrounding environment.

2.3.2.3.5. *Solar-life driven*. All of the energy on earth comes from the original formation of the universe, solar system, sun, and the planet, although the transformative energy of the sun directly drives most biogeochemical cycles as well as plant life. The traditional economies of animals and humans are based on solar energy and natural productivities. The earth is suitable for life because of three kinds of limits: the solar radiation that has stayed within certain limits for four billion years; the biogeochemical cycles of oxygen, carbon, nitrogen, phosphorus, sulfur, water, and other elements have stayed within certain limits; and, the constancy of the environment, which is constant enough for organic evolution, but variable enough for natural selection to be challenged.

The planet started as a mixture of chemical elements (over a hundred, including hydrogen, helium, and nitrogen) circulating over an active geology, driven by solar energy. The ecosphere acts as one system in which energy from the sun is cycled. The functioning biomass is integrated by feedback responses to extract enough energy and still maintain a balance. Most of the solar energy is used for maintenance by the biosphere. The regular effect of light, the availability of oxygen, the thickness of soil, and the area and depth of the oceans is almost a steady state (or homeorhetic state), that is, a constant pattern from the steady flow of energy.

2.3.2.3.6. *Aesthetic creation*. Living in place orders experience, which is an aesthetic function. As animals perceive nature, they use pieces of things as food, nutrients, resources, or tools—at least wolves, termites, and chimpanzees do. Most animals and maybe plants in a species share similar aesthetic preferences. For human beings, most prefer natural scenes similar to an African savanna: Rolling expanses of grasslands with clumps of trees in a warm but dry climate. For a long time, that environment dominated created images. This may be why humans value walking in the woods or observing the production of art.

2.3.2.3.7. *Waste generating*. As a mature ecological system becomes more efficient, it supports a larger biomass with the same amount of energy. The food chains become more web like (dominated by detritus chains as opposed to linear grazing). Mineral cycles become closed and the nutrient exchange between organisms and the environment slows. All systems generate some waste, from degraded energy to unused productivity. Waste is defined as the materials or energy not used by a single system. Waste is a strangely inappropriate category; the waste of one system is almost always a potential resource for the next system. Even the waste of the sun, light, is a resource for plants on earth. Renewal of a system is limited when too much of the system is lost through waste. In nature, other systems develop that can use the waste of 'up-stream' systems. These become partnerships when the first system can also use wastes from the second, as a result of larger cycles. In economic terms, waste can be part of the capital for a subsequent system (in space or time). For example, coal formed as the result of slow cycles that produced waste vegetation (not consumed by insects or animals and returned to the system—however, this waste is capital in modern industrial systems).

2.3.2.3.8. *Free play/change*. Change occurs as the result of the free play of elements in a system. Change does not seem to have a purpose or function. Nature has no cost or efficiency considerations, although more complex forms may be more efficient—actually the system, an ecosystem, may be more efficient as it matures.

2.3.2.3.9. *Gigatrends*. Things change, sometimes rapidly, sometimes slowly. Rapid change may be considered a revolution or a catastrophe; slower changes as sometimes referred to as trends or fate. A number of large, long-term ecological trends are evident, for instance, long periods of increasing or decreasing temperatures. The long-term increase in complexity that emerges from historical life activities, as well as the increase in cooperation between members of different species, either partnerships or symbioses. Ecosystems build up information. There are at least three different interacting channels of information in an ecosystem: The genetic, in replicable individuals; an ecological based on interaction between cohabiting species, expressed in changes in their numbers; and the cultural, transmitted through individual learning based on experience. Feedback within the interaction of species is expensive memory with little storage capacity. Whenever succession starts again, after a volcanic eruption, for instance, old information of interactions has not been saved. Genetic memory has a larger capacity and is long-term. Cultural memory has a large potential capacity.

2.3.2.4. Valuing

Living beings value their living. They value the things they need to keep living. They modify themselves and their environment, as a result of living.

2.3.2.4.1. *Living*. A response is a reaction to a challenge (as an event or condition). This is not the same as a responsibility that involves an obligation or accounting. During the evolutionary development of living responses to environmental challenges, living beings tested many kinds of designs for their tools, places, and living habits. These initial designs often worked well in situations of limited resources or limited power.

2.3.4.2. *Fitting*. Animals and plants try to fit into places in the environment to use what it offers to survive. That is their strategy. Patterns have a form, sometimes repetition, and sometimes regularity, but each of these is caused by some limiting factor. Fitting the pattern to patterns of the environment can lead to both continuity and predictability, and both of these are needed to adapt living activities to natural limits. Being fit is the ability to function and reproduce under normal environmental conditions. Fitness can be measured quantitatively by testing. Fitness builds up in an ecosystem as it matures. Selection at the organismic level is selection of the fit. The levels of selection must balance, so that life is not too fit or too unfit. Evolutionary fitness cannot keep increasing. In some cases it decreases with time (E. Haeckel's observations on senescence support this idea). Perhaps species are self-limiting in fitness.

2.3.2.4.3. *Harmony-building long-term*. Harmony is related to wholeness— indeed, the word 'whole' comes from the Indo-European root, which is the root word for harmony, health and holy. Living order can also be defined in terms of the influence of the whole over the parts. Disorder at the level of a molecule can reflect the higher level of the order of a cell. The machinery of a cell is not a permanent fixture, but is disassembled and rebuilt periodically, according to specific patterns and in harmony with the functioning of the cell in its environment, that is, the organ or body. Paul Weiss shows that parts of a cell are constantly changing, growing, dying, breaking up and recombining, but under control at a cellular level. Harmony can contain discordant notes and themes and weave them into a rhythm.

2.3.2.4.4. *Existence Value*. In the larger view, evolution is value-free. Creation and destruction, as well as beauty and ugliness, are expressed in one complex pathway. At the same time, a reversal of values associated with an evolutionary, or ecocentric, perspective supports the concept of intrinsic value. Values usually encode information having survival or prestige importance. Perhaps the most valuable thing is living time. The experience of life—aesthetics—is also valuable. Each being has intrinsic value as a perspective, a unique packet of in-form-ation and experience. Bees have bee value; wolves have wolf value. Wolves are not efficient at binding nitrogen; neither are humans. Lichen are poor predators, but they break apart rock better than bighorn sheep. Living beings also have value to others; according to Eugene Odum, every being that is part of the food chain has value to many others. Dung has value to a dung beetle, mice to a coyote.

Individual beings may have not only self-value and other-value, but ecosystem value, as when mycorrhizal fungi fix nitrogen and support cycles and systems. Values are not always hierarchical or consistently ordered, however. Some things have value for the species (or ecosystem or culture) that may not be apparent to or wanted by the individual—in the sense that the predator contributes to the diversity and health of the prey. Some things of value to the group are harmful to the individual. Ecological value includes predictable changes to the system. In this sense, the everglades in Florida depend on hurricanes as much as Ponderosa pine forests in Oregon depend on occasional fires.

2.3.2.4.5. *Learnable*. Through living, an individual learns the seasons, the foods, and the values of the group. They learn what they need for living. Ecosystems 'learn' the rhythms of patterns of disturbance or change. The ecosystem 'learns' the changes, e.g., seasons, of the environment. Any system formed by reproducing and interacting organisms must develop an assemblage in which production of entropy per unit of information is minimized. It is a general property of some systems that acquired information is used to close the door to further inflow. A mature system needs less information, since it works toward preservation rather than growth or expansion. The limit of maturity allows maximum variability between systems with slight external differences, like temperature. Ecosystems consist of different prefabricated pieces: species. Since the supply of species is limited, succession becomes asymptotic, that is, it leads to maturity (or in the old terminology, a climax).

2.3.2.4.6. *Adjusting*. Living beings make the places they live in, or rather they adjust themselves to fit the places and then remake places by adjusting them to fit themselves. They fit into a place and make images of a place that also fit, that is, they adjust themselves as well. Species are place-making species. Adaptation is not simply beings adjusting themselves to place or adjusting the place to them. Each is a constraint on the other. Adaptation is a process of making fit by adjusting to circumstances, environmental or cultural. Here it means fitting into an ecosystem, within established cycles and functions. Once a living being adjusts, it learns to exclude information that may not be relevant to living. It is adaptation that improves the chances of survival for a living being. Life does not adapt to a passive prior environment, it produces and modifies its surroundings.

2.3.2.4.7. *Formation*. Formation is the interaction of a physical and an intentional process. Physical or living things take forms. The making of form is informing. Ramon Margalef considers "information" to be more basic than energy or matter and more in line with the concept of patterning. Information is not transferred because the field itself is in-form-ed.

2.3.2.4.8. *Chaotic/Free*. Nature is chaotic and unpredictable. We should recognize that nature provides opportunities, but also that it may remove them through the occasional violence of its chaotic systems. There are chaotic events, plagues and random frenzies in every system. An ecosystem is a self-organizing, chaotic system with emergent properties. unique from those of individuals, species, or communities. Ecosystems develop in time. That is, an ecosystem develops by a reasonably orderly, directional process that involves changes in structure that result from community modification of the physical environment. Although the physical environment imposes limits and sometimes determines patterns and rates of change, the community controls the development of the system. The recognition of possibilities can excite and inspire living beings.

2.3.3. *Principles of Nature?*

We often describe design principles as being based on basic principles of nature, such as the principle of change. It might be more accurate to consider change a property of nature, that can then become a design or scientific principle. Nature is in flux, culture is in flux, everything is. The climate will change, the shorelines will change. Human understanding and behavior is changing. But, nature is also self-regulating—this is the principle of self-regulation. Nature has evolved to maintain its stability in the face of many kinds of disturbances from planetesimal impacts to changes in atmospheric composition. Nature will continue to regulate itself even as human beings make dramatic changes. The danger is not so much that nature will collapse, as that humanity might, or lose those things that it values the most.

Nature seems to flow, which is necessary to the functioning of organisms as well as to the biosphere. At each level of a natural system, from cell to biosphere, the units involved do more exchanging internally than externally with other units at the same level. Flow and division must be in balance. Individuals in nature exist through separation, by walls, barriers or membranes, which means nonflow or limited flow. Barriers are necessary to maintain the form and integrity of individuals as well as of ecosystems. By removing some barriers, such as releasing carbon that has been locked up for eons, we unbalance natural cycles. Even though ecosystems exist within large ecoregions, which exist within the biosphere, they need closure to maintain their integrity. At the level of local ecosystems, there need to be fewer closures, so that there is a flow of genetic information within a species as well as between species. Human activities block the flow at local ecosystems, with asphalt and wires, yet increase the flow between large regions with ships and airplanes—mostly the flow of pests and domestic species.

Nature exhibits error, or play, which permits diversity. Transmission through systems is not flawless or efficient, but it is generative of difference and diversity. The diversity of the current ecological world evolved through the breakup of Pangaea, which provided the distances and barriers to isolate species. Many other properties of nature, such as least action or complexification, can become the basis of principles.

2.3.4. *Summary*

Nature produces many complex patterns. Living beings create further complex patterns, but this is done without conscious design, without plans. Natural ordering of the world makes places from spaces. A place changes qualitatively; it becomes structured. Some change, such as growth or decay, is quantitative. Other change is qualitative, resulting in breakdown or formation of the entire system. Life is also a property immanent in an organization of molecules; and language emerges in a higher level of organization. New qualities that emerge at every step are unpredictable on the basis of the past; natural reality is creative. Nature is more like an artist than an engineer in this sense, that is, nature provides novel patterns that can be duplicated or reformed by living beings within nature.

The scale of nature is fundamentally different than the scope of any design. The time scale of evolution is measured in billions of years. The size scale of evolution is measured in trillions of living individuals. These scales permit any speed of operation of selection through reproduction and genetic mutation. Nature does not design at all in the human sense, limited by a single lifetime or even group longevity. Nature makes patterns that change, on many levels, over an immense scale.

2.4. *What is Traditional Human Design?*

Human beings have an ability, shared with many species, to alter their environments. They are able to reform natural forms and flows with their hands or with tools that have been made for that purpose. They are able to design the tools, as well as other larger objects and patterns, such as landscapes.

2.4.1. *What is Traditional Design?*

The word 'design' comes from the Latin word for "to mark" and means 'marking off a pattern.' Tracing lines can be inclusive or exclusive, but if the line is more like a membrane then it permits certain sizes and shapes of intrusion. The verb form of the word 'design' means to make a pattern or plan, or to intend for a purpose. A design is a purposive plan, which itself is a diagram in two dimensions. Design is a human project in which, as Oliver Lucas says, "visual and physical parts are assembled in order to achieve a specific end result." A design can also be an orderly arrangement of parts in an overall pattern. Designers make visible creations from plans, using the resources available.

Most design is concerned with products, from magazines, clothing and toys to houses and buildings. Our designs are often shaped by the impulses of technological feasibility, assembled randomly in neighborhoods and cities. Of course, cities are the results of complex adaptive behaviors in response to environmental conditions. Cities are not designed as whole systems, with a few possible exceptions. Landscapes around houses and buildings are often designed. But, large landscapes are not considered or designed. They are made up of individual patterns, such as farming and manufacturing. Sometimes the landscape is charming; other times it is not. The landscape is a common property that can be understood and integrated by perception. The loss of design is the inability to imagine, shape and build things that enhance life and safety; it is the inability to respond to changing circumstances. Too much of a world is overdesigned by professionals, according to Victor Papanek, with the result that design simultaneously ignores needs and creates further dangers with many designs.

2.4.2. *What is the Difference between Natural & Human Design?*

Design is creation for reproduction. Design is intelligent reproduction. Life is experience that continues by reproduction. Life is experiencing and reproducing forms to continue experiencing. Design is the production of forms for experiencing and reproducing. Although the phrases seem circular, in fact they form a historical spiral (see Table 242-1).

2.4.2.1. The Biophysical Environment of Design

The environment provides a framework for design, but it also limits some of the possibilities of design with resources and cycles.

2.4.2.1.1. *Patterning*. The word 'design' itself means 'marking off a pattern.' The verb form of the word means to make a pattern, so the concept of patterning is built in to the idea of design. The human creation of designs extends a natural process.

2.4.2.1.2. *Conscious intention*. Design is a conscious and intuitive effort to impose significant order, according to Victor Papanek. Design implies intent, and intent implies foreknowledge, as Anatol Rapoport notes. Van der Ryn states that 'Design is the intentional shaping of matter, energy and process to meet a need or desire.'

2.4.2.1.3. *Making/Generating*. Papanek also states that design is a process for making meaningful order (as well as objects). Design makes things into a new pattern.

2.4.2.1.4. *Focus*. Focus is the ability, as Erich Jantsch says, to organize one's total experience towards a purpose. The focus must include rational experience and technical substance. The intent of a designer focuses on the object, however, not on process or fitness.

2.4.2.1.5. *Feedback accepting*. Anatol Rapoport notes that improvisation is an important part of design. Being open to feedback allows design to function without complete rational knowledge, as long as we recognize that the design has negative and positive consequences. This is a way to make improvements and have design adapt to change.

2.4.2.1.6. *Objective/object-oriented*. Design is used for shaping and producing functional industrial and artistic things. The word 'thing' goes back to Old English words that mean 'object' or event—the word might have been used originally as a metaphor for some event under certain conditions. Nature is regarded most often by design as a set of challenges or a storehouse of resources than as a mutually created matrix.

Table 2421-1. Contrast between Biophysical Environment of Design.

Natural Creation	*Traditional Design*
Self-patterning	Patterning
Creating forms	Conscious intention/form
Autopoetic	Making/Generation
Whole	Focus
Systemic	Feedback accepting
Processing patterns	Objective/object-oriented
Development/Filtering/Sorting	Growth-permitting
Place generating	Place independent/isolation
Place responsive	Principle limited
Dynamic equilibria	Equilibrium
Interaction limiting	Maximizing/Optimizing

2.4.2.1.7. *Growth-permitting*. Design can operate without regard to expanding or contracting conditions, that is, it does not pay attention to the over-all growth of the number of objects or to their relationships in an economy.

2.4.2.1.8. *Place independent*. Although design can take inspiration from the uniqueness of a place, it does not depend on that place. It can take inspiration from anywhere and combine it without any reference to place. Formal development of design is more recently concerned with an assembly line model—simple, isolated, efficient, and easy to maintain—than with the uniqueness of a place. As a result of indifferent designs, we become remote from, and indifferent to, the system that supports us. We acquire unrealistic images of the world and harmful values, and then make bad decisions based upon them.

2.4.2.1.9. *Principle limited*. Design is often based on principles of form and style. In fact, designers are expected to follow recognized design principles. But, these principles do not incorporate principles of ecology or properties of nature to use as a foundation.

2.4.2.1.10. *Equilibrium*. Design is concerned with balance and balance is conceived as a state of equilibrium between two or more elements. Sometimes, design depends on a static environment.

2.4.2.1.11. *Maximizing/Optimizing*. Design is obsessed with maximizing beauty or optimizing usefulness. Yet, it does so without attention to any social or environmental constraints on a maximum.

2.4.2.2. The Ecocultural Level of Design

At this level, design is influenced by the environment and shaped by the images and demands of a culture.

2.4.2.2.1. *Culture-based*. Designers, like others, are raised in a single culture and acquire the unique attitudes and values of that culture. Many of their designs are more successful in their culture than in other cultures. This means they also imbibe the weaknesses and peculiarities of one culture. Design limited to shaping and producing industrial functional and artistic objects unconsciously supports a division of artifact and nature. In fact, nature becomes more of an artifice, when we make meadows and lakes, and restore rivers and forests. Most approaches to design are dualistic (wilderness-industry) or triune (wilderness-design-industry).

2.4.2.2.2. *Bricolaging*. Design puts pieces together to see if they fit. The pieces may be unrelated or related. They may fit well or not. The assembly is sometimes just an aggregation that falls apart or unravels quickly.

2.4.2.2.3. *Conscious Trial & Error process*. Unlike natural processes, design is almost always a conscious process of trial and error. Papanek states that design is a future-oriented, trial and error process for making meaningful order. This kind of experimentation does produce things where the pieces may fit within a new object.

2.4.2.2.4. *Learning from failure*. Designers often have an acceptance of failure and the ability to learn. Designs are improved in this way. Design as an art shares the same relationship with failure as 'science,' where knowledge is increased through the failure of experiments more than from success.

2.4.2.2.5. *Novelty emphasis*. Novelty is attractive to many people. Many designs aim for novelty to be successful. People recognize, value and seek novelty for itself. Thomas Birch and John B. Cobb Jr consider that the richness of the world and the freshness of a living response are matters of novelty.

2.4.2.2.6. *Rules/Geometric grids*. In some designs, grids are used as a frame that supports certain elements, but also limits the freedom of possibility. Using grids has been basic for many kinds of design, from graphic to urban design. Movements that tried to sweep aside all rules and start from zero, like the Bauhaus School, were not as successful as they wanted to be.

2.4.2.2.7. *Top down direction*. Design tends to impose patterns from the top down. The direction is orchestrated from the top. That has advantages for individuals and teams, especially when it comes to control of all aspects of a design, but it requires knowledge and control of all details and levels.

2.4.2.2.8. *Creative Play.* Design is goal-directed play, states Papanek. The creative play of design often starts with creating a line or boundary. Play is the method of learning for most juvenile animals and a means of enjoyment for many adult animals. For humans, play is imaginative experience, entered into freely. Much human activity is play, in place in a community. Even science and philosophy are forms of play, as attempts to solve the puzzles of existence. The object of the senses is life, the object of reason is form, and the object of play is living form—called beauty in the widest sense. Aesthetic play, like physical play, requires order and control.

2.4.2.2.9. *Goal-directed*. A goal is an end to which effort is directed. Papanek states that design is goal-directed play. Design requires understanding the process as well as the tools and goals.

2.4.2.2.10. *Conceptual.* A concept is an idea or generalized idea of a thing (as well as a unifying idea or theme). Designers often start with the concept before the particulars. The conceptual design may not always translate well into the physical.

Table 2422-1. Comparison of Ecocultural Levels

Natural Creation	*Traditional Design*
Nature-based	Culture-based
Aggregating	Bricolaging
Trial & Error process Novelty testing	Conscious Trial & Error process
Trial generating	Learning from failure
Novelty generation	Novelty emphasis
Reciprocal interactions	Rules/Geometric grids
Bottom-up organization	Top down direction & control
Physical restraints	Creative Play
Natural process	Goal-directed
Actual Existing	Conceptual

2.4.2.3. The Economies of Design

At this level, the designer has to consider the commitment of time and expense in relation to the product.

2.4.2.3.1. *Capital-using*. Larger designs rely on the input of capital from some source. Finances have to be borrowed or granted in order to start a design. This requires trust or advances.

2.4.2.3.2. *Constructive*. Designs are constructive, in the sense that elements are fitted together systematically to build an object. The object is put together from a variety of parts at a certain scale.

2.4.2.3.3. *Auto separation*. The design is usually conceived as an independent object that is addressed separately from other objects or their contexts. It does not have to fit within a definite pattern nor does it have to participate in a network of ecological relationships.

2.4.2.3.4. *Independent destructive*. Because design is such a limited system, however, waste is produced and sent to other systems and may be destructive to other systems. The design itself may explicitly wreck other designs or systems.

2.4.2.3.5. *Energy use*. Van der Ryn repeats that design is "the intentional shaping of matter, energy and process to meet a need or desire." Design requires energy to make its forms. Design may use energy efficiently. It is, however, usually unconscious of the energy source or of the costs of producing and using that energy. Most of the energy used in current designs is derived from fossil fuels.

2.4.2.3.6. *Technological tool use.* Design is an art that uses technology to produce its object. Technical proficiency is an aspect of design. In fact, some design is treated as a technical problem, to be solved through an understanding of tools and technology. Design may overemphasize technological considerations, which can shift or shape the actual design. Design must include technical substance and rational experience, but also systematic organizational and cultural themes.

2.4.2.3.7. *Waste production*. Design seems to be unconscious of waste, also, not only the waste from energy and the acquisition of materials, but the waste from the use of the designed object and its premature disposal. Although waste can often be used by another system, many designed objects cannot be deconstructed or reused without great care and expense. The waste is independent of waste-incorporating cycles.

2.4.2.3.8. *Cost consideration*. The true or actual cost of an object is rarely considered by design. This includes the energy and material costs as well as the psychological and social costs of poor or thoughtless designs. Many modern designs are driven by market considerations, such as profit or turnover, and are created for specific temporal markets at the lowest possible cost.

2.4.2.3.9. *Fashion & Style*. Thoughtless design is susceptible to fads and styles. Designing superfast cars for slow, crowded highways (or for rare circular tracks somewhere) is an example of an expensive, wasteful fad. Many designs are created exclusively to fit an ephemeral style or fad.

Table 2423-1. Comparison of Economies Differences

Natural Creation	*Traditional Design*
Productivity	Capital-using
Interrelational	Constructive
Nested	Auto separation
Interdependent	Independent/destructive
Solar-life driven	Energy use (any, fossil)
Aesthetic creation	Technological tool use
Waste generating	Waste production, Efficiency
Free play/change	Cost consideration, Market-oriented
Gigatrends	Fashion & Style

2.4.2.4. Values of Design

At this level of design, value is incorporated into traditional design, although the value may be limited to immediate economic value or restricted aesthetic value.

2.4.2.4.1. *Responsibility* to product, consumer, and community. Perhaps the first responsibility for design dealt with effective usefulness—either the digging stick worked or it did not work. Later, designers discovered a responsibility to the consumer, for the safety of the materials and design, and later, to the community, that a product not harm others.

2.4.2.4.2. *Planning*. A design is a purposive plan, which itself is a diagram in two or three dimensions. The plan was concerned with the orderly arrangement of parts in an overall pattern. Designers can be thought of as people who make visible creations from plans, using the resources available, according to Erich Jantsch. Specific designs based on plans can help people visualize the consequences of policies. Large-scale designs represent a synthesis of all planning studies, according to Frederick Steiner. Site design is the application of planning process to a specific parcel of land, according to Kevin Lynch.

2.4.2.4.3. *Meaningful order.* Meaning in design seems to refer to usefulness. Victor Papanek states that design is a process for making meaningful order. And what makes it meaningful is that it enhances not just survivability but human life, as it fits into the needs and expressions of a culture. The lifetime of a designed object is not considered in terms of its context or extended use. In fact, the object tends to be short–term and tied to economic time frames, which tend to be much shorter, at 2-5 years, than the artifactual use—digging sticks are still being used after at least 40,000 years.

2.4.2.4.4. *Goodness concepts*. We judge the results of our designs as good or not good. The word ‘good’ is derived from the old English word meaning ‘suitable’ or ‘pleasing.’ Design is usually considered good when it is pleasing and functional. David Holmgren suggests that good design depends on a free and harmonious relationship to nature and people, generated through continuous reciprocal interaction.

2.4.2.4.5. *Teachable*. Traditionally, design is taught from master to apprentice or mentor to student. A designer acquires knowledge and technique from practice and imitation. History and principles may be learned at that time. Recently, design started to address specific problems, where students model possible solutions and faculty evaluate their work. The evaluation focuses on the object, not on the process or its fitness. It may address questions of goodness or meaning, but it rarely tries to fit the surrounding culture or ecology.

2.4.2.4.6. *Exclusive*. By its nature in marking off boundaries, design is exclusive of those things considered irrelevant or uninteresting. Many things are considered to have no immediate impact, regardless of subtle or long-term influences. Other considerations are excluded as being irrelevant or too expensive.

2.4.2.4.7. *Information*. Designers need information to create designs. Information is the presentation of the forms of nature before they is distorted into facts or data. The information considered necessary for a design is often a small subset of the information needed for a design to fit in a particular context.

2.4.2.4.8. *Exciting*. Design is exciting. It is exciting to design. The product develops out of materials and energy, as well as human effort and inspiration, and can contain many surprises. Design should be exciting, and excitement can come from novelty, beauty, or many other sources.

Table 2424-1. Comparison of Values Levels

Natural Creation	*Traditional Design*
Living	Responsibility to product, consumer, community
Fitting	Planning
Harmony-build/long-term	Meaningful order/short-term
Existence value	Goodness concepts
Learnable	Teachable
Adjusting	Exclusive
Formation	Information
Chaotic/Free	Exciting

2.4.3. *Design Components Elements & Variations*

There are basic geometric elements of any design, from 3 (volume) to 2 (plane), 1 (line), and 0 (point) dimensions. These elements can vary in numerous ways, by number, position, direction, size, shape, interval, texture, color, and temporal. Furthermore, the elements can be organized into groups by nearness, similarity, and difference (diversity). Then they can be combined into whole structures by principles of rhythm, balance, and finally sensory force. The design of any dimension can affect all dimensions.

2.4.3.1. Elements

There are basic geometric elements of any design, from the 3-dimensional (volume) to 2 (plane), 1 (line), and 0 (point) dimensions.

2.4.3.1.1. *Point*. In geometry a point is an element having no size, shape or extension. As an element in design, a point has extension as a detail or striking feature, for example as the center of a book cover or single treetop in an urban park. A point may be a value. Points may be anywhere.

2.4.3.1.2. *Line*. A line is a mark between two points (containing an indefinite number of points) or the path of a moving point, having length but no breadth, straight or curved. It is sometimes mathematically a limit. A line may simply be where two shapes meet. In design, a line may be a border between colors.

2.4.3.1.3. *Plane* (lines). A plane is a surface that contains every line that joins two points on the surface. The plane may be horizontal, vertical, or diagonal. A flat surface, such as a desert or grassland may form a plane.

2.4.3.1.4. *Volume*. A volume is the amount of space occupying three dimensions. It can be created by the interaction of points, lines, and planes. A stream or volcanic island has a volume.

2.4.3.2. Variations

Mathematically, a variation is the manner in which two or more quantities change relative to one another. In design, it is the degree or process of change in appearance. Thus, there is great variation between a concrete walkway and flower garden.

2.4.3.2.1. *Number*. A number is a symbol showing how many items are in a series or collection. Numbers measure quantitative change, the source of all qualitative change.

2.4.3.2.2. *Position*. A position is a location or place where a thing is. It is also a description of earlier elements, such as lines in the environment. Diagonal lines are most pleasing to most observers; lines at right angles to the contour are rarely pleasing because the landscape is broadly horizontal; geometrical shapes look artificial (even when they are natural); natural shapes, perhaps fractal, are considered more natural and interesting. Fractals, or self-similar structures, allow larger units to have the structure of smaller units. This applies to coastlines, mountains, and art, as well as to political structures. The diagonal lines, as opposed to horizontal and vertical, of hills is both dynamic and pleasing to human senses.

2.4.3.2.3. *Direction*. A direction is a point towards which an element faces or a line along which something moves. A horizontal direction may be associated with tranquility, whereas a vertical may suggest formality. In the design of ecosystems, up is preferred to sideways or down. Diagonal lines give the impression of energy and movement, which is quite true as the hills are still being shaped geologically by erosion and wind. The eyes of travelers are drawn down one slope and up the next, or along the series of slopes. As people respond to one element and then another, the elements are perceived as parts of the whole. The sinuous path of the road through the corridor draws the eye toward the end of the corridor. The skyline is made more interesting by the shape of the hills.

2.4.3.2.4. *Size*. Size is the quality of an element that determines how much space it occupies. It is the extent or magnitude of the element. The size of an element determines the perceived size and relation of other elements. For instance, a large talus slope on the side of a small mountain may look larger than it is.

2.4.3.2.5. *Shape*. Shape is the quality of a thing that depends on the relative position of all points on the surface, or the spatial form characteristic of a thing. Shapes are one of the first things one notes in a design. For instance, a complete inventory of elements in an Oregon creek starts with the shapes of the features in the area. The large volumes are rounded and natural hills—even the agricultural evidence is almost natural, that is, from the roadside, not the air, the fields appear not to be squares, triangles, or circles; a small number of geometric shapes exist in the buildings by the road, but because of their scale are not too intrusive. Although the road itself has been flattened, it is not perfectly straight and does not conflict badly with the curving planes of the hillsides.

Shape to some extent determines how we see our surroundings. Shapes dominate other design factors, so appropriate shapes are critical. Proper scale or diversity cannot save a design if shape is wrong; the mind can pick up incongruities and artificial geometric qualities. Suitable shapes are vital for the unity of the landscape. As stated in by the English Forest Authority: "The perception of shape is influenced by overall proportions, viewing position and direction, and the nature of the external boundary edge."

2.4.3.2.6. *Interval*. An interval is the space or time between two things. The relation between objects in space or time. For instance, the distance between streams is greater than the distance between draws on the slope.

2.4.3.2.7. *Texture*. Texture is the surface quality of a shape or volume. The graininess of the system, the structure of an ecosystem, or quality as a result of the interval of elements. The texture of an old growth forest is rougher and more interesting than a tree plantation.

2.4.3.2.8. *Color*. Color is the property of the reception of different wavelengths of light. Color is distinguished by the qualities of hue (e.g., red or yellow), brightness (or lightness for pigmented surfaces), which may result in value, and saturation (the degree of intensity of a hue). Colors are vivid qualities in objects or ecosystems. There is an indefinite number in nature, although some ecosystems, such as forests, have smaller palettes.

2.4.3.3. Organization of Variations

Variations can be organization within patterns, which may be across many scales of time, space and embeddedness.

2.4.3.3.1. *Time*. Time is a duration in which things happen. Time is a period or measurable interval between two events, or a period of existence. Temporal patterns can be classed into four groups: circular, the eternal return, disintegration, reintegration, as of forests, nothing new; spiral, that is, a circle under stress, a cycle under change, something new; linear, the straight line of industry, progress to an end point, such as heaven; and, nonlinear, the line combined with chaos, ending in extinction or creation.

2.4.3.3.2. *Groups*. A group is an aggregation or a number of elements forming a unit, regardless of whether they have common characteristics or similar connotations. Elements can be grouped by likeness, patterns or weights.

2.4.3.3.3. *Nearness*. Nearness refers to the spatial or temporal closeness of elements. Nearness implies an intimacy of elements.

2.4.3.3.4. *Similarity*. Similarity is a state of likeness or resemblance between elements. Elements may be almost identical in shape, but of different size or position, for instance, an old understory tree may have the same shape as a dominant, but only be one-fourth as tall.

2.4.3.3.5. *Density*. Density is the quality of being compact or having a quantity per unit. Density can be related to closeness or connectivity. Blades of grass in a prairies may be perceived as dense from a low perspective.

2.4.3.3.6. *Diversity* (difference). Diversity is the number of differences in a framework. Increased diversity also has the effect of reducing scale, so adding diversity can be used to do reduce the scale. A high level of diversity is acceptable if one element is clearly dominant or if the differences cannot be recognized from a distance.

2.4.3.4. Organization into Structures

Patterns can appear in structures.

2.4.3.4.1. *Structure* (Paths, Patches). Structure is the manner of organization of elements in space or time; it can also be thought of as the arrangement of the parts of a whole. This is especially so for ecosystems, as whole units; a tropical forest ecosystem, for instance, has a typical structure of six levels, from the herbal layer to rising dominant trees.

2.4.3.4.2. *Rhythm*. Rhythm is a flow characterized by the regular recurrence of elements in space or time. Ridges on the side of a mountain range provide a rhythm in space. (Biologically, rhythm is the periodic occurrence of specific physiologic changes in organisms in response to geophysical factors, as when deciduous trees lose their leaves with low light levels and cooling temperatures. The units of time may range from milliseconds to thousands of years, although most will seem to be daily, seasonal, or long (in 2-25 years). Rhythm generates interest.

2.4.3.4.3. *Tension*. Tension is the balancing of elements in opposition or the interaction of elements without resolution. Tension connotes a state of strain, stress, or force in a pattern (sometimes exerting force against resistance). A large clearcut area may create tension in a mature forest landscape.

2.4.3.4.4. *Balance*. Balance is a state of equilibrium between two or more elements. It is also related to the harmony of elements in a system or the state of the system. It can also be defined as the stable movement of elements around a center (or attractor) in a dynamic equilibrium. In forest design, a larger meadow is needed to balance a dense woods, due to differences in perceived masses.

2.4.4. *The Principles of Traditional Design*

In addition to the basic elements, structure and variations, design can be presented through a number of principles. Principles are fundamental rules or laws, based on the characteristics of objects or systems, that we can use to create images or models to meet stated objectives, that is, the goals towards which our actions are directed, such as a functional beautiful bicycle or a comfortable inspiring city park. Principles unify our images. Select principles are introduced briefly to show the depth and breadth of design.

The principles presented are derived from the typical characteristics of design objects. Characteristics are qualities that distinguish unique individuals, systems, or patterns—Gregory Bateson refers to characteristics as differences that make a difference. From these principles, standards for design activities can be established. Standards are models or examples of quality or value, established by authority or mutual consent, which can be repeated as procedures.

The principles identified form the basic axiomatic truths of design. They represent the basic assumptions of the human world that guide the practice of design. These principles affect the arrangement of objects, elements or components within a composition. These principles, not exhaustive by any measure, state that any composition has to display: Proportion, Rhythm, Emphasis, Balance, and Unity.

2.4.4.1. The composition has to exhibit *Proportion*. Proportion is the comparison of the dimensions or distribution of forms in a composition. It is the relationship in scale between one element and another, or between a whole object and one of the parts. Differing proportions can suggest different kinds of balance or symmetry, or relationships between scale and proximity. Elements of a larger scale can dominate the composition, presenting more visual weight or altering perspective.

2.4.4.2. The composition has to have *Rhythm*. Rhythm is the repetition or alternation of elements, often with defined intervals between them. Rhythm can create a sense of movement or progression; it can establish pattern and texture. There are many different kinds of rhythm, such as regular, flowing, or progressive, which are defined by the feeling evoked.

2.4.4.3. In most compositions, there is a *dominance* of one or more elements. This may emphasize elements that are in closer proximity, are larger or are centered.

2.4.4.4. The composition must be in *Balance*. Balance is an equilibrium that results from looking at images and judging them against our ideas of physical structure (such as mass, gravity or the sides of a page). It is the arrangement of the objects in a given design as it relates to their visual weight within a composition. Balance usually comes in two forms: symmetrical (also formal) and asymmetrical (also informal), depending on whether the weight of composition is evenly distributed around a central axis or not, and whether the axis divides identical forms or not.

2.4.4.5. The composition has to have *Unity* (or be in harmony). The concept of unity describes relationships between the parts and the whole of a composition. Unity, the relational aspects of a design, provides a sense of wholeness to the composition. Without unity, a design may fall apart. Gestalt theories of perception have contributed to understanding of the organization of information into categories. In a harmonious design, the contradictions, conflicts, influences, and emphases are recognized as a whole composition. The elements are no longer independent things; they are constrained by the unity or harmony.

2.4.5. *Applied Design Stages*

Traditional design proceeds in four stages.

2.4.5.1. *Review the function* or goal. What is the composition supposed to inspire or do? Is it to be a public or private composition?

2.4.5.2. *Find appropriate materials.* Some materials are better than others for certain purposes. Understanding the purpose, as well as the potential materials that can be used, insures a better design.

2.4.5.3. *Create outline* or plan of design, using elements and principles to guide the design.

2.4.5.4. *Build the object*. If a single object, it is given or sold. If it can be reproduced or mass-produced, it usually is.

2.4.6. *Three Levels of Traditional Design*

The traditional design process considers three levels: Components, products, and the community.

2.4.6.1. *Material Components*. Many cultures have found, released and used materials for tools and designs. The materials themselves were often the thing itself.

2.4.6.2. *Object/Products*. Often, materials were melted, woven, or combined into specific objects as tools or chairs.

2.4.6.3. *Social context* in Community. The objects that were made were usually integrated into an order described by a culture, based on knowledge and techniques handed down through generations. These things acquired social value even when their utilitarian value diminished. Chairs, for instance, beyond being useful for sitting, can grant authority to the person sitting in it.

2.4.7. *Evolution of Design*

Charles Darwin and Alfred Wallace described a theory of evolution that was based on natural selection. Through many forms of interactions, from competition to cooperation, members of different species exploited each other and the environment, changing the whole structure and process, and generating conditions of diversity and complexity that made the process effective in a changing and developing planet. The success of a species was measured by its fecundity, which allowed the actualization of more possibilities. Some species were able to colonize harsh habitats, others mild ones. A few species, such as lichen or human, were able to thrive in almost every environment. Species adapt to the environment and then adapt to the environment as it is changed by them. The progressive development of wholes is evolution. Evolution can form a harmony over many decades or millennia. At all levels evolution includes freedom of action as well as interdependence.

Evolution uses different levels: The physical was replaced by the chemical, which has generally been replaced by the electronic in human systems. Plants are generally chemical; electronics becomes important with motion for processing information. But electrical systems outran their design (hunting) in humans. Within culture and especially technology, humans have created artificial systems that are faster than their own organisms.

Evolution does not have goals. But, design has to be based on goals and images. The goals have to be comprehensive at a larger scale. Like several other species, humans were able to use tools to adapt to challenging situations. They exploited materials and patterns to develop tools, clothing and culture to accelerate their adaptation. The sophistication of early designs seemed to be correlated with the difficulties of the environment. Design was limited by the energy and materials available in the local ecosystem. They were integrated into the ideas of the culture.

Culture, with its new way of transmitting information; it involves a mix of trial and error learning, social learning through observation and imitation, and finally teaching. By this definition, animals as well as humans can have culture. Some classic criteria of life require self-reproduction, to preserve biological information, and variability and selection, to enlarge an individual information store. Memory keeps the information immediate. Culture is an emergent property of the evolution of speech and tool-making; economic and political structures, with their ideas of disparity and wealth accumulation, emerge from culture. We can think of agriculture as an information system that can overcome some limits of local environments. Cities are another kind of adaptation to uncertain environments.

Tools and technology have evolved also, as human culture has evolved. According to Radovan Richta, technology is evolving through three stages, from tools to machines to automation. Tools, from plows to microscopes, augmented physical labor or senses. A powered machine, such as a water mill, tractor or computer is a complex, often powered tool that replaces all physical effort but allows human control. An automation is a machine that uses an automatic algorithm to replace human control; automation can be observed in digital watches and automobile assembly factories.

It looks like a fourth autonomous stage is developing, where the tools are capable of self-direction (and perhaps rudimentary intelligence and consciousness). Possibly robots and living cities may decide how to achieve harmonious relations with human or wild systems. At the same time a fifth stage may be developing, hybrid systems, in which humans become additional components in a larger whole.

After each fundamental type is introduced, however, it continues to be used widely, thus simple tools, such as digging stick, or a machine, such as a cotton gin, are still being used with automated telephone interchanges. The overall use of technology displays several gigatrends: Increased efficiency, increased control over external conditions, and increased complexity of technology nests.

T.M. Lenton, K.G. Caldeira et al. suggest that humans have managed to escape the constraint of adaptive genetic selection (the Red Queen Hypothesis, drawn from Lewis Carroll's character in Alice in Wonderland, who has to run to stay in place; constant rates of speciation and extinction lead to general stability). The escape is based not just on the advantages of reproductive sex in resisting parasites, but the advantages in culture for escaping environmental constraints. The general hypothesis proposes that evolution within a species must keep pace with environmental selection or the species will go extinct. Like other species humanity altered its habitat. Unlike most species, humanity seems to have escaped the constraints of a single habitat. The evolution of tools may have destabilized our levels of exploitation. We can alter all ecosystems, even those where we do not want to dwell. The alterations are so widespread and fast that they themselves exert selection pressures similar to catastrophic interference events, such as meteor strikes or ice ages. The alterations are not limited to single habitats but extend to biomes and planetary biogeochemical cycles, such as nitrogen and carbon. Lewis Mumford suggests that at larger scales and with centralization, technology becomes another tool of authoritarian decision-making.

Design adjusted to increased knowledge of materials and possibilities. It adjusted to the environment. It started to adjust to new limits, to issues of safety, to new techniques and technologies, and now to flows and life cycles. Some tools, however, may work against biological fitness. David Berman suggests that the slot machine is an ingenious piece of industrial design that assists in the triumph of the greedy over the vulnerable. The design magnifies a combination of subtle weaknesses in the human decision-making schema. The schema works quite well for mammals in the wild, but it is short-circuited by the a low grasp of probability.

Evolution seemingly did not prepare the human species to exceed certain limits. Humans as a species have figured out how to rearrange resources so that this drive could be regularly over fulfilled. The result is that we are caught up in seeking, as a society, more than simply enjoying. Has this has to do with our many generations as hunter-gatherers? Berman notes that design can affect how you behave and think; he asks designers if they really want to spend the best years of their careers spreading misery and feelings of inadequacy, or encouraging addiction, or destroying hopes and dreams. Does this happen because the profession has no code of ethics?

2.4.7.1. Expanding Ethics for Design Responsibility & Safety

Traditional societies usually had a strong moral compass. People sought fulfillment and balance, some more mystical or secular than others. In modern societies, once people tracked the dangers of a particular design to the designers, design as a profession started to address matters of safety in their products. Designers gradually became responsible for using safe materials and safe configurations, mostly because it was good business not to be attacked or sued for designing flammable night clothes or bedding.

Berman notes that design can affect how you behave and think and then he asked designers if they really want to spend the best lives of the best years of their career are spreading misery and feelings of inadequacy, or encouraging addiction, or destroying dreams.

Howard Gardner points out that the unit of human thought is the symbol. Through design many symbols are presented to deceive. Gardner suggests that symbols are the building blocks of reason and the memory. Berman suggests that it is unethical to insert misleading symbols into our environment. He suggests that as our civilization matures we will recognize that visual communicators manufactured misleading memories, and that these visuals can be as dangerous as hot steel.

As we know, advertising is capable of many manipulations of symbols that compel people to consume too much. David Berman suggests that legislation to prohibit lying with imagery might help. Berman suggests that design needs to be more ethical and express its professional behavior, which could inoculate culture from the downside of global velocity or rather the velocity of globalization. The greatest threat to human future is consumption or overconsumption. Design fuels mass overconsumption. Victor Papanek noted that designers were trained to aid and abet corporations whose policies are relatively unenlightened as regards aesthetically pleasing, well made, ecologically responsible products. Often the corporations litigated to avoid their legal responsibilities, since enforcement and judicial agencies were so weak. Berman suggests that designers have more power than they realize and could short-circuit this.

Human civilization cannot afford another major mistake, such as agricultural conversion, overconsumption or mass pollutants. We can leave a better legacy by using our best ideas and not by copying our chromosomes or consuming everything. So the question is why do we consume so much? Why do we consume some things and not others? Overconsumption is a very destructive pattern and the pattern is defined by deception and lies. Our entire society now focuses on spending, for psychological reasons as well as economic ones. The banks do not help either with their irrational campaigns to push second mortgages at higher interest rates. Tim O'Reilly suggested that more than real estate bubble, we need to be concerned with an inflated reality bubble.

According to Papanek, the good life depended on satisfying four basic social desires: Conviviality, religion, artistic/intellectual growth, and politics. In response to ethical dilemmas, designers need to learn applied design ethics, so that when they perform deeply satisfying responsible work, and expose their clients to social and environmental needs, they might not feel guilty doing or earning less. Creating new approaches and professions is endorsed by Papanek and Fuller.

Most sets of ethics make the rules easy to follow. They emphasize the differences (relativism) or similarities (absolutism) of human beings only; or of the individual or the group; or of good feeling, reason, or desire. We must develop specific rules to live with other species, more formal than isolated cultures like the Campa and more comprehensive than modern cultures like the French or German. Ethics has to confront the individual, embedded in a community, located in a bioregion, on earth. And, the rules really are not as easy as human systems have presented. Schweitzer made them too difficult, with a constant valuing, but neither are they that difficult. An ecological ethics can be detailed only on a local level—even when it uses a global strategy.

Extensions of ethics are developed in response to problems that arise from increasing knowledge. Science has phenomenally increased our knowledge of physical and biological processes. It has now become the basis of our moral code, but it cannot very long be a science divorced from feeling and art if that code is to help us survive. To do this science requires aesthetic perception as well as disciplined thinking and feeling. As there is a rational component to ethical judgments, so there is an intuitive and emotional one, also.

The extension of ethics to animals and land is an ecological necessity with the history of human pandomination. This extended ethics defines a social conduct that is a mode of cooperation and, ultimately, symbiosis. Aldo Leopold argued that voluntary limitations of freedom are necessary in a complex world of which we remain incredibly ignorant. This ethics suggests that humans avoid tampering with complex evolved systems, not because they are good, but because they are the basis of life. This ethics is situational because ecology is the study of changing systems. It is pluralistic, as Stone notes, because of the variety of entities involved. The morality of the act is determined by the current state of the system. Adaptive modes should conform to ecological patterns.

This ecological ethics is based on attributes of ecosystems and human compliance with ecological laws. The aim of an ethic must be harmonious with the whole population of living beings. An ecological ethics is not distorted by human needs and wants when it argues for the preservation of animals and habitats themselves, because they are as they are, independent communities on which we rely for all levels of 'services.' Because of the uncertainty of human actions, ethics has to encompass the far past and distant future. No one knew that when DDT killed mosquitoes, it would concentrate in the food chain to kill birds. Values are time dependent, and ecological time can be very long indeed. The futures we invent are viable only if compatible with constraints imposed by evolutionary past. An ethics that requires a long-range responsibility also requires a new humility, since technological power exceeds the ability to foresee its consequences. An ecological ethics recognizes the moral obligation to leave the world habitable for future generations. Ecological design ethics has to do more. Berman believes that the future of the world is now "our common design project."

It has to show that ethical designs have immediate and long-term values. It also has to recognize that speed of response is essential.

2.4.7.2. Summary: Design Exuberance

As a profession, design is a special self-consciously separate, economic discipline that adds value to human artifacts, and in fact distinguishes its objects from lower-quality goods. It is the separation of specialists from the vernacular design of self-sufficient people. Design is a historical process of the development of a profession. Of course, it can be regarded as more. Victor Papanek characterizes design as the "primary underlying matrix of life" and states, "All men are designers."

The basic elements and variations apply to all kinds of design. But, as traditional design expands to ecological design and to global design, the number of groups and principles has to increase to reflect the larger scales and increasing connections. Heroic design and extravagance in life is needed. It is not contradictory or antithetical to frugal lifestyles or to restoring a healthy environment. Life is exuberant; energy is used, lives are lived and used, not saved. Life is the accumulation of individual experiences that cannot be saved, stored, or owned. Design is a way of expressing conscious life.

2.5. *What is Ecological Design?*

What is ecological design? Benign design? How is it different from traditional design? Is it different enough to justify more words about it? This is an academic question. Ecological design is, in Nancy Jack Todd's words: "design for human settlements and infrastructures that incorporates principles inherent in the natural world …" David Orr defines ecological design as: "the careful meshing of human purposes with the larger patterns and flows of the natural world and the study of those patterns and flows to inform human actions." Let us take these ideas as a working definition and expand on them, by comparing ecological design to traditional design and 'natural' creations.

2.5.1. *Definition of Ecological Design*

The word 'design' comes from the Latin word for "to mark" and means 'marking off a pattern.' Marking creates a line or boundary that is inclusive or exclusive, but, if the line is more like a membrane, then it can permit certain sizes, shapes and regularities of intrusions. In ecological design boundaries must be designed as membranes.

Traditional design is a human project in which, as Oliver Lucas says, "visual and physical parts are assembled in order to achieve a specific end result." But, the end result has to be placed in context. As Lewis Mumford pointed out: All thinking must now be ecological. Ecological design has to consider the context and the long-term implications of any designed object. Van der Ryn has qualified design as ecological by stating that it "is any form of design that minimizes environmentally destructive inputs by integrating itself in living processes."

Ecological design has two meanings in this discussion. The first regards the connection of design to its ecological context, while the second refers to the design of ecosystems. In its large sense, ecological design is the creative modification of ecosystems to repair or enhance their ability at self-organization and maintenance of their complexity and diversity. Diversity, as in biological diversity, means species richness, different age and size classes in a population, and genetic differences in a species, as well as kinds of habitats present in an ecosystem and the kinds of communities occupying the habitats; and the kinds of ecological processes that maintain habitats; and the variety and richness of the planet's genetic heritage. Ecosystems that are designed so are healthy. A definition of health is the condition of being sound in body or well-being.

2.5.2. *Differences between Traditional Design & Ecological Design*

The four topics from the design matrix— Biophysical systems, ecocultural play, economies, and values —are expanded to highlight the differences between traditional design and ecological design. The characteristics of natural systems are also repeated with both kinds of design.

2.5.2.1. Physical & Biological Environment of Ecological Design

At this level of ecological design, the object is related to the environment, with all its relationships, constraints and details.

2.5.2.1.1. *Repatterning*. The physical world is a patterning, a flowing whose constituent functions are interacting fields of force. Patterns of complexity shade and grade into one another endlessly. Their history allows things to express minor differences that become larger differences as the history of a pattern unrolls. Differentiation is the discrete unfolding of things, within limits, in a place. The ecosystem is generated by the ebb and flow of energy, substances, individuals, and species across a suitable landscape, and design should fit the flow.

2.5.2.1.2. *Ecological restraints*. Ecological design does not have to merge technology with nature, as Van der Ryn and others suggest. For buildings, technology is an important component, but for the shape of rivers or ecosystems, it may play a minor role. Ecological design has to respect nature and natural limits, while integrating human patterns into natural processes.

Connection is important factor related to restraints. Too little isolation can lead to the weaker or smaller system being overwhelmed; this is similar to overconnection. Overconnected designs and processes are not as flexible under changing circumstances. Designs that are underconnected may be too independent to have mutual restraints.

2.5.2.1.3. *Remaking/Regeneration*. Ecological design stresses regeneration (especially in the sense that Robert Rodale uses the word, sharing meaning with restoration and renewal). Ecological design has to fit the design into systems that remake themselves over time. Ecological design is also the creative modification of ecosystems to repair or enhance their ability at self-organization and the maintenance of their complexity and diversity. Like John and Nancy Todd, Van der Ryn suggests that seeding a design with a diversity of elements makes environmental processes more diverse. Certainly this is true with depauperate systems, although there is a risk of exotic species displacing native species under such circumstances, when both are introduced simultaneously.

2.5.2.1.4. *Peripheral frame/system*. Most designers, especially architects and city planners focus on instrumentalities and institutions. Industrial designers seem to focus on human wants and relations. Ecological design needs to pull back from a focus. It needs to approach sideways, searching for those edge effect perceptions of the whole. It is not quite right to say that ecological design is ecocentric, because it is actually concerned with the frame and not the focus, the periphery and not the center. It is acceptable to focus on a design but the frame has to always be a part of any design.

2.5.2.1.5. *Feedback driven*. Places and organisms shape each other through feedback. There are two fundamental modes of behavior: (a) Maintenance, based on negative feedback loops and characterized by stability, and (b) Change, based on positive feedback loops and characterized by growth or decline. The two modes almost always work simultaneously to create a typical series of behavioral patterns, from stagnation to rhythmic regulation. Attention should be directed toward dynamic equilibrium of ecosystems as the subjects of design. And design has to relate outputs—material and social technics—to positive and negative feedback. This kind of design has to be more comprehensive and consciously planned.

Nature is expressed by complex adaptive systems with nonlinearities, feedback loops, and thresholds (Holling, 1973). By ignoring such dynamics, the ecological design cannot indicate possible ecological consequences of overshoot. It is also important to keep in mind the scale and acceleration of changes. Any large system, such as ecosystem or city, is a high-order, multiple-loop, nonlinear feedback system. In the system feedback loops are the basic structural elements. Each loop is a circular path of interaction between several elements. Ecological analysis forces us to look at the obvious—generating nonmarketable use values occupies the center of every culture because it provides a satisfactory life to its members. Improvisation is an important part of design. Open to feedback, we can design without complete rational knowledge, as long as we recognize the process. It is the only way to achieve balance. To use a simple analogy from gymnastics, we cannot plan every arm motion on a balance beam, although we can design a routine; arm motions are reactions to small changes in activity, which cannot be predicted ahead of time.

2.5.2.1.6. *Dimensional process relationships*. Paul Shepard and others have written that relationships are as real as the objects that result from them. The science of ecology attends the overall pattern of relationships, beyond the details. A specimen is more than the sum of its species' relationships to an environment; it is an intentional being that, with other members of the species, can create niches, as well as adapt to them. The relationships of humans with plants and animals have changed dramatically in the past 12,000 years, since the beginning of domestication and landscape conversion. The increase of humans and the destruction of plants and animals have unbalanced the relationships. Ecological design has to reroute relationships into a better balance.

2.5.2.1.7. *Development after initial growth*. In organisms and systems, growth serves an immediate function of allowing the system to reach an effective size. After growth stops, the system continues to develop, or mature. In economics, as Herman Daly and others have shown, there is no necessary association between development and growth. A community is forced to accept an upper limit, beyond which it cannot grow any further. Further growth results in destruction or disruption of itself and nature. There is another distinction between growth and development. The ecological social approach (or a redistributive environmental strategy) to development makes it irrelevant to discuss global limits to growth. Local limits are far more significant to the majority of population.

2.5.2.1.8. *Place specific*. Ecological design can fit society within an ecological perspective by following the principles of ecology and applying them to the properties of good places. The approach has to be tradition-based and partially self-conscious. It has to be responsive to the genius of place, as well as to human meaning derived from the existential and phenomenological significance of the place. The concept of place incorporates physical, biological, and cultural dimensions. Land use should be matched to the limits of the land. The task of ecological design is to create land use and structures adapted to place. Design should respond to the deep structure of place, the fundamental geological and ecological processes that form the landscape.

There have been attempts to define and design places. Edward Relph outlined the essence of place and then the disappearance of variety that results in placelessness. Christopher Alexander decomposed environmental objects and activities into their constitutive elements, to be reconstructed into designs that could fit local places. These formal solutions can improve strategies for design and can provide a matrix for the making of places. But, they should not assume that human variables can be manipulated to achieve a predicted response. And, they cannot ignore psychological or cultural patterns.

2.5.2.1.9. *Fitness-oriented*. Fitness is the ability to function under normal environmental conditions. Fitness of the components builds up in an ecosystem as it matures. Selection at the organismic level is selection of the fit. The levels of selection must balance, so that life is not too fit or too unfit. Evolutionary fitness does not always keep increasing. In some cases it decreases with time. Fitness is achieved after progressive reciprocal adaptations; it requires a stability of relationships between societies and the place.

Ecological design has to incorporate the idea of fitness to be effective. Ecological designs are modes for conveying ecological sense; they are less concerned with survival than the survival value of a good fit between agents of life. Balance is needed between self-restraint and self-expression, between self-protection and self-restriction. It is not self-expression or self-restraint, but both in a satisfactory fit. Fitness attunes us to limits.

2.5.2.1.10. *Nonequilibrium incorporating*. Ecological organization is a nonequilibral state, where order is governed by amplified fluctuations. Organization is also related to the harmony of elements in a system or the state of the system. It can also be defined as the stable movement of elements around a center (or attractor) in a dynamic process. Design has to address the continuous shifting and change of systems that may be stable for thousands of years or only weeks.

2.5.2.1.11. *Optimizing/Satisficing*. Individual people are concerned with having maximum freedom or producing maximum values, and in fact, the idea of unlimited value tends to encourage the effort. Values may be indefinite, but they may not be maximal or infinite. Like the principle of limited good, there may be a principle of limited value. Even aesthetic appreciation requires limits, to avoid having our over-appreciation overwhelm the values evident in nature.

A value in nature, such as diversity, may seem to have an optimum. While it is meaningful to speak of an optimum diversity, as the result of limits and the interaction of many factors, a maximum diversity may never be reached. As Paul Weiss noted, the patterns of organic nature are a combination of order and diversity; order involves constraint while diversity requires freedom for difference. A maximum order would result in a static universe, where a maximum freedom would create a nonordering chaos. What is a minimum, optimum or maximum size of a city design? Science might identify a few minima or maxima but ecological design should aim at what is optimal or satisficing (satisfactory).

Table 2521-1. Comparison of Natural, Traditional and Ecological Design of Biophysical systems

Natural Creation	*Traditional Design*	*Ecological Design*
Self-patterning	Patterning	Repatterning
Creating forms	Conscious intention/form	Ecological restraints Experiential
Autopoetic	Making/Generation	Remaking Regeneration
Whole	Focus	Peripheral frame/system
Systemic	Feedback accepting	Feedback driven
Processing patterns	Objective/object-oriented	Dimensional process
Development/change Filtering/Sorting	Growth-permitting	Development after initial growth
Place generating	Place independent/isolation	Place specific
Place responsive	Principle limited	Fitness-oriented
Dynamic equilibria	Equilibrium	Disequilibrium incorporated
Interaction limiting	Maximizing/Optimizing	Optimizing/Satisficing

2.5.2.2. Ecocultural Play of Ecological design

At the ecocultural level of ecological design, designers have to contend with the diversity of human cultural values and behaviors.

2.5.2.2.1. *Nature & culture-based.* Ecological design extends the consideration of cultural value to the values and limits of nature. Design that is nature-based and culture-based looks different than one that singles out just one. It has to fit the local ecosystems and constraints of the landscape, as well as the values and experiences of a culture. A better approach to dualism and division would show how these interweave so extensively that it would be hard to just use boxes or circles as metaphors. The dualism of nature and culture can be resolved with an understanding of the recent (60,000 years at least) coevolution into domiture (a neologism encompassing the previous nature/culture divide). Domiture has to include human reason and human emotion, rather than simply putting them on opposite columns in a table, as with order and chaos, higher and lower, and linear and cyclic.

Nature evokes feelings of beauty and terror, joy and sadness—we can stare at the wild or feel pleased from the experience of nature. Nature is fun. It invites play. Ecology can be fun. It invites play. No matter how tiresome or frustrating ecology as a science can become, there is always the potential to enjoy it. Who cares if nature is not natural anymore? This is only human words and ideas. Nature is healthy, and that lets us be healthy. Who cares if culture is claiming dominance? Hurricanes, tsunamis and other events can act as agents of cultural humility.

2.5.2.2.2. *Niche-assembling*. An organism is more than the sum of its species' relationships to an environment; it is an intentional being that, with other members of the species, can create niches, as well as adapt to them. Those species that enlarge their niche also enlarge the system as a whole. Species integrate themselves into the system over time, using previously unused productivity or waste in developing their special niche. Each ecosystem, however, sets the limits and determines the style and complexity of its individual species. Species diversity increases because there are more possibilities for making niches in the increased structural variation. Within species there is more genetic variation. Less energy leaves the system, because it is bound up into maintenance of the structure.

Ecological design can create new niches and increase the diversity of a system; it can modify niches and restore natural systems, but it has to do so with caution. Up to a point, niches can be enlarged or increased, but with so many humans, it creates the danger of supplanting other species entirely.

2.5.2.2.3. *Ecological redundancy*. The universe as a whole seems to work with fifty percent reliability; existence is already half determined. Freedom and necessity seem to be balanced at about fifty percent—perhaps this is comparable with redundancy in information theory, where the predictability of particular events within a larger aggregate of events is technically referred to as redundancy.

Some forms of industrial design build with adequate physical redundancy to allow objects, such as airplanes and bridges, to fail partially. Ecological design has to incorporate appropriate levels of redundancy to allow the system to be relatively stable and flexible. Ecological redundancy has value to an ecological system.

2.5.2.2.4. *Failure incorporation*. Ecological Design, like science and art, can learn from previous failures and add that knowledge to future designs. Many unconscious designs of large-scale efforts, such as agriculture or urbanization, have begun to fail, but the lessons have not been added to a redesign effort. Ecological design can approach these patterns with a holistic perspective. Design as usual, like business as usual, could precipitate a catastrophic ecological failure if smaller failures are not corrected and if demands for "natural capital" are not reduced to a level that the biosphere can provide on an annual basis. Of course these failures can occur in endless combinations.

2.5.2.2.5. *Historical tradition*. Design is experiential and historical. As it proceeds, it not only changes parts of the environment, but also human reality in its total context. The approach of ecological design has to be tradition-based and self-conscious. It has to be responsive to the genius of place, as well as to human meaning derived from the existential significance of the place. The concept of place incorporates physical, biological, and cultural dimensions. The solutions cannot, and do not need to, be precise; they can be unfinished and ambiguous. They can be fuzzy. They do not need to guarantee rootedness or workability, but they can identify limits. They can provide possibilities through a matrix that allows tradition and richness. They can provide direction from the understanding of the parts. For instance, they can understand how to make a fertile kind of soil, as a metaphor, where things can live in and develop. Living beings synthesize the parts and find meaning in living there, and in doing so revitalize a place. Design can learn from the history and successes of many lives and cultures to create high-quality designs.

2.5.2.2.6. *Quality emphasis*. Quality can arise as a break in quantity, that is, it can emerge from simple quantity. In an ecosystem, individuals and species are connected to some degree, in terms of the quality and quantity of their connections. By emphasizing quality, ecological design contributes to long-term products and patterns. Design can make models of quality environments. By embracing ideas from ecology, design participates in a movement of consciousness, concerned with equality, diversity, and health, as well as with humane methods, and a holopoetic cosmology—and is affected by them simultaneously.

2.5.2.2.7. *Bottom-up action with top-down restraints*. Complex adaptive systems display emergent behavior. As an example of emergence, slime molds can form a community without a pacemaker cell that determines when the cells need to combine. It seems that self-organization is bottoms-up. Emergent systems are rule-governed, though; slime molds explore by adhering to low level rules. Individuals coordinate work, even if they cannot assess the global situation. Emergent systems are local; individual molds "think" locally and act locally. Random action serves to explore local space. Individuals pay attention to their neighbors, however, and patterns emerge from local activity.

Simple behavior seems to work, with local feedback, and more sophisticated behavior "trickles up" to approximate a global perception. As design becomes more complex, individual design can be aided by the emergence of social creativity. For a social, bottom-up design to work, there has to be sufficient inflow. The cultural basis may have to be slightly redesigned to allow top-down restraints and forms to shape the whole design.

2.5.2.2.8. *Consequences attention*. One challenge for ecological design is to avoid simply repeating the same errors and consequences in the rush to acquire minimum standards and wealth for most people. To survive, an ecosystem depends on the interactions and balance of many variables, most of which are not well understood. In agriculture or forestry, we try to maximize one of those variables. When that happens, the balance or harmony is altered, and although it may take decades or centuries for the consequences to be known, the system is affected. The decline of Rome and many other civilizations demonstrates that ignorance of ecology can have important consequences. Some cultures ignore the long-range ecological consequences of drainage, irrigation or overexploitation, and these cultures may decline and die. But many archaic cultures display a form of fitness and limitation. Some, such as the Tukano Indians, try for adaptation before domination, according to Ricardo Reichel-Dolmatoff. Ecological design can learn from cultural history to foresee as many consequences as possible.

2.5.2.2.9. *Permanence sustaining*. Permanence is important element in the idea of place and dwelling. In English the term for dwelling means 'to stay.' This is the symbolic opposite of moving or changing. It means to 'withstand time.' Dwelling resists and persists. Attachment leads to valuing a place. In terms of ecological design, this can bring about a change from unsustainable activities to sustainable, since movement and waste would be reduced. The benefits of settlement are economic, ecological and spiritual. Economic because everyone will have to learn to live within the limits of photosynthesis and watersheds. The ecological benefits of rootedness are that people will take care of their place if they realize they are going to be there for a thousand years. Having a place means that the inhabitant has stock in it and participates in its unfolding, through planting and caring. Detailed understanding of plants in a locale allow gathering of food and medicine. People in place acquire a sense of community, nonhuman and human; shared set of values and concerns; health and spiritual benefit.

2.5.2.2.10. *Perceptive*. The use of a metaphor alters the perception of the secondary as well as the primary systems of reference. Using metaphors, ecological design can shift our perception of humanity and the earth, from the center of the universe to participants in a multidimensional process. No culture is the center, or the evolutionary survivor of other cultures. By enlarging human perception, ecological design can create designs that are appropriate for individual cultures or for the common needs of many cultures.

Table 2522-1. Comparison of Natural, Traditional & Ecological Design of Ecocultural Play

Natural Creation	*Traditional Design*	*Ecological Design*
Nature-based	Culture-based	Nature & culture-based Connecting
Aggregating	Bricolaging	Niche-assembling/ connecting
Trial & Error Novelty testing	Conscious Trial & Error process	Ecological redundancy
Trial generating	Learning from failure	Failure incorporation
Novelty generation	Novelty emphasis	Historical tradition
Reciprocal interactions	Rules/Geometric grids	Quality emphasis
Bottom-up organization	Top down direction Control of actions	Bottom up action with top down restraints
Physical restraints	Creative Play	Consequences attention
Natural process	Goal-directed	Permanence sustaining
Actual Existing	Conceptual	Perceptive

2.5.2.3. Ecological Economies of Ecological Design

By considering an enlarged concept of economy, in which there are no real externalities, ecological design can produce forms that fit well within the larger ecological regional and global systems.

2.5.2.3.1. *Natural capital-preserving*. Production forms need to be redesigned to incorporate renewable energy forms and longer-used materials, that is, fewer materials that can be recycled by the system driven by plentiful alternate energy sources. Using renewable energy, and fossil fuels at one six-thousandth the current rate, would allow the energy capital of the system to remain intact. Keeping materials in the system longer allows the natural capital of the minerals or the overburden—which is usually a functioning ecosystem—to be saved, also.

2.5.2.3.2. *Adaptive process*. A material ecosystem is an adaptively organized system of living beings and elements that recycle important elements within the system (after Lynn Margulis's definition); it is the smallest unit that recycles biologically important elements through circular paths. 'Culture' is a word that refers to a form of human expression that is adaptive to the environment of nature. Culture has been a useful adaptation to environmental challenges, such as cold, drought, and rapid change. Design can use purposive policies that mobilize the adaptive capacities in these dimensions of culture and nature. Without certain knowledge, however, we can make adaptive decisions based on partial knowledge; this is adaptive design, which is very much like adaptive management.

2.5.2.3.3. *Integrative*. Most approaches to design and production are dualistic (wilderness-industry) or triune (wilderness-design-industry). Ken Yeang states that ecodesign is the biointegration of artificial systems to natural systems. The ecosystem is the level of integration and the unit of organization undergoing a directional development, according to Eugene

Odum. Energy is bound into organic material, measurable as productivity. It is not landscape strictly—it is domiture, which includes all agriculture, wilderness, and other forms. Ecological design can make connections visible and restore the interconnectedness of the systems, especially ecological and human social systems.

2.5.2.3.4. *Dependent constructive minimally destructive*. Ecological design minimizes the waste produced by designing for reuse. By using more benign arrangements of elements and materials, design can minimize damage from unnecessary or toxic waste. Ecological design depends on the coconstruction of artificial and natural systems moving under constraints from each other.

2.5.2.3.5. *Appropriate energy use*. Ecological design tries to determine the source of energy and to use energy from renewable sources, such as solar energy and wind power. But, it also has to be cognizant of the scale and appropriateness of these sources and try to use small-scale, distributed sources. When possible, power generation could be integrated into the design. With efficient homes and electric transport, all of the energy needs of some areas, the Pacific Northwest for instance, could be met by established water power, which is estimated to be half of the potential.

2.5.2.3.6. *Appropriate technology*. Van der Ryn states that ecological design is about merging nature and technology. Certainly technology is emergent from human activity, which is emergent from "nature," but ecological design is also concerned about separating technology from nontechnical species. Advanced technology is not always necessary. To be sure, it is wonderful, but it should not be the driving force for ecological design. Conservation and fitness are far more important. Since 'Natural services' cannot be replaced by technology, either economically or completely, large areas are needed to be left wild. However, due to our extreme, inconsiderate interference, we need to design a protective framework, for that "nature." Artists have certainly agonized over the dehumanizing effects of technology on natural landscapes and the human spirit. Perhaps art can help shape an emerging ecological consciousness (or a stage for disillusionment and collapse).

2.5.2.3.7. *Waste integration/Ecological Efficiency*. Other designers, including Nancy and John Todd, and William McDonough, suggest that design should create no waste by following natural systems. But, every group, and many systems, create waste; often it is just used as a resource by a system down-stream. Although in the evolutionary past, and possibly in a few systems now, so much waste was produced that it was incorporated into geological processes as carbon forms or other metallic forms, like iron waste. Waste could be drastically reduced by designing the process to use common reusable materials. Much unavoidable waste from production can be used in other processes. Some waste may have to be separated and buried, that is reintroduced to geological processes.

2.5.2.3.8. *Cost Constraints*. What is the total cost of any design? Not just material, but ecological and psychological costs? It may include pollution and loss of community, with the attendant loss of trust. Cost constraints should be based partly on physical constraints. Ecological accounting includes all the costs that impact consideration. Costs to ecological systems should also be calculated and minimized. Longer time-lines make a difference, also.

2.5.2.3.9. *Size/scale constraints/Quality consideration*. Although fads are part of biological and human life, ecological design considers the material and scale constraints that will discriminate against wasteful or stupid fads. The second law of thermodynamics is a real constraint. It guarantees that cost is always a consideration with design. Gravity also limits extents in design. Limits reduce options. Constraints and limits, however, can be sources of creativity rather than just hindrances.

Table 25239-1. Comparison of Natural, Traditional & Ecological Design Use of Ecological Economics

Nature Creation	*Traditional Design*	*Ecological Design*
Productivity	Capital-using	Natural capital-using
Interrelational	Constructive	Adaptive process
Nested	Auto separation	Integrative Identity?
Interdependent	Independent/destructive	Dependent constructive minimally destructive
Solar-life driven	Energy use (any, fossil)	Appropriate energy use
Aesthetic creation	Technological tool use	Appropriate technology
Waste generating	Waste production Efficiency	Waste integration Ecological efficiency
Free play/change	Cost consideration Market-oriented	Cost constraints based on physical constraints
Natural Teratrends	Fashion fads Style (e.g., more speed)	Size/scale constraints/Quality consideration

2.5.2.4. Values of Ecological Design

Ecological design treats value differently, partly because it is holistic, and partly due to the increase in the number of values.

2.5.2.4.1. *Responsibility to living community & environments*. Ecological design takes responsibility for the state of the ecosystems in which design projects, at any level, are embedded. This responsibility includes caring not to disturb the operation and cycles of ecosystems by adding unbearable amounts of waste, energy or materials. The ecological responsibility for the production of goods is important. Choosing to use designs for yourself involves knowing an ecology, knowing a politics (being astute), and protecting what is valued. People in wealthier nations could cultivate voluntary simplicity, living in a way that is outwardly simple and inwardly rich, by consuming less, and thus release more rare goods to other people.

2.5.2.4.2. *Strategies*. Ecological design uses strategies to shape the overall plans. These strategies consider ecosystem use and exploitation, as well as long-term effects on the human realm. An ecological strategy defines a larger end—one that includes the welfare of other species and ecosystems, as well as the welfare of individuals and other people, over a longer period of time.

2.5.2.4.3. *Flexible order*. Order must be more than meaningful to humans. It has to consider time scales beyond human, on evolutionary living order times. The order has to be flexible to accommodate changing conditions and changing human meaning. Flexibility allows for more options under different constraints. This flexibility allows designs to be useful for longer times under different cultural values.

2.5.2.4.4. *Fitness concepts*. Fitness is treated as a value by ecological design. In an organic world, fitness is defined as the continued free interplay of energies and structures without dissolution. Perhaps, as a working definition, we can just use 'harmony,' that is, a good fit into the environment. Harmony as an ecological concept includes the health of people, other life forms and the living systems.

2.5.2.4.5. *Limitable Cautious*. David Orr's characteristics of ecosustainability include the idea of nature summarizing the code of evolution as a model. Nature uses limits; ecological design can treat limits cautiously. Many things 'stand in the way' of designing a sustainable livable environment. Lack of knowledge is one thing. Another is the focused self-interest of an institution or a culture. Another is individual self-interest, which may be broadened by culture or narrowed. The goals of a collective society may not reflect the goals or intentions of individuals. Our imagination is limited, our abilities are limited, and our vision is limited. In our excitement to design good things for ourselves, we have to be careful not to dispose of a tremendous base of traditional ecological knowledge (and we might avoid movements, like the Bauhaus School, with its slogan of "Start from Zero" and desire to sweep aside all rules). Relearning is the process of investigating past designs without rejecting them. Strong past designs created a meaningful human order. The modern order of design has to recognize, respect, fit, and work with environmental conditions. Of course, some people use design to try to force the environment to fit human desires or to try to escape from its limits, but designers need to be cautious about displaying too much power.

2.5.2.4.6. *Inclusive*. Ecological design has to be inclusive, not only of objects and ecosystems, but of a long temporal order. Anything that impacts the ecosystem health has to be considered in design. Although a design has a boundary, ecological design considers the boundary more like a large enveloping membrane that allows flow through the design.

2.5.2.4.7. *Knowledge*. Design has to consider innate knowledge and the spectrum of ignorance, rather than just rational knowledge, which is just part of a large system of knowing. Designers need more than sensitivity and ambition. They need an understanding of human experience and an understanding of a balance of nature and culture. They need the ability, as Erich Jantsch says, to organize their total experience towards a purpose. Design is presented as a counterpoint to analysis, but analysis is necessary in design, before it can begin a synthesis. To design products with minimal environmental impact, we need to have a basic understanding of ecosystem impacts and the interactions between them.

2.5.2.4.8. *Inspiring*. Design can be inspiring, as well as exciting. It can inspire almost everyone to try to design objects and forms to make things more interesting, as well as safer and more useful. Design can capture the excitement of the ecosystem context to provide inspiration for creators, as well as for users and viewers.

Table 2524-1. Comparison of Natural, Traditional & Ecological Design in Values

Natural Creation	*Traditional Design*	*Ecological Design*
Living	Responsibility to product, consumer, community	Responsibility to living community & environment
Fitting	Planning	Strategies
Harmony-building long-term	Meaningful order short-term	Flexible order Living order times
Existence value	Goodness concepts	Fitness concepts
Learnable	Teachable	Limitable Cautious
Adjusting	Exclusive	Inclusive
Formation	Information	Knowledge
Chaotic/Free	Exciting	Inspiring

2.5.3. *Ecological Design Components, Elements & Variations*

Ecological Design builds on the basic geometric elements of traditional design, from 3 (volume) to 2 (plane), to 1 (line), and to 0 (point) dimensions. These elements can vary in numerous ways, by number, position, direction, size, shape, interval, texture, color, and temporal. Furthermore, the elements can be organized into groups by nearness, similarity, and difference (diversity). Then they can be combined into whole structures by principles of rhythm, balance, and finally sensory force.

2.5.3.1. Elements

Ecological design has the same elements—point, line, plane, volume—as traditional design (see Section 2.4.3.1.), but they are understood in an ecological context foremost, in treetops, promontories, and mountain ridges, in the outline of a forest edge or a volcanic island, the surface of a grassland or the path of a shark.

2.5.3.2. Variations

Ecological design shares the same variations—number, position, direction, size, shape, interval, texture, color—as traditional design (see Section 2.4.3.2.), but there are many more occasions: Sand blowout and a forested tertiary dune, the diagonal lines of hills, the path of a corridor, the framing of a skyline by the shape of hills, a talus slope on the side of a mountain, the volumes in and around an Oregon creek, the shape of an agricultural field squared by a road, the texture of an old-growth forest compared to a young tree plantation, or the palettes of a coral reef.

2.5.3.3. Organization of Variations

Ecological design shares the same organizations of variations—time, groups, nearness, similarity, density, diversity—as traditional design (see Section 2.4.3.3.).

However, time in ecological design is ecological time, which ranges from the lifetimes of bacteria to the development of landscapes over tens of thousands of years or the lifetimes of species in millions of years. Trees in the temperate northern hemisphere tend to grow in stands. Nearness for ecological design can range from the interpenetration of endophytes to a general community grouping in a desert mesquite landscape. Blades of grass in a prairie may be perceived as dense from a low perspective. With fewer elements, a Japanese garden of the same area as a Dutch Tulip garden may look smaller.

2.5.3.4. Organization into Structures

Ecological design shares the same organization into structures—structures, rhythm, tension, balance—as traditional design (see Section 2.4.3.4.). The structure may be more complex for ecosystems, as when a tropical forest ecosystem has a typical structure (of interrelated parts) of six levels, from the herbal layer to rising emergent trees. Rhythm in ecological design has units of time that may range from milliseconds to thousands of years, although most will seem to be daily, seasonal, or long (in 2-25 years). A large clearcut area could create tension in a mature forest landscape because it would rarely develop under natural conditions. In forest design, a larger meadow could balance a dense woods, due to differences in perceived masses (especially if it reflected differences in soils or topography).

2.5.3.5. Concluding Thought: Ecosystem Complexity & Wicked Problems

There are not many examples that give the interests of the ecosystems independence or priority, perhaps because the project would be too large or complex, or perhaps because there is no funding for it. Eric Higgs thinks that this may be a wicked problem for ecological design. Rittel Horst, in 1960s, defined a wicked problem as a kind of social problem that is formulated with confusing information, too many clients, and confusing values. Imagine how wicked ecological problems are when they include all those nonhuman perspectives and values. Problem definition is subjective based on a point of view (or two or three). The solution is participatory design, which can reduce domination by one point of view. Design is political; there is no way of envisioning other approaches.

Complexity is not the only variable that can make a problem wicked. The scale is a problem if we think we can destroy the planet by burning fossil fuels. And, it is a problem if we think that nothing we can do will affect the planet.

Orientation is another variable that can influence the wickedness of problems. Design can be object oriented, like a building, and not seem wicked. But, design can be pattern-oriented, like planning for minimized polarized light surfaces on buildings in sensitive ecosystems, and then it pulls in scale and complexity—we are finding that we cannot avoid the things that make designs wicked, and that denying them does not make design good.

But, design can work things out in an artistic way. There are ways in which design can be subversive; *Adbusters* is an example. Perhaps that might solve the wicked problem situation of design. Being subversive may turn over and expose wicked design problems. That artistic way is a wild way of thinking and meshes or can mesh with restoration design better than a simple technical approach. Ecological design requires an ecological perspective, systems understanding, participation, and standards of knowledge. However, it does not require a degree or certificate, which means that fewer people, educated or self-educated, will be ecological designers.

2.5.4. *Characteristics of Ecological Design*

The characteristics of ecological design have to address the properties of ecosystems and places. The courses of the design have to imitate the processes of systems and places. The wholeness of the design has to address the ideas of spirit of place and sensory force. After the processes are identified, they have to be related to the patterns. Design may have to try shortcuts, unless it can afford to take ecosystem time, which is often many human lifetimes.

2.5.4.1. Imitating Courses

Design has to identify patterns of movement and construction, then it has to imitate the processes and patterns, modifying them to include more things of human interest and need. This is more difficult than copying a shape or a structure. Fortunately, imitation is a human strength, even if the recognition of complex, long-term, moving patterns is not. Courses can be thought about using topological and mathematical models representing a four-dimensional landscape.

2.5.4.2. Extending Identity & Wholeness

Ecological design has to capture the integrity of a place, or to restore it. Unity is a fundamental objective of landscape design. Unity is the way the elements, including shape and scale, of a landscape are combined. It is sometimes related to simplicity and character.

For instance, visually, a forest ecosystem usually dominates the landscape. From a distance, even-aged forests have much the same impact, in terms of color, shape, and scale, as uneven-aged forests. Diversity becomes more important visually at a smaller scale. Natural forms of the forest are unified with the landscape because the margins are very uneven, and open space in the forest is part of the mosaic caused by birth and death of individual or groups of trees. Whole means containing all of the elements to be complete in itself or being a system. In Arthur Koestler's idea, things are wholes related in nested levels.

2.5.4.3. Enhancing Diversity

Because the operation of the universe tends to change systems, the design of a place should be open to the types of processes that could destroy the design, as well as enhance it. Furthermore, flexibility, defined as the unused capacity for change, can be designed into the system.

The parts of a system have to maintain the potential for many possible behaviors that could flow from any other part of the system. Openness and flexibility are characteristics of healthy ecosystems, and they can be considered and enhanced by design.

Play is an activity that can lead to relaxation, or practice for more serious things relating to survival, such as food and mating. In another sense it means to move freely within limits. As an activity, play can increase the openness and flexibility in design.

2.5.4.4. Participating in Coconstruction

Designs are limited by the real biological constraints of ecosystem processes and biogeochemical cycles. We must know the constraints in order to create a healthy design. The design has to work within the constraints of the ecosystem. Rather than emphasize static equilibrium, the design should emphasize heterogeneity and adjustment to disturbance, within a dynamic nonequilibrium.

People have needs, animals and plants have needs, the site has constraints, and these things can be married into a good pattern. Design is the participation in the process of the ecosystem as a harmonious system, with mutually restrained conflicts and constrained influences. In fact, harmony is a constraint of the whole system. An ecological design is a form of co-constrained construction, where the organisms, environment and designs are co-implicative, co-defining, and co-constructing. They all engage in a process of self-assembly, within the whole system.

2.5.4.5. Investing in Stability & Constancy

People often judge the health or wholeness of ecosystems, or the goodness of designs, by how they look. Traditional design has emphasized visual results above all else. Ecological design, however, achieves the same results by paying attention to the structure and function of the ecosystem first, before sketches out an ideal form. Design has been concerned for centuries with making domesticated landscapes out of wild ones. Now, design is addressing the opposite problem: How to preserve or provide the conditions for wild ecosystems so that they are stable and healthy within the processes shaping and affecting them.

Signs of ecosystem health include the homeorhesis of the system, that is, the stable, directional flow of the system capable of resistance, resilience, and accommodation. The design for an ecosystem describes the system in a comprehensive interdisciplinary approach, using dynamic concepts such as constancy and stability.

2.5.4.6. Stimulating Productivity & Health

Most products of an ecosystem are produced, consumed and recycled within the ecosystem. Humans need to minimize the external inputs to systems in the form of energy and exotic substances. The community must be restored to health. This means balancing human needs with bird or fish needs in a sustainable pattern.

Ecological design is the creative modification of ecosystems to repair or enhance their ability at self-organization and maintenance of their complexity and diversity. Health is the overall ability of a system to maintain itself under a normal range of environmental conditions. Ecosystem health is one of the goals of design. The goal, of course, is not an end point that can be reached once, but is rather a continual striving. Responsibility is the condition of being accountable for actions or obligations. Here it means undertaking all aspects of a design, regardless of the expected level of success. These six characteristics have to be related to other levels by ecological design.

Table 2546-1. Properties at Different Levels.

— Nature —		— Culture —		— Design —	
Field	*Ecosystems*	*Place*	*Culture*	*Good Places*	*Good Society*
Motion Process	Course	Dynamic Change	Conduct	Action	Method
Autopoesis	Identity	Self-making	Wholeness	Individuality	Self-extension
Differentiation	Diversity	Uniqueness	Flexibility	Richness	Variety
Integration	Constrained Construction	Integration Investment	Adaptation	Conviviality	Cooperation
Constancy	Stability	Regularity	Endurance	Consistency	Loyalty
Development	Productivity	Renewal	Vitality	Health	Harmony

For instance productivity of the ecosystem level promotes vitality in cultures and harmony in good societies, which are embedded in human places, which are embedded in ecosystems. And, diversity at the ecosystem level promotes flexibility at the cultural level and variety in good societies.

2.5.5. *Principles of Ecological Design*

Principles reflect the differences between local and global systems. Principles cannot be reduced to other principles, because they emerge from earlier ones and they expand into new forms. This expansion is why we cannot fit them into the old can of old principles. These design principles are based on basic principles of nature, such as the principle of change. Nature is in flux, culture is in flux, everything is in flux. The climate will change, the shorelines will change. Human understanding and behavior is changing. But, nature is also self-regulating. This is the principle of self-regulation. Nature has evolved to maintain its stability in the face of many kinds of disturbances from planetesimal impacts to changes in atmospheric composition. Nature will continue to regulate itself even as human beings make dramatic changes. The danger is not so much that nature will collapse, but that humanity will.

2.5.5.1. Ecological Principles

Principles of ecology, such as stability, have to contribute to the design of landscapes because those landscapes have derivative principles, or maybe emergent principles. Design has to incorporate those principles because it is in place, in an ecosystem, in a culture. Some cultural principles, such as sacredness, are actually emergent from ecological principles, such as the principle of pattern. It expresses the values of the locale and the culture. Principles must be flexible to mirror the flexibility of open systems; flexibility is provided by diversity in fact.

2.5.5.1.1. *The principle of flow*. Nature is in flux. It changes; it flows. The principle of flow is necessary to the functioning of organisms as well as the biosphere. Flow can only be realized through structure, however, cell or ecosystem. Another principle is the principle of flow, which is necessary to the functioning of organisms as well as to the biosphere. Flow can only be realized through structure, however, cell or ecosystem. It is the problem of free flow or division by membranes. At each level of a natural system, from cell to biosphere, the units involved do more exchanging internally than externally with other units at the same level. Flow and division must be in balance. The diversity of the current ecological world evolved through the breakup of Pangaea, which provided the distances and barriers to isolate species.

2.5.5.1.2. *The principle of separation*. The principle of separation, by walls, barriers or membranes—nonflow or limited flow, is crucial to design. Barriers are necessary to maintain form and integrity of individuals as well as of ecosystems. By removing some barriers, such as releasing carbon that has been locked up for eons, we unbalance natural cycles. Even though landscapes exist within large ecoregions, which exist within the biosphere, they need closure to maintain their integrity. At the level of local ecosystems, there need to be fewer closures, so that there is a flow of genetic information within a species as well as between species. Human activities have the effect of blocking the flow at local ecosystems, with asphalt and wires, yet increasing the flow between large regions with ships and airplanes—mostly the flow of pests and domestic species.

2.5.5.1.3. *The principle of growth*. Everything seems to grow, from the universe to the human population and its activities. Urbanization attracts people to live together in larger populations. Everything tries to expand, beyond serious constraints or limits if it can, or if, not to survive within them. Cells produce many more daughter cells than can be used. Many species produce more offspring than can ever live. This principle seems to be limited by the principle of pattern, which provides limits to growth, and the principle of separation.

2.5.5.1.4. *The principle of self-regulation*. Nature is self-regulating. It has evolved to maintain its stability in the face of many kinds of disturbances from planetesimal impacts to changes in atmospheric composition. It does not need to be regulated by external factors or an internal regulator—the regulation emerges from the complexity of patterns.

2.5.5.1.5. The principle of error (or play). Error permits diversity. So many things are thrown at the flow of life. There is not just a little error. Half of everything seems to be error: billions of pollen grains, billions of eggs, millions of species. Transmission is not flawless or efficient, but it is generative of difference and diversity. The diversity of the current ecological world evolved through the breakup of Pangaea, which provided the distances and barriers to isolate species.

2.5.5.1.6. *The principle of pattern.* A pattern is an arrangement of form of elements. Process applied to components yields pattern. Nature is composed of patterns. Organisms have characteristic patterns, such as the branching of trees or the cloud forms of tree crowns. Lichens have lobes, wood grain under stress has spirals. The cracks in tree barks form nets. Patterns are not still. A circular pattern through time can be recognized as a spiral (the earth's orbit for example). The pattern should allow for surprises and discontinuities; it can do this if it is flexible. The design of ecosystems is vulnerable to surprises because nature is chaotic (unpredictable) and science itself is uncertain (by definition) about patterns of change in ecosystems.

These principles seem to be interactive, each forming part of the environment for the others. These principles result in a definite set of standards and behaviors that can guide ecological design. For instance:

- Work within the scale and duration of an ecosystem. Processes like succession can be assisted, slowed, or speeded up, but not skipped or ignored.
- An ecosystem is designed by its limits, time, scale, and complexity.
- Only details and exceptions form the ecosystem; only generalities are important—so you have to live with contradictions.
- Make the smallest number of changes, in case they are not effective and have to be modified. Nature seems to follow its own principle of least effort.
- Adapt process of change to the site (you fit the ecosystem, not other way), so that you do not have to put as much effort into control.
- Seek the best use for the products of the system; everything in the system is a resource for something; many can be directed to human use, but not all or most of them should be.

- Extend the life of things through cycling, then return the waste to the ecosystem; things can be recycled indefinitely, as in an old growth cycle.
- Preserve the components, structure, and function of an ecosystem. The redundancy of a system will allow the system to continue to be self-making.
- Understand the patterns and connections. Make sure they are not broken. Try to fit within their limits.

2.5.5.2. Ecological Design Principles

Ecological design principles emerge from knowledge of ecological principles. They must combine the constraints of ecology with the ascendant sensitivity of design.

2.5.5.2.1. Spirit of Place

The spirit of each place is unique. Place is not just location; it is the total sum of objects in the landscape combined into a unique whole. The identity of place often leads to human identity, thus people call themselves by their place names. The more unique a place the stronger the emotional attachment of the inhabitants. Every place has certain characteristics that enforce the spirit of place, for instance, a strong definition of place or indicators of great age (trees or rocks), or where a place distills the essence of larger landscapes. A sense of wildness and water also contribute greatly to the spirit of place.

Each place expresses a unique combination of elements, including contrasts, dramatic features, and the presence of water. Design can work to be consistent with the recognized spirit of place. If the design recognizes this aspect of the landscape, it may be stimulated by spirit and it may further enhance it—what it should not do is degrade it. Forest design can emphasize some features above others. The goals of good designs include: To relink people with genius of their places, to revivify image and identity with places, and to develop and maintain the identity of places.

2.5.5.2.2. Sensory Force

All the elements of design can be combined in an image. Every organism creates an image of its place from what is meaningful to it. This image is what fits the organism to its place. Suckers and caddisworms have simple images; coyotes and humans have more complex ones. Kenneth Boulding notes that the image as a cognitive construct of the world has several aspects: Spatial, temporal, personal, relational, value, and affectional (emotional) for each individual. Cognition is an active relationship that is creatively shaped by the participants. Participation is not an option by the way—every scientist or inhabitant becomes part of the system of observation. The total sum of individual images is a world. Some of the images we impose on nature result from idealized notions of pastoralism or technological futures. Thus landscapes abound in nostalgic or consumptive trends on many levels of explication—some are iconic, some invisible. We originally perceive the landscape symbolically, but the landscape has other functional dimensions that increase according to use.

Visual force is a psychological interpretation of perceived power in a landscape. As a principle, it is embodied in psychology, art, graphic design, and architecture. The human mind responds to visual force in predictable and dynamic ways, for instance, visual forces in landscapes draw the eye down convex slopes and up concave ones—the strength depending on the scale and irregularity of the landform. The effect of a landscape is not completely visual, however. Smell, sound, touch, and even taste play a large part of our appreciation of forests. Crawling, which is highly recommended by Gary Snyder, climbing, listening, and tasting things, such as soil or lichen, can expand our perception of other aspects of the forest.

2.5.5.2.3. Precautionary Principle

We should adopt a precautionary principle, which asserts that, if harm is threatened, and if there is uncertainty about the seriousness of the harm, then precautionary actions must be taken. Since the 1970s, in fact, this principle has been incorporated into Swedish and German environmental laws. This principle means that not doing something, "benign neglect," becomes a valid management option. Carl Walters suggests that inaction is an inappropriate alternative to gambling as a result of confusion, but inaction is a very appropriate alternative in the face of confusion—when in doubt about an ecosystem, we should not interfere. As appropriate alternatives, both inaction and action can be suggested by theory.

Traditional planning asks "what is most likely to happen," where uncertainty planning asks "what has already happened to create the future," in terms of long-term trends and demographics, according to Peter Drucker. Traditional approaches to uncertainty management are probabilistic, focusing on uncertainty as a measure of randomness or of confidence.

2.5.5.2.4. Scale Principles

Scale means basically a larger size or time. There is more mass and more momentum. There are more connections. This can mean lower interunit communications or connections get weaker as they are farther apart. There is a longer response time with size. Collapse may be absorbed by the connections, but sudden collapse becomes more likely. The interior/exterior system ratios change. A larger surface area is required to dissipate heat or pollution. This is why giant ants are not possible; they would cook in their exoskeleton. The breakdown would occur immediately if something was made larger suddenly.

Principles must be flexible to mirror the flexibility of open systems; flexibility is provided by diversity and redundancy. These principles also result in a further qualification of standards and behaviors. Some actions based on these principles might be listed. For instance: Contribute to excitement and to life (being); Act from the bottom, restrain from the top (and act locally in parallel, within the constraints from the top and blueprint); Cultivate feedback; Develop rather than grow; Use a sideways approach, rather than focus on details; Work with errors, learn from, and allow them; Work with and allow disequilibrium; Structure the design to allow change; and, Pursue the satisfactory (saticficing in H. Simon's words) instead of a perfect maximum or even optimum.

2.5.6. *Applied Ecological Design Practices As Lessons from Nature*

Design can imitate nature on many levels, from structure and process to landscapes. We can imitate the structure of mature forests by planting on every level of the forest hierarchy, from canopy to below ground. We can use native species. We can imitate the process of forests by allowing birds, bats, and other animals the opportunity to distribute seeds and energy to other areas or to prey on "pests." We can create microclimates within the landscape that may shift the landscape in new directions. Planting trees, for instance, allows new species to become established under their protection. Ecosystem health is one of the goals of design. Although the goal is not an end point that can be reached once, but is rather a continual striving.

The landscape provides its own metaphor for design. The landscape is a unique individual, a community, a dynamic system of interacting patterns—the human pattern is a part of it now and should be preserved as part of the whole pattern, but not necessarily as the only pattern or a completely dominant one. Most products of an ecosystem are produced and consumed and recycled within the ecosystem. Humans need to minimize the external inputs in the form of energy and exotic substances. The community must be restored to health. This means balancing human needs with birds or fish needs in a sustainable pattern. Each element in a pattern relates to others and to the whole.

Natural patterns can suggest a number of regularities to understand for the design of ecosystems, according to Michael Soule. Well-distributed species are less at risk than concentrated ones. Large blocks of habitat are safer from species extinctions. Blocks close together are more effective than those far apart. Contiguous blocks are better than fragmented blocks. Interconnected blocks are better than isolated blocks. Corridors can make functionally larger blocks functionally. Roadless blocks are better. Human disturbances similar to natural ones are more likely to be resisted or accommodated.

These rules work well with natural processes that operate in ecosystems, such as metalysis (building up and breaking down), animal movement, interelement flows, human interactions, and shifting mosaics. For instance, forest fragmentation can be reduced through the design of forested areas, taking into account the genetic diversity of the trees, catastrophic conditions, minimum viable populations, corridors, and edge effects. The survival of organisms usually depends on one of two factors in the web of relations. These factors can be modified by design.

Wild landscapes are affected by climate, soils, interactions, and disturbances. Domestic landscapes are affected by these and by land use as well. The greatest changes have been brought about by the destruction and creation of forests. With the predominance of artificial forests, it is important to consider the qualities of naturalness in the landscape. Forests are expected to meet the needs of society by producing timber, creating wildlife habitats, and providing recreational opportunities for people. But, forests are also expected to look natural.

The English Forestry Commission's guidelines (1994) to principles and practical applications of forest design may be of use. They represent an established standard. They do not cover every aspect of landscape design or all of the details of design techniques, however, nor do all of them apply to wild forests. The guidelines indicate what to look out for, and which situations may need special attention. Forest landscape design is a complex subject, as are forestry and ecology.

The values of the land and forest must be most carefully assessed. The characteristic qualities must be identified and measured for uniqueness. Comprehensive landscape plans should be required when planting or extensive felling is planned on a large scale. The patterns established at these times may persist for many years or centuries. Good design maybe able to resolve conflicts between characteristic qualities of the landscape and the changes from use. Also, the design should last as long as possible and should be self-sustaining.

2.5.6.1. Levels of Ecological Design

As a design process includes the planning of ecosystems, this means a fourth and fifth level of design— notice that numbers lower than number four, all are properties of traditional applications of design: (5) Regions, landscapes, and watersheds (as well as airsheds), (4) The community, for instance forest, city, or corporation, (3) systems, such as ecosystems, traffic, or industrial areas, (2) products, as habitats, houses, roads, or plant sites, and (1) components, such as trees, fungus, bats, tools, rooms, cars, or land. Many problems occur at level three—more are to be expected at the new levels four and five.

All levels of design need to be addressed, from the conceptual to the political, and are involved in all stages of the process. This involves new challenges for ecological design, which has to:

6. Relate a project to its global context (sixth level of design). This is the level of global

cycles relating to renewal of living processes and resources from long and short-term global cycles.

5. Relate a project to its regional context (fifth level of design). This is the level of regional cycles relating to precipitation and waste recycling.
4. Relate a project to its ecosystem context (fourth level of design); be concerned as much with cultural survival, justice, and wilderness preservation as with cost, efficiency and aesthetics.
3. Consider the whole perspective (ecocentric, perhaps); the proper vision is of the whole community in which we dwell. Apply ecological concepts, such as networks and carrying capacity.
2. Make designs that are anticipatory, flexible, pluralistic, polyvalent, and polytechnic. Make open guidelines for long-term decisions.
1. Essentially, work backwards from values and goals, and from the bottom up and inside out, drawing designs from the genius of place.
0. Participate in place, care for all inhabitants, and assume responsibility for the designs.

One of the shortcomings of design has been the lack of consideration of the higher levels, which can result in specific problems with safety or recycling.

2.5.6.2. Stages of Ecological Design

Ecological designs can be applied in eight stages. These stages should be typical of all designs:

- First, Decide to design; Use a design management matrix, review the situation; Evaluate ecological history of the site, observing patterns of movement; Account for interconnectedness, population change, land use, building and development, boundaries, limits, and life; Conduct ecological and functional analyses.
- Then Inventory, record all of the resources, from physical resources to cultural resources. Survey the area and create base maps, from geological to zoological maps.
- Next, evaluate the interactions in terms of impacts, needs, goals, and limits. Assess the whole system. Delineate and balance components.
- Create a series of plans, from the site plans to value plans. Integrate with biosystem services. Kinds of integration: horizontal, Vertical, temporal. Consider aesthetic-perception factors.
- Start to design, which is a community process requiring the participation of all people, including the elderly, handicapped, and poor, as well those ultrahuman beings who cannot voice their concerns. Synthesize simulations and models (conceptual, capability, and suitability). Make another series of plans, from landscape plans to policy plans, within a master design.
- Implement the design together. Use appropriate measures and techniques, emphasizing native species over an adequate time period to ensure the stable processes of transformation. Create new connections, Reduce unwanted effects, such as road effects or heat island effects. Integrate into context. Optimize passive mode integrate water, biomass, materials flows. Conserve water and energy
- Maintain and manage design. Provide services for continuity and management. Monitor and improve constantly. Monitor, Reassess.
- Prepare for undesign and disintegration.

Ecological design must work within the components, structure, and function of ecosystems. Unless it does, it will not be long lasting or satisfactory. Because ecological design has to work with wild ecosystems, whose aspects are often ambiguous, fuzzy, changing, and general, design has to be able to work with these aspects. Furthermore, the design has to work within the constraints of the ecosystem.

Ecological design takes far more time than graphic or automobile design, due to the complexity, size and longevity of its subject. A number of factors have to be carefully assessed before design work starts. Wild ecosystems require a lot of observation before activities can take place. Wild ecosystems can be highly reactive to change. Some people value different character of such ecosystems than others.

2.5.7. *Applying Ecological Designs to Places*

All design elements are related psychologically by designers, as focus or frame, as contrast or uniformity, as dominant or recessive, or in a number of other pairs. Good ecological design means not violating any of the aforementioned principles and ideas.

Design can improve the results of bad practices. Bad forest harvesting practices, for instance, often result in geometric wastelands. Good design can correct reliance on straight lines, parallel lines, right angles, and perfect symmetry. In cutting or planting forests to improve natural appearance, a number of things have to be considered, including the age of the forest, windthrow, the width of corridors, and the minimum size of the habitat.

2.5.7.1. Place-Based Ecological Design

Geology, climate, disturbance, and stability all produce diversity. Landscape diversity is linked to ecological diversity, which depends on diversity of the substrate. Different ecosystems introduce diversity into a landscape, but different ecosystems often can look similar. Excessive diversity can lead to confusion in a landscape design. Increased diversity also has the effect of reducing scale, so adding diversity can be used to reduce the scale. A high level of diversity is acceptable if one element is clearly dominant or if the differences cannot be recognized from a distance.

Psychologists have recognized the need for diversity for people's quality of life and emotional well being. Ecological diversity in the forest has been reduced by human activities, such as planting or grazing. The overall landscape diversity of many forests has not fared as badly, due to the addition of human artifacts, which can increase the diversity. An increase in ecological diversity would lead to an increase in diversity of the landscape, however. It would also tend to reduce the scale, but this would not be a problem in large forests.

Process applied to components yields pattern. Nature is composed of patterns. Organisms have characteristic patterns, such as the branching of trees or the cloud forms of tree crowns. Lichens have lobes; wood grain under stress has spirals. The cracks in tree bark form nets. Patterns are not still. A circular pattern through time can be recognized as a spiral (the earth's orbit for example). The pattern should allow for surprises and discontinuities; it can do this if it is flexible. The design of forests is vulnerable to surprises because nature is chaotic (unpredictable) and science itself is uncertain about patterns of change in forests.

2.5.7.2. Ecological Design of Buildings

Design cannot be separated from social and political questions. Designs, as Winston Churchill recognized, especially buildings, steer our experiences and actions. According to Langdon Winner, design includes the deliberately chosen, enduring forms of both material and intangible entities that affect human relations. Ecological design is a field that aims to recalibrate what humans do in the world according to how the world works as a biophysical system and a cultural entity. Design in this sense is a large concept having to do as much with politics and ethics as with buildings and technology.

Green buildings are more sustainable, energy-efficient buildings. In the United States, buildings account for 36 percent of total energy use, 65 percent of electricity consumption, 30 percent of greenhouse-gas emissions, and 30 percent of waste output. Making new buildings that use recycled, nontoxic materials, recycle their own waste and derive multiple benefits from the renewable natural resources around them, such as the sun, wind, rain, not only reduces their environmental impact, but also creates indoor environments that are healthier and are more inviting places to live and work.

Adapting existing buildings has advantages. The creative reuse of existing buildings offers the multiple benefits of "harvesting" already built structures, reducing the demand on our overflowing landfills and allowing people to maintain a stronger connection with the history and development of a city. Changing buildings leads to rethinking transportation. Efficient, convenient public transit can be used to get within and between neighborhoods, reducing congestion, pollution and the use of fossil fuels. Modifying roads, especially in neighborhoods to slow or redirect traffic, could allow more walking and bicycling.

Design could integrate the city into its environment like a living organism in an ecosystem, although in this case the city is an extension of living human organisms. The city could generate its own energy with solar and wind power. The effects of climate could be modified with building shapes and vegetation. Design could influence human connections and diversity, with good psychological shapes and connections. Design could also reduce the scale to a more human scale, requiring less management and rules.

2.5.7.3. Ecological Design of Tools and Things

The ecological design of tools considers tools in every aspect as an extension of the human mind. Tools and things are extensions of human ingenuity. The design examines the effects, short-term and long-term, of the tools, and attempts to balance the trade-offs. Tools have environmental effects, as well as physical, biological, and cultural effects on their inventors and users. Tools have different levels of involvement, as well as levels of intensity.

2.5.8. *Ecological Design Management*

Ecological design is not finished with the design. The system may need to be managed as a result of the design. Noninterference matrix management is proposed as a technique for design management. An ecosystem exists as part of matrix that many interacting elements. Any activity in the matrix can have some effect on these elements. The whole matrix needs to be managed with the ecosystem in mind.

Understanding of the principles of ecology can lead to better management. One critical message of ecology is that if we diminish variety in the natural world, we debase its—and our own—stability and wholeness. Many ecosystems have been simplified and degraded. Perhaps we do not have sufficient knowledge to manage a complex landscape because it is too complex to understand scientifically. But we can understand the pattern and drive it in a healthy direction with minimal intervention. We must do all that we can to restore its richness and the natural processes that created the richness.

2.5.8.1. Principles of Ecological Design Management

Management, whether it is archaic, traditional, industrial, or ecological, should adhere to basic principles.

- Holistic Practice. Forestry practice should be holistic since it affects the whole forest. You should harvest in the context of planning, measuring, monitoring, protection, and restoration. Manage for preservation, reservation, protection, and use. Create a practical plan, based on the forest (especially riparian areas). Emphasize interconnectedness over separate structures or operations. Sustain the forest before any yield.

- Retention. Retain the structures and processes (which produce the complexity and diversity) of the forest, including legacies and special areas. Soil is an important structure. Preserve the diversity of microsites. Preserve all components, structures, and functions. Protect and maintain diversity/preserve the patterns. Design your uses or harvests to maintain connectivity, thereby minimizing fragmentation.
- Noninterference. Do not interfere with the health and stability of the forest. Do not block flows of air or water. Water Flow. As the medium for life, water is used and transported by organisms and systems. Water is necessary in any organic energy conversion. Air flow. As the medium for gaseous and water cycles, air is essential for most life. Do not block flows of nutrients, materials, or animals and plants.
- Least Effort (also a principle of economics and cybernetics). Encourage natural regeneration; let the forest do as much work as possible—it has millions of years of practice in some cases. Make the fewest cuts, go the least distance. Broaden the base of use of materials from the forest; avoid concentrating on timber only.
- Respect and maintain natural disturbance regimes through time and space in order to maintain forest landscape patterns. Natural disturbances, from the death of individual trees to large fires or windstorms, are responsible for critical composition, structures, and ecosystem functioning necessary to maintain fully functioning forests. For example, the death of an individual tree sets off a process of change, beginning with a standing snag that provides habitat for cavity-nesting birds and ends with a fully decayed fallen tree that serves as Nature's water storage and filtration system. At a landscape level, natural disturbances, large and small, are responsible for diversifying habitat patterns and, therefore, maintaining a natural diversity of plants and animals. Natural disturbance regimes are also critical to the maintenance of soil nutrient cycling and adequate levels of soil nutrients. Protecting, maintaining, and, where necessary, restoring natural disturbance regimes provides for natural composition, structures, and functioning at the forest landscape and stand levels. Respect traditional practices in place-based cultures.
- Managerial Flexibility. Be flexible—keep your options open. Principles must be flexible to mirror the flexibility of open systems; flexibility is provided by diversity in fact. Small is more flexible (and beautiful as Schumacher says); small mills, small operations, small businesses are easier to run and easier to change with conditions or trends.
- Work with the changing ecosystem. Succession can be assisted, slowed, or speeded up, but not skipped or ignored. Only details and exceptions form the forest; only generalities are important—so you have to live with contradictions. Make the smallest number of changes. Adapt process of change to the site (you fit the forest, not other way). Keep acquiring understanding and knowledge. Manage personally. Probably no one will know that forest as well as you do (especially if you live in it).
- Appropriate Scale & Time. Scale management to forest size. Approach the forest as in a partnership; do things to benefit the forest as well as yourself. Give back to the system. Work with forest time; do not try to do everything in the industrial schedule. Be as slow as you want or need to be. Attempt to set up a transgenerational land tenure system to accommodate forest time, which spans human generations.
- Profitability. Make your business profitable (by profit, I mean simply the excess of returns over expenditures—thus your health and happiness might be considered a return from caring for the forest). Adjust your input to expected goals. If your goal is to restore the

forest to health and enjoy it, then the profit may be spiritual. Seek best use for products; everything in the forest is a resource for something; many can be directed to human use.

- Keep wild ecosystems wild by minimizing control and interference. Preserve the structures and functions of a forest. Preserve minimum viable populations of species. Create standards of forest classifications.
- Accept Management Limits. Management is limited, by costs mostly, to regulating animal and plant populations in a system, rather than climate, geology, or water, soil, mineral cycles. Manipulating plants and animals to the environment is more likely to succeed than the opposite. Management limits are determined by the ecological characteristics of the resources, before any economic, technological, or political limits are applied. The use must be limited by the ecology before monetary considerations. For legal stability, find the best combination of ownership, trusts, easements, and plans to ensure that the forest will be cared for in the long-term.

2.5.8.2. Noninterference Matrix Management

A noninterference approach to ecosystem management, the essence of a taoist way, is to let the system take its own course. Therefore, once the temporary constructs were in place, whether planting or cutting or any other manipulation, the system would be allowed to develop without further interference.

In nature, noninterference means 'letting be.' Noninterference matrix management (NMM) is not indifference, which is diffuse. It is caring. Noninterference will not lead to chaos, poverty, and stagnation. The technocratic vision strives for "life under control," but the forest is self-managing, productive, efficient, and orderly. We need to practice the rule of noninterference so that all beings can enhance themselves. Noninterference can be derived from nonviolence, or from taoist nondoing. This attitude would entail using what is necessary, exploiting parts of some ecosystems, changing a place to fit human aspirations, and killing plants and animals for sustenance. But it would also mean limiting humanity and its technological effects, limiting human use to local impacts, and letting other beings live without interference. It is not necessary to dominate or terraform the ecosystem completely to save it. Noninterference matrix management weaves people back into the fabric that supports them and in a sense makes them subject to the constraints of ecosystem processes.

NMM would manage the system with minimum subsidies; manage activities that could upset equilibrium; manage sustainable conditions; align human activities with natural processes; work with system instead of attacking it; and, restore context. According to Garrett Hardin, many of the ideas necessary to fitting humanity into the pattern of nature are known but not yet popular. For instance, exponential population growth, or economic growth, cannot be maintained very long. Human communities cannot grow 4 percent per year without disastrous consequences to the infrastructure and the quality of life. Growth cannot be continued because the landscape is limited, in terms of productivity, energy, and resilience. Thus, we need to fit our population into the limits of the landscape, although some limits can be expanded by technology or by lowered expectations. The carrying capacity of the area is not only a function of the limits of the community, it is equal to the number of people multiplied by the level of comfort, the quality of life style. Having more energy and space means having fewer people.

The ecosystem may be too complex to design. How do we design an ecosystem, such as a complex, self-making, self-sustaining wild forest? We could identify the parts and functions and try to duplicate them, but that would prohibitively expensive and time-consuming. Management has to recognize the limits of design. Limits of ecological design include the fact that ecosystems are wild, and we have no real control over them. The scale of ecosystems is often too large to manage everything. The longevity of ecosystems is too long, and we will never complete the design in human lifetimes. The costs may be prohibitive—indeed, we have depended on the free goods of ecosystems for economic advantages, which would disappear if we had to rebuild the system. Other human limitations apply to our ability to see and understand any ecosystem.

2.5.8.3. Uncertainty & Management

Carl Walters discusses how we recognize and measure uncertainty. He presents material on decision theory. He also distinguishes between three kinds of uncertainty in natural systems:

1. Regular disturbances over time generate unpredictable and uncontrollable changes. Certainly this is true, but we have found that regular disturbances are also responsible for creating diversity in ecosystems; furthermore, regular disturbances "habituate" the ecosystems, so that often the system requires the disturbance to continue. Certainly, as he suggests, monitoring is necessary. The uncertainty of these disturbances is usually just in the exact timing and scale, not whether they will occur or not.
2. Statistical uncertainty about parameter values of functional responses, e.g., production rates as a function of stock size, can lead to problems with exploitation. He suggests the solution to this is simply assigning probabilities to parameter values. Probability is mathematical way of describing "random events," such as coin tosses. Nature, of course, is not random, even at a quantum level. Probability is also a degree of belief, according to Savage (1954). Probability theory centers on the notion of uncertainty as it applies to independent or conditional propositions. There are at least two kinds of probability: Personalistic, which depends on personal beliefs and confidence, used in Bayesian contexts, and Objective, which deals with repeatable events. Probability, in the face of some history, becomes conditional probability to reflect events that have already occurred. In nature, unfortunately, we are not always sure which events have already occurred and which have not.
3. Basic structural uncertainty about what variables to consider can lead to indecision. Incomplete structural representation implies time-varying parameters and surprises involving changes. Surprises are usually the result of incomplete knowledge, but also can be from the emergent properties of systems.

These three kinds of uncertainty are not that different, being basically levels of ignorance. There are other levels and kinds of uncertainty. There are levels of uncertainty, from the quantum to the human. Elementary processes at the quantum level are not subject to a precise description in time and space. Predictions about location and velocity are just statements of probability—this is Heisenberg's uncertainty principle. The effect of this principle on epistemology is that our exact interpretation has to be abandoned. There are uncertainties at higher levels of organization as well; for instance, the hysteresis of some magnetic solids determines their subsequent behavior—without knowledge of initial conditions and all past events, it is not possible to predict present or future behavior. Furthermore, the higher up in levels of organization, the more kinds of uncertainty there are. There is genetic uncertainty, as well as environmental and social.

There are also many kinds of uncertainty, as suggested by Max Black. There is fundamental uncertainty in the thing/event/pattern, as well as in the channels (noise, meaning) of relationship. At the human level, uncertainty can be distinguished between ignorance and conflicting knowledge.

Ignorance can further be divided into kinds: vagueness (indeterminate knowledge),probability (confidence in partial knowledge), incompleteness (of knowledge, missing elements), irrelevance (place in a pattern is unknown), and fuzziness (with overlapping interpretations).

Conflicting knowledge also can be broken down into kinds: anomaly (incongruity of knowledge, simple error), ambiguity (alternative interpretations of meaning), inconsistency (simultaneous untruth), equivocation (knowledge is constant and inconstant, true and untrue), and belief (confidence in subjective knowledge, taboo).

There are probably other components of ignorance, as well as other ways that they can be combined into a formal typography. There are many different kinds of ignorance, maybe more than kinds of knowledge, and that these determine our approach to the practice of making places. If we think of knowledge as an expanding sphere in a space of ignorance, then as the sphere grows, the surface area in contact with ignorance also grows.

Walters stresses that managers have to live with uncertainty, and then makes the great connection that management decisions are essentially gambles. Gambling is a profession that acknowledges the operation of chance and makes conclusions in the absence of facts—few people are successful at it. This is an important admission, that we do not have facts to base our actions on, that nature is a stochastic process, and that ecosystems always changing. Furthermore, we do not know for sure what effects our actions will have on the forest, which used to live so long. If we do not act responsibly, we are gambling that the cost is more than damaging the planet. If we act responsibly we are gambling also. Successful gambling suggests that the proper attitudes for gambling with nature are awareness, humility and courage, not arrogance, fear and maximum use.

Although he suggests that inaction is an inappropriate alternative to gambling as a result of confusion, in fact, inaction is a very appropriate alternative in the face of confusion—when in doubt about an ecosystem, perhaps we should not interfere.

Walters suggests that managers should embrace uncertainty rather than always strive for "certainty-equivalent" policies. That is, they should try to define a set of possible outcomes, e.g., models, consistent with experience, rather than make a single best prediction. Managers have to live with uncertainty, but they can make intelligent gambles, based on their ability to work within real ecological and physical limits. Of course, they should not gamble with all their resources at once.

2.5.9. *Ecological Design Limits*

People often judge the health or wholeness of ecosystems by how they look, as a function of richness, despite the fact that ecosystems have to fit into extreme climates and places. Traditional design has emphasized visual results above all else. Ecological design, however, achieves the same results by paying attention to the structure and function of the system first. Design has been concerned for centuries with making domesticated landscapes out of wild ones. Now, design must address the opposite problem: how to preserve or provide the conditions for wild ecosystems.

Design must address the common good, that is, the good of the entire ambihuman community; it can do so by: Promoting the well-being of all individuals in larger community, deciding what is preferable, attempting to regulate and anticipate all effects, encouraging convivial activity, recognizing links and dependencies, mediating the relation between technology and community, and alleviating some of the problems of industrial society.

Designs provide a framework for natural and artificial processes to work in. The patterns in design are echoes of patterns in nature. Good designs learn to embrace error and failure, so necessary in open systems. Most ecological designs of ecosystems will not be restorations, because of the uncertainty about the kinds and associations of native vegetation. Furthermore, humans are now a large part, although not yet an integral part, of the system; therefore it could not be restored to a premodern or prehuman state, even if we knew the proper or historical state. This design is not the biotechnological design of a new ecosystem, either; we cannot accurately control and predict ecological events in most ecosystems. However, we can steer some of the events in a known direction—known because we have historical records of the system, although not complete. We can also reduce those human activities that we know alter the conditions of the forest, such as overcutting and pesticide use.

2.5.9.1. Ecological Balance

Although ecological design attempts to restore some kind of balance, the balance does not exclude human activity. Rather, it integrates it into the larger community. A moderate number of human impacts can be absorbed by the system—too many destroy the systems capacity for self-maintenance. The design should be open to evolution and to human technological and social development. The design should be based on a model of ecosystem functions, considering diversity, complexity, and the maintenance of natural process—natural here meaning a self-sustaining system composed of elements now lost through human disturbance.

How do large-scale processes influence design? That is, how can design be flexible and open enough to cope with change? How does design accommodate those processes? The processes provide constraints on the designs, which when implemented, force some constraints on the processes themselves. The question is how to limit the latter constraints so that the processes are not fundamental shifted into a new regime. For example, a dam is located depending on waterflow, canyon walls permeability, location, rainfall, and other factors. After being built, however, the dam changes rainfall, erosion, waterflow, species groups, and other factors, which may reduce the rain upstream that reduces water behind the dam.

The role of designers is to optimize or satisfy the fitness of people with their environments. To fit cultural goals to ecological characteristics and limits. It is adaptive creativity, not just for the current technology, but because it needs to adapt to the technological and natural environments. An ecological design involves designers and people in reshaping and recreating a self-sustaining community. Individual resources are limited. The relationships to strive for here are community relationships. Furthermore, there are limits for human manipulation of other communities. Total control has limits, also. We should not aim to try to control ecosystems. We have to trust that natural processes are self-correcting and organizing.

Ecological design is the design of communities. We design places as organic wholes to promote the well-being of individuals and the common good. The immediate goals of design are to reverse degradation and reclaim places for communities, but also to work to increase public awareness of the interdependence of communities, to create environmental quality, and to transform public values by generating new metaphors for living. Unlike what Robert Bailey and others imply or say, local design cannot ignore culture, politics, and economics. Design has to commit to limits, constraints, and optima (physical, biological, psychological, and social). Ecological design can restore the interconnectedness of the systems, especially ecological and human social systems.

2.5.9.2. Ecological Perspectives

According to Victor Papanek, an ecological perspective can change design: With a greater emphasis on quality and permanence. So products can be more timeless and age gracefully. By questioning the ultimate consequences of a new product, regardless of profit or prestige.

By adding new products for new approaches or new professions; monitors, scrubbers, converters. By understanding that all design has ecological and cultural consequences that need to be discussed and evaluated. And, by having a greater concern for and understanding of nature, preserving and restoring the health of the environment. Ecological design importantly has to do with ecological scale, which explains Papanek's conviction as a designer that: Nothing big ever works! Not corporations, building, schools, or bureaucracies. Ecological design has to fit designs into the scale of their context, so that they harmonize with it. Ecological design fuses art and ecology from the work on forests and rivers to agriculture and buildings.

On the other hand, our tendency to redesign nature, rather than to tolerate and cherish, is dangerous; it leads to "curing" abnormal people and "solving" weed problems. We do not respect the wild, complex side of human nature. So we need ecological designs that seem like 'dedesigns.' Ecological design does not have to merge technology with nature, as Van der Ryn and others define it. For buildings, technology is an important component, but for the shape of ecosystems, it may play a minor role, of necessity; we may not have the knowledge or the ability to completely control technological replacements for natural services. Ecological design has to respect nature and natural limits, while integrating human patterns into natural processes. The role of designers is to optimize the fitness of people with their environments, to fit cultural goals to ecological characteristics and limits. Ecological design is adaptive creativity, not just for the current technological fix, but because it needs to adapt to the technological and natural environments.

An ecological design is the creation of a clear vision of the ecosystem that is aesthetic, useful, and self-sustaining. Some of the relationships can be captured by maps and drawings, but not the dynamic four-dimensional qualities of the system itself, which can only be understood by dwelling there for years. Nevertheless, a simulation of the view from foot or airplane is more compelling than a recital of the statistics or species lists.

The goal of ecological design is not to restore a damaged wild system to some vague prehuman state—it is to revitalize and reinhabit the wild ecosystems. We do not want to live in the dead bones of a mechanistic failure. We want to live in a healthy environment with aesthetic appeal—aesthetic appeal is a requirement for human health. Every system has physical, biological, economic, and political characteristics. The ecological design, planning, and management for a forest, for example, describes the system in a comprehensive interdisciplinary approach, using dynamic concepts such as feedback and stability, recognizing limits to change and sustainability with different levels and scales of structure and function in an anticipatory, flexible planning approach, recognizing human and nonhuman goals, and incorporating personal and institutional interests.

Ecological design is the design of whole communities. We design places as organic wholes to promote the well-being of individuals and the common good. The immediate goals of design are to reverse degradation and reclaim places for communities, but also to work to increase public awareness of the interdependence of communities, to create environmental quality, and to transform public values by generating new metaphors for living. The long-term goals require a wild, heroic design and extravagance. It is not contradictory or antithetical to living frugal lifestyles or to restoring a healthy environment to create ambitious, heroic designs—this needs to be repeated often. Life is exuberant; energy is used, lives are lived and used, not saved. Life is the accumulation of individual experiences that cannot be saved, stored, or owned. This local ecological design is what brings all the problems into focus—or rather into context and out of focus. We have to creep up on the problems sideways like a crab.

2.6. *Fitting Local Design to Regional & Global Design*

Local designs are not going to work unless there are hooks at the regional and global scale to allow or encourage the designs to work. If a nation or international organization tries to enforce a top-down decision model for everything, then local decisions will be much more difficult. The challenge then is to start with local decisions and try to constrain and coordinate them based on regional or global requirements that are necessary for the continued health of local systems.

2.6.1. *Local Ecosystems Emerge from Conditions in Place in the Planet*

The planet originated as an aggregation of small pieces, within gravitational and electrodynamic constraints. Any local system seemed to resemble any other local system. At a point in its growth, the scale of the aggregation changed its interior and exterior conditions. The interior heated sufficiently to change the state of iron and nickel. Regions divided into separate spheres characterized by specific temperatures and pressures.

The sphere that was the molten core of the planet kept the heavier, hotter matter in the core. That part of the planet was not free to interact with the surface. The types of regions constrain their local systems so that they no longer interact outside the system.

Regions emerge from and constrain local systems. Other principles either emerge at the planetary level or become more important at that level, such as the Principle of Wholeness, which states that a whole emerges from the interactions of parts and that whole is more than the total number of parts. Regional patterns emerge from local ecosystems, from their properties and constraints.

2.6.2. *Local systems Push Regional & Global Systems*

The emergence of water from rock and from volcanic action created a global pool of water. The emergence of gases from the surface created a global envelope of gases. These pools then acted as constraints on regional systems in the planet. The suboceanic realm permitted anaerobic bacteria to thrive, as well as plants that could exploit shallow zones for light and animals that could use dissolved oxygen. The atmosphere limited most life at water, at first. As waste products, such as oxygen and methane, joined the atmosphere and built up, the scale of that change pushed the regional and global systems to change. Oxygen for instance, interacted with ultraviolet light, creating ozone molecules under those circumstances; this reduced the ultraviolet radiation reaching the surface of land and water, and allowed living forms to exploit the surfaces, especially terrestrial ones.

Regions are constrained by the global system. Global phenomena, such as atmospheric gases, can impose restraints on local systems, especially regarding carbon dioxide or fires.

2.6.3. *Are Local Designs Ever Independent of Regional Designs? Or Global?*

Because of the dynamics of the planet at least, local systems are not independent of the regional systems in which they are contained, as regional systems themselves are pushed by global flow patterns into distinct states with various degrees of temperature and moisture.

Local designs are never independent of regional designs. Scale-linking occurs with processes at different levels, such as evaporation. In a sense, no local system can ever be completely independent of the surrounding system, region, planet, or solar system.

2.6.4. *Leaving Hooks & Flexibility through Design*

No local life form has had to consider the regional or global effects of its accumulated exploitations and wastes. Changes in interactions or scale happened or did not happen. Some local forms, such as bacteria, became ubiquitous within the global system.

Humanity, however, has slowly, as individuals and small groups, become aware of the regional and global consequences of its wide-spread habitation, transformations and waste generation. As human designs, especially of transportation networks, waste disposal and habitations, have grown larger, people have recognized that the consequences to all systems have become negative and damaging.

A dynamic system can often reach a threshold or tipping point, beyond which the system enters a new stable state or an unstable state. Threshold: entrance, beginning point, when perceived. Tipping point turning point. The action that precipitates change is often called a trigger. A trigger is a mechanism that activates a release of information or energy (or an immediate change in scale). A trigger is also a small impulse that can release the stored energy of a larger impulse; it is a form of energy amplification. The changes triggered can be much larger than the expected results. We can suggest past triggers. The extinctions of woolly mammoths, subarctic horses and other megaherbivores, as a result of factors from climate change to overhunting, triggered the shift to less palatable plant communities after cropping stopped renewing vegetation. Fire triggered land conversion. Domestication triggered differences in animal behaviors, shapes and requirements. Fossil fuel use triggered waste, speed and atmospheric changes. We have been transforming the planet for over 12,000 years. We choose what plants grow where. We grab minerals, redirect water, and spread wastes.

External disturbances such as asteroid impacts or basalt eruptions have triggered significant transitions between different states. However, most transitions appear to have been generated internally with evolutionary innovation playing a role. There are many further considerations: To what extent is the Earth system self-regulating? What is the contribution of life to maintaining habitable conditions? In what sense can the Earth system itself be said to evolve? Does regulatory feedback predominate at the global scale?

There are many kinds of physical, biological, psychological or cultural triggers. A crisis can be triggered by a change in scale. A trigger can have connections to a global system. A trigger often creates positive feedback, causing dramatic amplification (see Section 17326 for a further discussion). The novelty and complexity of interactions of innovations can lead to thresholds that are tipping points, triggering punctuations in the functioning of the system with consequences that may surprise humans.

Is there a way that abrupt changes in the operation of the system can be anticipated and predicted? Can we identify the changes are most susceptible to triggering by human activity? Many aspects of system dynamics are believed to exhibit multiple equilibrium states, and therefore may display abrupt transitions between equilibria. There is evidence for a transition from a green to an arid Sahara in the mid-Holocene, 5500 years ago.

We admit that design and its effects can have local, regional and global consequences from slums, to the destruction of regional forests to atmospheric change. That means that all designs are going to have to be studied for fitness with other scales. No global design to change atmospheric temperature should be tried without understanding the regional consequences of shifts in wind and moisture patterns that could destroy rainforests or agricultural designs. No design of pest control should be considered without understanding its consequences in poisons spreading through regional food chains. No design to restore the regional Sahara to forests should be considered without understanding the local consequences to endemic vegetation and local adapted cultures, as well as to global wind patterns.

Design has to leave sufficient hooks, in order to respond to triggers and changes. A hook catches something due to its design, or connect the parts. Regional designs can leave hooks for local design to respond to changes. All the constraints of a system can influence or limit design. Harmony, of course, is a constraint on the whole system. The design imposes constraints on the system, but if it is flexible, it can be altered if the system is affected negatively. Some constraints, for instance, on technological interference, have to be top-down. Flexibility, defined as the unused capacity for change, can be designed into the system. The parts of a system have to maintain the potential for all possible behaviors that could flow from any other part of the system. Although there is quite a bit of flexibility for local orders, at the global scale it would be better to keep flows in dynamic equilibria. Diversity at the ecosystem level promotes flexibility at higher landscape or regional levels.

Globalization as a general trend is triggering a profound shift in human consciousness. First by forcing us to realize we cannot do everything that we want, and next that cultural differences are less important than what is held in common. Human societies, like climate, are open systems that have chaotic and complex dynamics. Recognizing that our industrial civilization is a dynamic social system that can evolve or devolve may be the key to managing changes. At the same time our civilization has become unstable, we are acquiring the ability to design living systems. Buckminster Fuller said that to change something you have to build a new model that makes the existing model obsolete, without fighting the existing reality.

Joseph Tainter notices that while converging stresses can result from disparate developments, such as a harvest failure at the same time as the invasion, they are often caused by cascading crises, for instance, when a harvest failure causes famine which triggers a rebellion or the invasion of some other society. This whole idea of cascading stresses is very important in many collapses such as the Mayan or Ik. Thus, there may be multiple triggers or cascading triggers. Autocatalytic loops keep self-organizing structures going. A trigger of one energy form sets off flow in another, which can trigger the release of another flow in the first, and possibly a chain of trigger/flow interactions.

Triggers can also be hot or cold, depending on the lag time between the trigger and the effect. Culturally, B.J. Fogg says that Facebook puts hot triggers in our path. The opportunity triggers our behaviors. Some behavior requires a trigger, although it can part of the path also. Cold triggers require later action, after a lag time. The goal with Facebook is connecting to people. Facebook and other interactive systems provide motivators, such as fear, hope or the desire to belong. Change, however, has to be a satisficing amount to be immediate and effective, not maximal or optimal, which even if possible would require longer lag times.

Ecological design needs to make hot triggers, that is, the actions have to be immediate: Saving kilowatts, planting grasses or food, or lowering the thermostat. We claim the ability now to geo-engineer the planet with large-scale ideas and projects. Even so, there are alternate ways of intentionally reforming the planet: An easy engineering way or a more difficult way of ecological design. If we experiment with engineering ways, we might want to localize the effects, by keeping the change to as few systems as possible, maybe in the southern or northern hemisphere only. For instance, gassing with SO_2 might have drawbacks: Acid rain, and shifting plant, animal and bird life. It might trigger uneven shifts. We rely on technology to 'change the game,' but we can change the game without involving more technology, by choosing ecological designs that incorporate conservation and frugality.

Ecological design requires understanding of properties that emerge from the local and regional levels; some regional properties cannot be understood without knowing global history. Global ecological design also requires a sixth level of design, which relates everything into a global context; this is the level of global spheres, such as the lithosphere and atmosphere.

2.7. *Insurmountable Problems at the Local Level*

Civilizations have experienced problems that seem insurmountable—because those civilizations subsequently collapsed and disappeared. Many of the problems are structural, logistical, or spiritual. Economic decline can lead to stagnation, disease and collapse. Many have to do with political power distribution, especially if related to the desire to conquer, control, and make uniform other cultures through war (and now the threat of nuclear war with nuclear winter). Over-administration has its own seemingly limitless costs that can lead to collapse. Imbalance as a general condition can lead to collapse. Some of these problems could have been solved or have been solved for a time.

Urban problems, and some national problems, seem insurmountable. Some problems, the largest ones such as earthquakes and tsunamis, seem insurmountable. The dedication of the legal system to human activities seems insurmountable. The problems listed below, having to do with water, heat, crime and structural maintenance, seem to be insurmountable for any civilization, industrial or ecological.

2.7.1. *Water & Drought*

Water has been a problem in many civilizations, from Mesopotamian and Indian to Chinese and American. The changes in wind and rainfall patterns or river beds have resulted in drought. In Mesopotamia, for instance, cities compensated for declining rainfall by irrigating wheat and barley with canals. But that lead to salt retention in the soils. By 3500 BCE wheat and barley crops were equal. Wheat can tolerate salt at only 0.5% in the soil, but barley can take twice that. By 2500 BCE wheat had fallen to 15% of the crop, although overall crop yields were still high, then to less than 2% by 2100 BCE. By 1700 BCE no wheat at all was grown. Overall yields fell 42% between 2400 and 2100 BCE, and by 65% by 1700 BCE. It was written that the earth was white with salt. After much intensification, the land collapsed. Many of these things are long-term problems and do not become evident for several generations. They are also very difficult to reverse. For a society that needs surpluses to continue, with growing dependents and growing people, there is little flexibility to change. The only way to avoid the problems was to let the land be fallow for long periods until the water table fell. This alternative was impossible due to food demands.

When cities started to fail, as a result of attacks or droughts, people were able to emigrate. Many returned to herding, or when possible, hunting and gathering. For thousands of years, starting possibly 11,000 years before the present, people participated in a cycle of emigration to rural areas when time were bad and immigration back into cities when the ecosystems recovered and could be made productive again.

In complex, self-regulating systems very small changes have large consequences. In some cases, where conditions like drought, are cyclic, in the Sahel region of Africa, humans expand during the good times, only to perish when the drought returns. In other cases, human activities, such as deforestation or overgrazing of herds, can cause weather changes. The scale and rate of changes allows people to view the situation as natural, but once these catastrophes pass a threshold, the people and their cultures have been trapped by their demands, and only severe reduction or collapse can allow the system to regenerate.

Drought has been a major urban or rural problem. Even cities that have been located on rivers have been destroyed by long droughts (usually over ten years). Fresh water has become an intractable problem in the past 50 years, as more aquifers have been drained and more water sources are used for industrial purposes, such as cooling or washing away wastes.

Areas of the Americas and Asia still rely on irrigation, and people steadfastly ignore the warning signs of drought and collapse.

2.7.2. *Heat & Control*

Life can be described in terms of heat differences, as well as of order and disorder. The process of ordering is like a river that flows uphill, but it creates a more massive downhill flow. Heat is necessary for indoor comfort in cold climates, but it usually comes from burning fuel. When the entire environment enters a higher heat regime, then people either adapt or emigrate. Our current form of adaptation is cooling the air in buildings by burning fossil fuels.

Individuals and groups desire to control the environment or specific events in it. Personal control is not only integral to the concept of health, but it is crucial to health. People in dependent situations, such as the elderly in rest homes, live longer if they feel they have some control. However, when it comes to large-scale temperature changes, we do not seem to have control. Living in hot climates has always limited the number of plants and animals, as well as humans. Controlling climate has not be possible with spiritual or technological techniques. Control of the environment on any but the very smallest scales has not be possible.

Heuristics, habits and shared illusions become shortcuts for understanding data and making judgments, but they can lead to systematic errors and biases, according to L. Mlodinow. Biases play an important role in decision-making, especially when related to kin or groups. When we have an illusion or bias, then we regularly interpret data to support it, rather than disprove it, and even actively seeking evidence to support it, for instance, whether it is for or against global warming.

We may be efficient at recognizing patterns, but we neglect our ability to assess them critically. We need to act critically on uncertainty and incomplete patterns. We can improve decision-making by understanding biases and illusions. And, by understanding that we cannot control every circumstance or avoid every unpredictable event or catastrophe. But, we can recognize negative patterns and plan for them, that is, have a framework for making decisions about them. We can recognize irrationality and unpredictability in our own behavior.

2.7.3. *Liberty & Crime*

People like being free to do whatever they want, but they also like being secure or protected. Usually the two conditions do not occur together in one political system. Even in a favored political system, crime and civic unrest do not disappear. Dangerous weapons, from automatic guns to tanks, and dangerous products, including nuclear reactors and biocides, are available to anyone to misuse. They are not strictly regulated. People choose to act badly sometimes. If a form of government is bad or ineffective, people can alter it. They can learn from mistakes or unintended effects. If the scale is small, then the catastrophe may be small. There will always be some injustice, inadequacy, and unpredictability. One law that Adolphe Quetelet described in his social physics was that vast inequities in wealth were responsible for social unrest and crime. Large institutions have made inequities worse.

A United Nations report has identified the world's rapidly growing herds of cattle as the greatest threat to the climate, forests and wildlife. And they are blamed for a host of other environmental crimes, from acid rain to the introduction of alien species, from producing deserts to creating dead zones in the oceans, from poisoning rivers and drinking water to destroying coral reefs. Cattle herds are the result of ignorance of the limits of local or global commons. Corporate cattle herds are worse. Corporations are especially bad at reacting to negative feedback from overshoot or drawdown—the lag time to the actual consequences is too great, as is the lack of a distinct trail leading back to individual or group poor decisions.

Extreme political views are divisive in a society not bound by minimum standards of behavior, especially regarding honesty or responsibility. Too little liberty results in as many problems as too much liberty, which is often the absence of agreed-upon cultural limitations. Too much division in a society, especially as regards material goods or luxuries, can result in crime as the perceived way of leveling differences. There are social controls on crime, include shame, which requires a smaller community where all people are known, and threats of punishment through laws, but shame is scale dependent, and only effective in small scale communities, and laws are only effective if they are enforced at a large scale.

2.7.4. *Globalization & Localization*

What is globalization and what does it do to the local? People have been trading items for over 40,000 years, starting with ochre, stone, copper, furs, and continuing with gold, tea, or people. Trade involved travel by foot, camel caravans, or sailing vessels, then, with steam-driven ships taking ores, grains and meats to many countries. Then coal and oil were traded, then shirts and manufacturing, electronics and computers. At first, there was a movement of people and luxuries. Later, there was a movement of materials and energy sources, followed by a virtual movement of money and capital. There was a specific movement of information.

Over the past 500 years, smaller economies have become incorporated in larger economies. The most recent phase of this development is now referred to as globalization. Globalization is a supranational trend and a gigatrend, as a result of exploration and trading. Globalization offers some advantages. Increasing globalization leads to more efficient production and to the recognition of the uniqueness of cultural creations. Because of the advantages of specialization, many nations produce and trade signature items. This kind of trade creates larger webs of interdependence, which is a crucial characteristic of globalization. This is not the same as trade between self-sufficient nations.

Global trade allows anyone to have access to any product or luxury. This access allows many to assemble comforts and technological marvels to enrich their lives. A global network increases the size of the frame of reference, so trade and social relations have a larger context, and shrinks apparent distance. Globalization seems to break down barriers and enhance cooperation. Despite its limits, the North American Free Trade Agreement (NAFTA) in 1993 did integrate issues of environmental quality and protection with trade.

Globalization increases the levels and scale of economic order. It creates more direct connections between local levels, as well as regional interests. Connections become tighter, more rigid and less flexible. Cities are unavoidably entangled in global networks. Cities used to be limited by the local carrying capacity, but can exceed that limit with advantageous trade. With global networks, self-correcting feedback has a significant lag time.

However, a countertrend of localization is growing and gaining momentum as a reaction to the threat of globalization to destroy local identities and homogenize unique local lifestyles. Localization responds to the increased abstraction of nature, commodification of places, and the modification natural processes. Localization emphasizes political governance of factors that impact the local systems. Localization can be typified by a number of trends: A slowdown of overall economic activity, population loss, urban shrinkage, an increase in the number of urban areas, and natural ecosystem rejuvenation. Localization makes feedback visible and more immediate, which could shape more self-reliant cities.

2.7.4.1. What are the negative impacts of globalization?

There are many arguments in favor of globalization. One argument contrasts it to the erroneous belief that the past was always nasty and short, teaming with suffering, disease, and tyranny from others. Thus, globalization acquires the patina of myth, that it has a destiny to save civilization. One myth of globalization is that it is saving and managing the planet. Another is that nature is a machine that can be simplified and streamlined. The metaphor of the machine is only a metaphor. Nature is not a machine and cannot be easily simplified to produce only positive and desired effects.

Globalization has always had negative impacts on people, places and economic exchange. As cities and communities traded over longer distances, for example, people were exposed to new diseases from other previously isolated populations. This exposure led to sudden epidemics and catastrophic losses of lives and cultures, especially in the American continents. This first wave of global trade destroyed many of the traditional societies of the Americas and produced incredible suffering. Globalization was destructive on other levels, not only from diseases, but also by conquests and exotic exchanges. American crops, for instance, grown under harder conditions, grew where native Euro-Asian crops grew less well. Exotic crops went everywhere, even manioc into Africa. This allowed expansion of populations into marginal areas. In general, the coming together of zones was destructive to native peoples, not just from trade and competition, but also from livestock, exotics, and diseases.

A later wave of globalization destroyed traditional economic systems in Africa, Asia and the Pacific. European exports, especially in textiles, undermined regional livelihood. These processes enriched the Atlantic shores, but also widened the inequities between and within nations. As a result of differential and interference trade (basically unfair), gaps in wealth increased and social inequality increased. Lester Thurow states that governments did not decide to start global trade and marketing. But, that is what happened through the establishment of East India, Hudson's Bay and other companies. There were also changes to local cultures, with clothing, foods, and songs being dominated by a few. These waves of globalization resulted in long-term changes to human immune systems, and to the composition of ecosystems. As national languages came to dominate local ones, many languages were lost, impoverishing knowledge and culture.

John B. Cobb Jr notes that after economic globalization was pressed under US Presidents Reagan and Clinton, the consequences for the developing world were terrible. Recognizing this, the World Alliance of Reformed Churches issued the Accra Declaration, which noted the convergence of suffering of people with damage to the natural world, locating the cause in an unjust economic system.

Donella Meadows has expressed reservations about the global trading system. It is a system where the rules are designed by corporations, and run by corporations for the benefit of corporations. The corporations have freed themselves from many local and national controls.

This system limits feedback from anyone else. Meetings are closed to reduce feedback. The lack of local feedback weakens communities. Aspects of globalization tighten inter-system linkages and hierarchies. This tends to distance resource users from the immediacy of their dependence on systems. This also weakens feedback loops that are essential for responding to adjusting services. Increased interdependence can make the network more fragile. The lack of global feedback is a severe problem. We do not observe ecosystem responses yet to consuming the capital of local ecosystems or the global ecosystem, since we can always trade for more resources from somewhere else. The biosphere that supplies resources and services, as well as absorb wastes (materials and emissions), is limited by amounts and rates. That ecological limit is a limit to consumption, which is related to technology, population, and wilderness. Lack of ecological feedback is what allows limited resources, such as forests or fisheries, to continue to decrease in price as they are destroyed. The stock is not increasing, but technology is more efficient and economic rules are bound by their two-year horizon—and new global rules allow better access to remaining stock. Living on the capital of the entire planet, we feel we can transgress ecological limits indefinitely, or at least until the capital is exhausted, then it's on to the rest of the solar system.

This system forces nations to race to the bottom, so to speak, weakening social and environmental safeguards in order to compete in the global market. Sturm and others have noted that 44 countries consume approximately one-third more ecological services than their capacity can provide. Thus, the global economy is poorly positioned for competition in the future. Significantly for their study, 16 of 20 eco-efficiency leaders are competitive, so overconsumption offers some short-term advantages. Some nations, such as Canada, are positioned well, due to their ecological remainder potential. Other nations, such as Japan, are competitive because of their efficiency, and because they save their own resources.

Many of the modern trade agreements are causing suffering and violence. The gross domestic product of the world increases, but what is produced? Who produces it? Eighty percent of the lowest produce only twenty percent of the global output. Globalization is a set of factors that offer advantages to traders or companies, but can weaken individual states (or possibly deterritorialize them).

Globalization disconnects identity from location. Globalization can de-territorialize culture, which has already happened to some cultures, through a disguised form of colonialization. Globalization presents the myth that cultures, through reterritorialization, can take root in new locations and develop new foods and new dances, without being bound by place-based foods, songs, or views.

The speed of globalization is a problem, especially for traditional cultures with traditional economics. When the speed is notably faster than traditional transactions, the culture can become less stable. With the globalization of trade and the domination of national languages, smaller cultures are being overwhelmed and absorbed into larger ones. Another concern with globalization is homogenization, as cultures shift to global materials and styles. Globalization could still occur without homogenization, but that would require respect and limits. Diversity and globalization are not totally incompatible.

Considering the clueless independent actions of corporations, the speed and novelty of the shifts of scale to a global system, with its social damages to communities and wealth, and the economic destruction of ecosystems for profits, the likelihood of some kind of collapse is growing. And, recovering from any collapse is going to be more difficult with globalized cultures in a completely occupied planet. We need—obviously—to rethink how we can redirect these accelerating trends.

2.7.4.2. How can we think of Globalization and Localization?

Globalization allows connections to other cultures and forcefully extends relations with them. But, we do not seem to have the moral development to live mutually and fairly with these other cultures, often constrained or limited by luck, geography, resources, or history. So, we take unfair advantage of them.

It is difficult for many people to respond to improve their lives or protect their places and ways of living. As local people become embedded in regional, national and international levels of relations, the number of connections and the scale of networks changes. Although some new information is shared between groups, much of the local information pool remains local. People became less knowledgeable about the distant center. Centers grow larger and dominate their peripheries, pulling them into a larger economy with less knowledge and power to act effectively.

Economic globalization allows design information to flow faster between nodes on a global scale. Consumption patterns can be recognized at a global scale. Globalism sucks values and people from their local context into the global context. Or perhaps destroys much of the local context, releasing people to the global. Capital becomes globalized. The economic nodes host exchanges that can bypass the control of sovereign nations.

Globalism allows most people to stay in place, but they still experience the displacement that globalism brings to them. Most human social existence continues to be local, of course, due to physical embodiment and attachment to home. Neighborhoods are based on proximity to start with.

Circumstances are more difficult than ever. Globalization stamps its undifferentiated image on the world. Traditional town based industries have largely disappeared as technology increasingly frees us from ties of place. The individual freedoms of the private car have had a high cost to the quality of the places where we live.

There are still many questions about globalization. Is globalization a universalization of the potential of one international society? Is international society just an aggregation of national societies? Are those just an aggregation of communities and individuals? Is aggregation the right word? No. Nations and communities are not thrown together. They develop in place through mutual concerns and shared values. Does globalization screw up the categories that we use for human behavior: Economic, political, social, environmental, or cultural? Global capitalism undermines traditional cultures by offering consumerism in the place of guides for behavior. Social roles seem irrelevant by comparison, if the good life can be bought without effort. This leads to a new kind of proximity. Inequities are made more visible. Threats to a shared environment become more visible. Dangerous conflicts are brought closer, which might set the stage for a violent clash of cultures. How does globalization react to Islamic militants? How does it react to sea level changes? How would it react to a possible collapse of China, Europe or the US?

An unquestioned, one-world, planned economy could become a great threat, if it continues to be based on unlimited industrial production, unlimited commodity consumption, increased exploitation of nature, and the free flow of resources and labor across cultural borders. This kind of planning requires the abandonment of local controls on development, trade, or lifestyles. All countries are expected to open their markets to outside investment, eliminate tariff barriers, reduce government spending (especially to the poor), convert small-scale, self-sufficient farming to agribusiness, and open all land to resource gathering. Planning is thus characterized by a utilitarian globalism that denies value to the systems that support it.

Localization is problematic, also, with its share of pluses and problems. Even the distinction of local can be fuzzy as centers at the local level are not recognized as local, unless each locale is the largest center of specialization, such as carriages or cheese-making; this seems to be a problem of focus and scale. Eventually, as a result of globalization, changes are made in behaviors and in public health strategies, from cleanliness and sanitation to isolation and inoculations, as hosts and agents both adjust. People in a strong culture may resist, which may revitalize the local. Local designs can communicate the identity of the place on a global scale. Terrorism, organized crime, and other emergencies will occur as often as other conflicts, but can be minimized in smaller nations.

The processes of globalization and localization have similarities with other binary or complementary processes, such as ektropy and entropy. Entropy is the running down of all systems. Ektropy can build order in a system but it produces and increases entropy in the surrounding systems. The processes cannot be separated. Globalization cannot proceed without the process of localization. And, it is likely that localization cannot exist now without some global exchanges. Both are evolutionary steps in human history. There seem to be tipping points now, especially related to runaway economic forces, that are favoring globalization. It is not hard to imagine tipping points that would favor increased and stronger localization; these points might rest in climate change and the scarcity of local resources.

Diversities are essential for human stability, capacity and resilience. Localization can suppress diversity; at first, globalization increases diversity, but then it works to suppresses many diversities. Human societies, like climate cycles and ecosystems, are open systems that have chaotic and complex dynamics. Localization often works to close a society. Globalization can make them more open for a while, but then the process disrupts society.

2.7.4.3. How can we balance localization & globalization?

During the collapse of some regional centers, such as Rome, monasteries provided an opportunity for a different way of life. They provided isolation and opportunity for innovation and the security in uncertain times. Centralization was no longer practical. Localization became much more manageable and useful for people dispersing from a center. The recovery of isolation and self-reliance in small communities helped local cultures to continue.

We need to challenge our fascination with the techno-optimistic 'gigantisms' and question the need for a single set of global trading rules. Increasing localization counters the threats of globalization to destroy local identities and homogenize cultural lifestyles. It can lead to knowledgeable governance and can respond faster to environmental destruction. Local institutions should anticipate global problems and react accordingly. They can assess sustainability at the local level, as well as increase awareness of restraints and impacts of the global level on local levels. Within a more reasonable global framework of economic governance, with new rules based on better principles, local institutions could have the power to choose or refuse global connections (perhaps a form of deglobalization). Local institutions can demonstrate that diversity and high-value yield more profit in the long run. As globalization has accelerated the speed of transactions, local communities have worked to reduce speeds. The citizens of Bra Italy promote slow food. Italian municipalities have created a slow cities cause. France favors slow economics, which boasts fewer working hours, longer vacations, and job protection. European Union wants work councils to protect local products. This is one good local answer to globalization, but it seems based on community anarchism more than a national movement to limit globalization to those things that it would be good at, and only to those things.

Institutions at the global and local level could monitor changes on different scales of STEM that might affect local sustainability. Global institutions could set standards for education and health; Global institutions could monitor all the major interconnections between systems at the level of the planet and coordinate the reporting at all levels of ecological accounting.

2.7.5. *The Maintenance of Civilization*

What is the relationship between amounts of complexity and amounts of design? Less is more, but so is more is more.

In an ecosystem, the energy required to maintain the ecosystem is inversely related to its complexity; succession decreases the flow of energy per unit biomass until the system reaches maturity (Margalef's concept of maturity). In a mature forest, for example, almost 100 percent of the energy is required to maintain the state of the forest. Any system formed by reproducing and interacting organisms must develop an assemblage in which production of entropy per unit of information is minimized, that is, waste is minimized in cycles.

The same relation seems to apply to cities or civilizations. The simplest economic transactions were between individuals who gathered food or made tools and then traded. The number of artifacts seems to increase as the populations increase. The number of artifacts seems to increase as the complexity of a culture increases. Materials can be used to express power. With the increase in specialization and complexity, came individual traders, then guilds, and finally corporations. A complex (or mature?) civilization tends to use 100 percent of its energy to maintain itself.

In every case where civilization has become more complex, according to Joseph Tainter, the cost of maintaining that structure has required an ever-higher percentage of income be set aside for maintenance; that income is no longer available to increase the standards of living. Modern civilizations have avoided collapse only by overusing fossil fuels to hide or override their true costs.

2.7.6. *Design to Surmount*

The ecological design of civilization has to address the true costs of maintaining levels of control and luxury. Ecological design has to be the creative modification of ecosystems to repair or enhance their ability at self-organization and the maintenance of their complexity and diversity. But, most of all, it has to become capable of reducing some forms of complexity and reducing improper uses of energy. Design has to fit human exploitation within the limits of a changing planet.

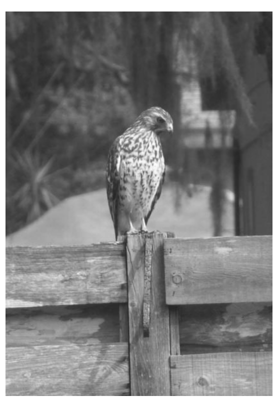

Figure 275-1. Suburban Hawk (Sarasota 2008)

3.0. Naming Nature for Design

Nature is a name we assign to a complex of things that occur in the dynamic planetary system. The system can be described as a set of interacting spheres—the geosphere, the atmosphere, the hydrosphere, and the biosphere, which interpenetrate and interact. The system has specific characteristics that have developed over billions of years: The atmosphere, for instance, has a unique composition, which is kept that way by the cycling processes driven by the sun and equally by a diversity of living forms living in complex, changing ecosystems. As a result of these activities and the composition, the planet has a relatively cool temperature.

The environment of the planet, that is the solar system and extrasolar space, is relatively isolated from local high gravitational influences as well as from intense radiation. However, it is also dynamic and provides many kinds of surprises and challenges, from the shifting of the planetary orbit to interstellar gas lanes and colliding space objects.

Materials have been built up and broken down for millions of years. We identify them as elements, molecules and compounds. In fact, many elements are sought as resources and can be used to create artificial materials (see Volume 1, *Redesigning the Planet: Foundations* for the extended discussion). Furthermore, we have the ability to design flows of elements as resources, if we pay attention to natural processes and historical connections. And, we have the ability to design ways of using wind and water energy.

The biodiversity of species and living environments has to adapt to the planet and its larger system to survive. The very slow changes from plate tectonics or climate shifts are also challenges, as are medium and large collisions with planetesimals. We tend to call these events catastrophes if a large number of species or families of species are driven to extinction. We think of them as anastrophes (positive turnings) if the environment is stable for long periods of time. Thus, life suffers mass extinctions, but responds with larger equilibrium levels of diversity.

Energy from the sun, combined with material cycles and living ecosystems, keep the global system in a mature high-energy state. Can these cycles and ecosystems be designed? Can we design forested systems that keep the cycles going? Can we do that with animal patterns or wilderness patterns? We have to try, because we cannot invent wilderness from rock, nor can we drive global material cycles with a technology of nanobots and computers. The designs may have to be limited to anticipating large events and disrupting them, to limiting human use and restoring ecosystems, to shaping human impacts and managing in partnership with nature (with benign neglect as often as possible).

3.1. *Local Design Factors: Organisms Communities & Ecosystems*

Why should we be considering these factors—ecosystems, communities, populations, and organisms? An ecosystem is a discrete unit consisting of interacting living and material components. An ecosystem is the unit of survival for living beings and communities. Organic structures, are building blocks for organisms for eating or nesting. They also nourish the soil. Ecology deals with the highest levels of biological integration, from organisms to the ecosphere. Autecology, for example, is the study of individual organisms in an environment. A group of individual organisms of the same species in a particular place is studied as a population. The assemblage of populations of different species in a habitat is studied as a community. The community in its biotic environment is studied as an ecosystem. Ecosystems comprise the ecosphere. There are emergent properties at each level of organization, such as the diversity of species and the structure of a food web. Furthermore, each level of integration has distinct attributes.

A living system is produced by living beings. A system is a set of things—such as people, cells, or molecules—according to Donella Meadows, interconnected in such a way that they produce their own pattern of behavior over time. The system may be buffeted, constricted, triggered, or driven by outside forces, but the response is characteristic of the system. A system is not just a collection. It is an interconnected set of elements that is coherently organized to achieve something. The system maintains its identity, despite the replacement of elements, molecules or organs.

Human perception of nature seems to be hierarchical, regardless of whether nature is. Several theorists distinguish levels of hierarchy in nature. G.T. Miller includes particles, atoms, molecules, organisms, societies, and nations. Mario Bunge extends the list to include processes and knowledge: Elementary particles (atoms, bodies); physical systems (organisms, ecosystems); physical processes (chemical, biological, social); material production (ritual, culture); and knowledges (physics, history). Ervin Laszlo makes a distinction between a macrohierarchy, comprised of a space-time field, particles, stars, galaxies, and various aggregations; and microhierarchies like the earth, composed of molecules, crystals, cells, organisms, ecosystems, and Gaia. Hierarchies can be regarded as vertically arborizing structures whose branches interlock with those of other hierarchies at a multiplicity of levels and form horizontal networks; arborization and reticulation are complementary principles in the architecture of organisms and communities.

3.1.1. *Organisms & Populations*

Even if individuals can be described in terms of vortices, as the poet Pound did before the physicist Prigogine, they do exist materially, and they participate in the field because they exist. Organisms are composed of atoms and molecules that energy forms under certain conditions of temperature and pressure, and their emergent behavior is more complex than just "energy vortices" or "patterns of matter." Organic molecules process quickly out of the pattern of the organisms. Although the molecules themselves may outlast an organism, the organism needs a turnover of the molecules. The molecules cycle within the ecosystem and to a lesser extent regional and global cycles.

Atoms that came from stars and rocks make up molecules of seeds, flowers, defecation, and rotting leaves, which are cycled through our bodies. Bodies are open systems exchanging materials with the whole environment. It used to be thought that organic molecules could only be assembled by organic beings. Various experiments have shown that organic molecules, such as urea, can be created by the operation of energy, such as lightning, on mixed elements, such as carbon and hydrogen. Matter organizations are stable holons that are used and reused, from elements through organic molecules (and DNA) to societies.

Each participant creates an image of nature from what is meaningful to it. J. Von Uexkull suggests representing these unfamiliar worlds with a bubble model. The life image, or umwelt, of an animal is what has perceptual and operational meaning for the animal. All animals are fitted to their unique worlds with equal completeness—simple animals to simple worlds, complex ones to well-articulated worlds. Each is optimally fitted to a habitat.

Furthermore, the organism must adapt to the environment, which implies having a memory and being capable of learning, and must reproduce, that is, duplicate its pattern in a separate being. Organisms are goal-seeking, and often stability is sought above change or complexity. The individual is a subject centered in a milieu. Because of this implied point of reference, Rodman concludes that ecology is teleological.

The life-form communities and physical elements are related in a definite pattern, which is a real but untouchable property (structure). In general, this structure becomes more complex as time passes, as long as the environment is stable or predictable. The structure acquires a historical character. Maturation, as a function of historical processes, increases the levels of complexity of an ecosystem. Principles of organisms include:

- The individual is the unit of experience and reproduction.
- An organism is inseparably related to its habitat, the place where it lives.
- The niche of an organism depends on what it does in its place.
- Many organisms identify with place.
- The size of an organism is related to metabolism.

Living sets are self-organized by the actions of their members. Sets consist of matter organized at various levels. Sets of molecules make up genes; sets of genes, genomes; sets of populations, species. Each locality supports a segment of the total species population in a unique context, with a particular set of predators, competition, food, physical habitat.

Principles that apply to populations include:

- The population is the unit that evolves in nature (according Krebs).
- A species population has unique properties, such as density, mortality, natality, potential, dispersion, age distribution, growth form, and structure (isolation, territoriality).
- Populations interact in neutral, positive, or negative ways.
- Competition limits the number of species in a niche (the competitive exclusion principle). Garrett Hardin (1960) states the competitive exclusion principle as: complete competitors cannot coexist. Niches must be different for species. Krebs states that the fundamental niche of a species has an "infinite number of dimensions," making a complete determination impossible. Another difficulty in definition is the assumption that environmental variables can be ordered linearly and measured. Furthermore, competition is dynamic, whereas models freeze single instants.

A group of individual organisms of the same species in a particular place is studied as a population. The assemblage of populations of different species in a habitat is studied as a community. The community in its biotic environment is studied as an ecosystem. Ecosystems comprise the ecosphere. There are emergent properties at each level of organization, such as the diversity of species and the structure of a food web. Furthermore, each level of integration has distinct attributes. A population has a property "density," the number of individuals per unit area, which is not applicable to individuals; a community has "species diversity," which is meaningless at the population level; processes like homeostasis or homeorhesis, which involve a relationship with the environment, occur on an ecosystem level.

3.1.2. *Communities*

Henry Thoreau extended the idea of human community to animals and plants. In a romantic paroxysm, Thoreau proposed that nature was a vast community of equals. The word community took hold and was used to describe associations in nature. Botanists noticed that plants tended to live together in communities.

Plants and animals are always figuring out ways to live. If two plants happen to be living close to each other, they may compete for the same energy and nutrients, or they may start shifting their requirements. Over time, a long time usually, plants and animals that have similar general requirements, in terms of solar energy, heat, water, and nutrients, tend to live together in associations. The plants and animals that form associations in a forest do not usually have the same requirements. Thus, the ninebark beneath the ponderosa pine does not compete for the same nutrients or energy. Often, the plants and animals benefit from the presence of their neighbors, as alder benefits from nitrogen-fixing fungi.

The trees and other plants and animals evolve into a community of thousands of different species. The "checks and balances" of a complex number of predators, prey, and decomposers tends to dampen any one species from getting out of control (and becoming a pest). This is not to say that everyone lives in a disneyesque fantasy of good will. Organisms survive by defending themselves or attacking others. But, the defensive and attack strategies "coevolve" (Ehrlich and Raven's term) over time. Organisms specialize to avoid competing. Relationships become more intimate, as organisms cooperate for survival advantage.

Although botanists recognized that change was inescapable as a principle of the new science, Frederic Clements insisted that change was not an aimless wandering, but a steady flow towards a stable state that he referred to as a final climax. The climax community was thought of as the final state after a series of developmental stages. For example, certain places, with variables of wind and rain and temperature always produced forests; others deserts or grasslands.

Community is one level of a pattern. A community can be described through a number of properties and principles. Properties of a community include productivity and development. Principles of community include:

- Community is the level of survival
- Diverse species live in a stratified order
- Communities replace one another as a result of orderly processes (e.g., succession)
- Communities are named by structural features such as dominant species.
- Communities are stratified.
- Communities have a diversity of species.
- Communities are characterized by rhythmic changes in the activities of organisms, which produce regular recurring changes in the community (periodicity may be daily, lunar, seasonal, genetic, or climactic).
- Communities replace one another in a given area in sequence by an orderly process of change called succession (Succession appears to be a process of self-organization in a cybernetic system at the ecosystem level. It is primary for Odum).
- The final community in a successional series is self-perpetuating and homeorhetic, that is, in equilibrium with the physical habitat, that is, the energy/material budget is balanced in a mature community.

This concept of maturity, as an attribute of a community, is related to structural complexity and organization. Maturity increases with time in an undisturbed community. The species diversity, that is, the information content, of a community also increases with maturity, leading to a more complex spatial structure. Diversity incorporates species richness (how many different kinds are present) as well as a measure of abundance—how many of each, as individuals or biomass. Other aspects of diversity, such as life cycles, are less often considered. The energy in a mature system goes to the maintenance of order and less for the production of new materials. In general, diversity is higher, and life cycles are more complex; symbiosis between species increases, and nutrients are conserved. Complexity and diversity offer advantages for living forms. Complexity allows increases in size, which allows the colonization of harsh environments. Diversity allows more effective behavior through specialization; for example, a specialized organelle may digest less common molecules.

But, Odum points out, as some communities age, Wisconsin forests for example, there is a decrease in diversity (in the understory anyway). Also, diversity can decline with productivity, as in the eutrophication of lakes, for instance. While it is meaningful to speak of an optimum diversity, as the result of limits and the interaction of many factors, a maximum diversity may never be reached.

Conventional wisdom, starting with Charles Elton, holds that increased complexity in a community leads to increased stability. But in the 1970s, work with mathematical models tended to support the reverse, that complexity leads to instability. Robert May constructed simple mathematical models concerned with local stability, in which an increase in complexity lead to a decrease in stability. His connection, however, may have been a mathematical artifact, since his food webs were randomly assembled and sometimes unreasonable. May admits that his arguments are only true of mathematical models and that things "may be different in the real world." Ecosystems are the result of historical processes that are mathematically atypical. Furthermore, real communities are not randomly structured. A system drives to a nonequilibrium state as a mature ecosystem. The adaptively reorganized system is not necessarily more stable, but it is optimally resistant to the outside conditions that elicited the self-organization, a natural normalization process. The ecosystem learns the changes, periods, or seasons of the environment.

Every forest community is composed of a variety of kinds, numbers, sizes, and ages of plants, from unicellular organisms to trees. "Community" is a general term of convenience, like ecosystem, to designate complex units. The largest kind of community is a biome; in North America, according to Packham et al., biomes include tundra, montane coniferous forest, steppe/grassland, and temperate rain forest (for example, Vermont is in the cold-deciduous broadleaved forest with conifers; New Orleans sits in the subtropical summergreen coniferous swamp forest; and much of Arizona is thornbush/succulent). Biomes are then subdivided into regions, zones, and associations. Associations describe plants that grow in the same habitat. The deciduous forest biome, for example, is composed of distinctive associations, including beech-maple, oak-hickory, and aspen-birch. Associations may be subdivided further into layers (or unions).

A community is forced to accept an upper limit, beyond which it cannot grow any further. Further growth results in destruction or disruption of itself and its environment. This is the law of the maximum. Production could be stabilized in a steady state, where processes and cycles are constant.

Human communities are embedded in natural communities. Furthermore, land continuously occupied by humans may form analogs of natural communities, guided by trial and error, by unconscious values, and by random changes. The American tall-grass prairie is a case of the creation and maintenance of an artificial but desirable ecosystem. Unfortunately, it was dependent on a multiplicity of unintended accidents. Ecosystems evolved through natural events, then as an effect of human activities, now through deliberate social choice in some places. All members of an ecological community contribute to the integrity of the whole, which is vital to maintaining what we humans consider important: Visible animals, pharmacological sources, a moderate climate, and clean air and water (in a sense, nature has meta-economic values).

3.1.3. *Ecosystems*

Some ecologists, like Arthur Tansley felt that the word community was too anthropomorphic, that plants did not voluntarily live together. So Tansley coined the word ecosystem to represent the interrelatedness of nature and to emphasize the flow of energy through a system, such as a forest or pond. The systems concept, however, is concerned with more than just a number of elements or their kinds (species); it is concerned with relations between them. These relations are not explainable from the elements, hence, 'the whole is more than the sum of the parts.' The relations are emergent, that is, they are new 'things.' The theory of systems offers unique properties and principles, such as wholeness, growth and openness.

A thing that grows, repairs, holds itself together, oscillates, and capture solar energy is an ecosystem, a system resulting from the integration of all the living and nonliving factors of the environment. An ecosystem is a community of organisms interacting with one another and their environment. Odum describes the ecosystem as a unit of organization undergoing an orderly process of development that is reasonably directional. Ecosystems, the essential unit of ecology, must be seen in dynamic and historical terms.

Ecosystems are ambiguous in a sense, since anything from a log to a watershed can be an ecosystem. Furthermore, ecosystems overlap and interact. It is possible to define close but not exact subsystems. The vast number of interrelationships between systems keeps them open. For example, grassland is affected by climates, soil conditions, fires, surrounding communities, and human agents. Ecotones between systems are usually shifting. Each ecosystem is unique and original. Each patch (locality) supports a segment of the total species population in a unique context, with a particular set of competition, food or physical habitat.

Ecosystems build up information. There are three different channels of information in an ecosystem: a genetic (in replicable individuals); an ecological based on interaction between cohabiting species (expressed in changes in their numbers); and the ethological or cultural, transmitted through individual learning based on experience.

Feedback within the interaction of a species is expensive memory with little storage capacity. Whenever succession starts again, after a volcano eruption for instance, old information in form of interactions has not been saved. Genetic memory has much larger capacity and is long-term. Cultural memory enlarged with higher vertebrates.

Ecosystems are described with a variety of terms: energy, matter, entropy and ektropy, productivity, cycles, diversity, complexity, stability, and trophic structure. Many terms in ecology, such as biomass, stability and diversity are inexact. It is almost impossible to estimate the amount of degraded energy in an ecosystem (that is, entropy from transpiration or mixing of water).

One problem with describing ecosystem attributes is that both quantitative (measurable) and qualitative (conceptual) factors are included. Resistance to external factors, for example, is a qualitative attribute. This may be more the result of succession than a factor producing an ecosystem. All ecosystem properties are not equally important. There is no whole system without an interconnection of its parts, and there is no whole system without an environment. Behavior at any level is explained in terms of the level below, but its significance is found in the level above. Ecosystem behavior does not emerge from a set of organismic equations.

3.1.3.1. Properties of Ecosystems

Properties of an ecosystem include: Wildness, Productivity, Diversity, Complexity, Stability, Change and extinction, Historicity, and Wholeness and renewability.

3.1.3.1.1. *Course as Property of Ecosystem*. The interplay of material cycles and energy fows generates a self-renewing "homeostasis" in Odum's words. Processes like homeostasis, which involve a relationship with the environment, occur on an ecosystem level. Yet, living systems do not display homeostasis—constant value—so much as a particular course of change in time—homeorhesis (from the Greek words meaning 'same flow'), according to Conrad Waddington. The course is stabilized, not the constancy. Changes to a system are symbolized by trajectories in a multidimensional phase space or landscape. Homeorhetic mechanisms protect the system from many disruptions. Negative feedback counteracts the effects of change to maintain the system in a steady state or homeorhetic state. A mature community is self-perpetuating and homeorhetic, with a dynamic balanced energy-matter budget.

Homeorhesis is a significant phenomenon in evolution. Waddington applies it to the tendency of a process to continue in its original pattern, even if disturbed. Homeostasis is tendency of spatial structures to remain the same. Like embryos, ecosystems have many properties and are affected by many environmental conditions. Their changes are symbolized by trajectories in multidimensional phase space; orderliness can be described in terms of constraints on trajectory courses, and these constraints are visualized as attractor surfaces. If the system starts from any condition, represented by a point in multidimensional phase space, the trajectory will move to nearest attractor surface and then move along it.

3.1.3.1.2. *Self-Making Identity as a Property of an Ecosystem*. Bertalanffy called life a system of self-organization, a developmental unfolding at progressively higher levels of differentiation and organized complexity. Living systems are autopoetic units in physical space. The system is autopoetic, that is, self-creating. It renews itself as its contents change, as disturbances change the parameters. As a mature system, it continues to move to a point of higher maturity, recovering from disturbance to its original trajectory, where productivity declines and stability increases.

The organism and environment are co-implicative, co-defining, and co-constructing, in a process of self-assembly, where the self is the organism/environment system. In an autopoetic framework, every being is embedded in a world and observed by an embedded observer. The material components of life move through physiological processes. Autotrophs (bacteria, algae, green plants) convert energy into organic compounds; heterotrophs reconvert into heterotroph flesh.

If there were no identity, there would be no differences and so no relationships. Without relationships, there would be no things, no events, and no universe. Objects precipitate out of relationships and are defined by them.

Ecosystems are part of an unending, imperfect process, without any final state. Furthermore, the human attempt at perfectibility through self-improvement causes disharmony, which is part of the same imperfect process. Each system is a practical application to place. Unknown factors determine a large part of the operation of any system. Furthermore, there is chaos in every system; there are plagues and random frenzies.

3.1.3.1.3. *Openness as a Property of an Ecosystem*. The ecosystem has to be open to flows of energy and materials. Closure, e.g., well-defined boundaries, with steady input output flow rate, is not a contradiction. Boundaries are produced by the system. The boundaries are permeable, allowing exchanges of energy and matter. Too much openness would allow the system to be overwhelmed by the environment. Too little openness would cut the system off from the environment and it would run down, in terms of energy. The system is a local system, with specific structures and functions. The vast number of interrelationships between systems keeps them open. For example, grassland is affected by climates, soil conditions, fires, surrounding communities, and human agents. Ecotones between systems are usually shifting.

3.1.3.1.4. *Stability as a Property of an Ecosystem*. Stability is the ability to maintain the identity of a system under the flow of external forces and disturbances. Stability can be refined through the specifics of constancy, resistance, resilience, and accommodation. Stability can be related to ideas of compartmentalization, communications, richness of interactions, and connections.

Stability is a complex topic. Ulanowicz suggests that stability might be explained by diversity flow topologies, where flow topology is a descriptor of how ecosystems develop. The homeostasis of the ecosystems, that is, stability, as originally proposed by Eugene Odum, becomes the result of regular flows of energy and materials. Growth and development are characterized by a qualitative formalism of increasing ascendancy, which explains the drive towards coherence, efficiency, specialization, and self-containment.

At least four kinds of stability can be identified. Persistence means continuity or the state of being in a continuous flow or coherent whole for a duration. The system is constant if it stays relatively unchanged in form or composition. This means a lack of change in a system parameter, like number of species. The system is persistent in time if it is self-maintaining, mature, and hysteretic (historical). The system changes and develops. It loses and gains species over time, but is still recognizable as a short-grass prairie, for instance. The integrity of its functions has not been greatly affected by changes in species. The system can have degrees of difference, malleability, and still be the named system. The system may have different states that oscillate. It may also have a trajectory to a mature state.

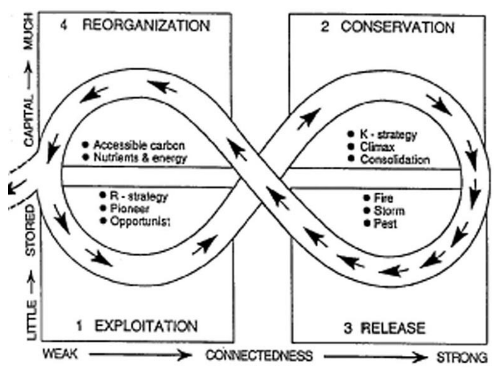

Figure 31314-1. A model (after C.S. Holling) showing four ecosystem functions and the flow of events between them. The distance between arrows show differences in the speed of flow. The cycle reflects changes in two attributes: the amount of accumulated capital (nutrients and carbon—the Y axis); the degree of connectedness between variables (the X axis). The exit from the cycle indicates a flip to a different stage, that is, a catastrophe or epigenetic change—see following. (redrawn by FS)

Finally, conciliance is the ability to absorb change and still maintain the system identity. The system adapts to disturbance. It accommodates disturbances. It incorporates new things, such as new organisms. It tolerates new levels of things, such as increased heat. It fits the changes within the structure and function of the system. Amplitude is a measure of the maximum amount of damage a system can sustain and still recover.

These preceding terms are not comparable. Constancy and persistence are descriptive, implying nothing of underlying dynamics. Resistance to stress is a useful notion if one is interested in the maximum extent of the deviation between stressed and unstressed systems. Resilience is relevant to those who are concerned with the rate at which a systems returns to prestress conditions. And asymptotic stability is concerned with whether or not a system will eventually return to prestressed state.

Cyclic and trajectory stability have measures of inertia, elasticity and amplitude associated with them. Elasticity and amplitude seem to mean centripetal and centrifugal. Oscillation, or cyclicity around a point, or cyclical stability, is the property of a system to oscillate around central point; predator/prey systems, for example, have the property of a stable limit cycle. Malleability is the degree of difference from original state.

3.1.3.1.5. *Productivity as a Property of an Ecosystem*. Productivity is the ability to convert energy into living forms and the ability to incorporate materials into living forms. Productivity, in general, depends on the vigor, strength or vitality, of the system—that is, health. Health is the overall ability of a system to maintain itself under a normal range of environmental conditions (which may include hurricanes, volcanic eruptions, or fires). Obviously, a pioneer community may change the conditions to favor a new level of the system with new components. Health is a dynamic measure of ecosystem organization, vigor, and resilience. Organization is described by diversity and connectivity; vigor is related to the amount and speed of productivity; and resilience is a measure of reaction to stress. Too much stress, for example, leads to unsustainable patterns of behavior; continuous stress leads to a breakdown of processes that becomes irreversible—the system dies.

To relate health to growth and productivity, we could say that the capital of an ecosystem would be its physical environment and its gross primary productivity; its interest would be the net ecosystem productivity. The production percentage would be the amount necessary to keep the ecosystem healthy. Our measurements of productivity, however, are not adequate. We are measuring over a year or two only to establish a growth rate or productivity. We should be measuring over centuries. A forest is a long-term, dynamically-changing being. We cannot use a short-term industrial approach to measure a few parameters and then pretend we know enough about a forest to cut a large percentage of it. Forests are created by slow processes that take millennia to develop.

3.1.3.1.6. *Diversity as a Property of an Ecosystem*. The environment has been constant enough for organic evolution, but variable enough for natural selection to be challenged. Variability challenges organisms to adjust and thrive. Variability, even in small ways, leads to diversity. Diversity, as a measure of genetic variability in ecosystem, enlarges information. A mature system needs less information, since it works toward preservation. The limit of maturity allows maximum variability between systems with slight external differences, like temperature.

Ecosystems develop knowledge bases that reflect information on themselves and their environment. Species richness may stabilize some ecosystem properties, such as Net Primary Productivity (NPP). Frank and McNaughton (1991) showed that plant community structure (and productivity and biomass) is more stable when a greater diversity of species is present. Also, diversity can decline with productivity, as in the eutrophication of lakes, for instance. While it is meaningful to speak of an optimum diversity, as the interaction of limits and other factors, a maximum diversity may never be reached.

Most healthy ecosystems have high degrees of flexibility. As Gregory Bateson interprets Ross Ashby, any biological system can be describable in terms of interlinked variables, each of which has an upper and lower threshold of tolerance, beyond which the system acts pathologically. Within the limits the variables can be moved for the system to be adapted to the environment. Under stress, some variables move to maximum values near the upper or lower limits—the system loses flexibility, that is the "uncommitted potential for change" (Bateson's definition), and can be destroyed by further stress. The danger in each case is working near the maximum of the system. Adaptive ecosystems are not static orders; they are flexible, as well as historical and irreversible. The strengths of local systems lay in the diversity of values and in their fitness to particular places.

3.1.3.2. Principles Standards & Practices in Ecosystems

Remember, principles are fundamental rules that we can use to create images or models, while standards are repeatable models of quality, and practices are the actual work in place (see Section 3.8). Ecosystems can be described as a series of principles:

- The ecosystem is the level of integration and the unit of organization undergoing a directional development (after Odum).
- Energy is bound into organic material, measurable as productivity.
- Energy/matter is transferred through individuals as a food chain.
- The interaction of individuals in a food chain results in trophic structures (pyramids).
- Chemical elements circulate in the biosphere in biogeochemical cycles.
- Energy and material no longer used by a system is the waste of that system (entropy)
- Energy required to maintain an ecosystem is related inversely to maturity (Margalef's concept of maturity).
- An ecosystem has a minimum size.
- An ecosystem has a distinct pattern, related to health.
- An ecosystem as a level of integration and organization undergoes directional development
- That quantity of energy and material no longer of use to the system is wasted.
- Chemical elements, especially those of life, circulate in the biosphere in characteristic paths known as biogeochemical cycles.
- Life is limited by elements and physical factors (light, water, gas, salt); too little of an element limits (Liebig's law); too much limits (Shelford's law of tolerance).
- The transfer of energy and materials through organisms is referred to as the food chain.
- The interaction of individuals in a food chain results in the trophic structure of communities (ecological pyramids).
- The energy required to maintain an ecosystem is inversely related to complexity; succession decreases the flow of energy per unit biomass (Margalef's concept of maturity).

To maintain ecosystems, we can create standards based on those properties and principles. These can be general, for instance an aesthetic standard of preserving the spirit of place, or they can be site specific with exact measurements, e.g., a 150-foot buffer. Sample standards (many of these based on Conservation Biology) include:

- Preserve the spirit of a forest place
- Preserve minimum species and habitat for wholeness
- Preserve diversity at all levels
- Retain appropriate shapes and corridors for pattern unfolding

- Retain hierarchy of all levels
- Allow for limits, disturbances, processes, adaptation, evolution
- Leave 5 snags and 7 fallen trees per acre
- Leave 2x buffers around riparian zones, e.g., 150 ft in a coniferous forest
- Restrict roads/trails to appropriate terrain
- Use appropriate equipment, e.g. cable yarding, in steep areas
- Take/leave trees of all ages
- Avoid damaging activities, e.g., slash burning or cat hauling

Based on these standards, we can describe practices of exploitation, which would allow limited exploitation of an ecosystem, to keep it wild and healthy. Samples of practices include:

- Maintain size and completeness of forest
- Strengthen shapes and margins by leaving mature trees
- Keep density and openness in a balance
- Preserve the interior/protect riparian zones
- Plan paths to avoid sensitive areas and emphasize pleasing perspectives
- Bundle paths (power lines, utilities) to minimize intrusion
- Preserve the character and all aspects of the forest

Ecosystems comprise the ecosphere. There are emergent properties at each level of organization, such as the diversity of species and the structure of a food web. Furthermore, each level of integration has distinct attributes. Ecosystems are the result of historical processes that are mathematically atypical. Furthermore, they are not randomly structured. A system drives to a nonequilibrium state as a mature ecosystem. The adaptively reorganized system is not necessarily more stable, but it is optimally resistant to the outside conditions that elicited the self-organization, a natural normalization process. The ecosystem learns the changes, periods, or seasons of the environment.

Figure 45-1. Elegant Cat's Ears at Altazor Forest 1999

3.2. *Local Design Factors: Landscapes*

A landscape is a heterogenous area composed of a mosaic of interacting ecosystems of various sizes. How are these local design factors like cycles and spheres? They recycle elements regionally. Landscapes contribute to cycles and flows as a result of their form and size. Transforming an entire landscape alters flows.

Landscape is a convenient idea that serves as a unit of analysis. Landscapes have a range of scales rather than an intrinsic spatial scale. As ecology undergoes a scalar shift, microecology, with ties and cellular biology and dominating the field, yields some attention to macroecology, the study of wildlife and landscape ecology. Macroecology has fewer practitioners. Russian scientists pioneered the concept and only recently have other scientists perceived the need for regional and global scale ecology. Ecology can learn much from geology by working at multiple scales.

The patterns of ecosystems are addressed best at a landscape level. The word landscape was used by the geographer Alexander von Humboldt as a scientific term in the 19th century. A German biogeographer Carl Troll used the phrase “landscape ecology” about 1939 to describe land—and not just living organisms—as an integrated holistic entity to be studied in its totality by geographers and ecologists, geography providing a horizontal approach to the vertical one of ecology. F. E. Egler in 1942 emphasized the active role of humanity on the holistic nature of vegetation in the landscape. Later, Raymond Dansereau noted that landscape was the highest integrative level of environmental processes. Like G. P. Marsh, Dansereau described landscape modification by humans throughout history.

The modern science of landscape ecology was developed in Europe in the 1970s and formalized as a discipline during that time. Landscape planning is interwoven with the interdisciplinary aspects of urban and local planning. Naveh and Lieberman list three factors that form a new science of landscape ecology: (1) Landscapes are recognized as natural and cultural entities whose health and integrity are vital for human survival; (2) As an approach to the study of landscapes, the conventional reductionistic scientific paradigms are replaced by integrative and holistic methods based on a systems view; and (3) Technological advances in remote sensing and satellite images, combined with the capabilities of processing large quantities of data, support the possibility of dealing with landscapes holistically.

Landscape ecology is a goal-directed science for studying the complexity of landscapes, as well as for preserving their integrity and health and natural and cultural diversity. In order to manage complex landscapes, it has to develop better methods for study and management. The conceptual framework for landscape ecology is derived from three connected theories: General systems theory, a holistic description of the hierarchical order of nature as complex open systems; Cybernetics, a theory of self-regulation of those systems through deviation counteracting (negative) and deviation-amplifying (positive) feedback cycles; and, Ecosystem ecology, a set of transdisciplinary concepts with the ecosystem as the level of integration.

Landscape ecology addresses the overall patterns of large-scale ecosystems, considering the biogeochemical, atmospheric, and hydrological cycles in relation to the shape and extent of individual landscapes. Landscape ecology can identify: Candidate ecosystems for restoration; candidate ecosystems for preservation, conservation, or reservation; and, patterns of forestry to preserve larger functional islands. Landscape ecology, with its holistic, cybernetic ecosystems approach, can address the emergent features of large systems and large cycles.

Landscape is the level lower than the biome and larger than the site or watershed. Landscapes include stable communities and fragile habitats. A landscape has to be large enough to offer diversity of resources for cycles, and small enough for exchange between organisms. It as to have sufficient time for development, that is, changes cannot be too fast. It has to incorporate a number and diversity of species, trends and patterns.

Before satellite data analyzed by GISs, ecologists and foresters did not have tools that could address the scale of landscapes. Regional and global data was hard and expensive to collect. The International Geosphere Biosphere Program (IGBP) coordinated by the U.N. uses GISs for global and regional issues, such as deforestation or desertification. The large images from satellites are exceptional for identifying landscape patterns, especially those related to the scale of species behavior, e.g., home range or breeding dispersion. Pattern can also be measured at the level of patch size and spatial relationships (that is, inter-patch distance), which is critical for relating the size of a habitat to the species in it—to apply the theory of island biogeography. The data derived from satellite imagery and from field studies can be used to model the landscape at various levels. Some of these tools are used for specific problems in the classification of forest ecosystems and harvesting schedules.

3.2.1. *Morphology History & Productivity*

The morphology of a landscape has effects on nutrients and soil. For example, slope stability determines the potential migration of material into watercourses, the effects on landscape structure, changes in overland flow of materials and nutrients, and, changes in habitat conditions suitable to resident species. Soil erosion causes changes in physical properties of soil, such as structure, texture, bulk density, infiltration rate, depth for favorable root development, and available water-holding capacity. These flows determine the productivity of a landscape.

As humans began to settle permanently to exploit their surroundings continuously through agriculture and animal productivity, landscapes became more disturbance-dependent and became less resilient to climatic events. Human cultures attempted to cope with risks or to exploit opportunities, which required more management of the environment, although different parts of the environment operated at a range of scales, most of the natural dynamics and landscape occur slowly by comparison with human dynamics. As a result humans adapted themselves to a dynamics of the environment at the beginning, but over time cultures served their own needs by modifying the environmental dynamics. Human cultures thus become dependent on colonized systems, which required certain social institutions, especially those involved in organized production and storage.

Descriptions of historic landscape disturbance regimes, e.g., fire magnitude and frequency, and the ecosystem component patterns they maintained, e.g., vegetation composition, provide an initial template for descriptions of ecosystem health. Some regimes result from economic needs, such as large timbers, as well as from cultural influences and human values, especially fads. In a way, the internal disturbances have as much effect on the dynamics of forest communities and forest landscapes as fire and blowdowns. Castello, Leopold, and Smallidge suggest that pathogens, by eliminating less vigorous or genetically unfit (filtering them out of the stream of life), control the direction and rate of succession. Tree mortality from pathogens occurs on various scales: gap phases (small scale), forest development (large scale), and landscape patterns (immense scale). Pathogens are one of the determinants of growth and development by determining tree mortality, which drives forest patterns.

3.2.2. *Human Uses & Impacts on Landscapes*

Human use of fire, as mentioned, can shape landscapes. Geologists have noticed an increase in fossil ashes from the Pleistocene (1 million years BP—before present) that may indicate that early hominids used fire. Peking man (250,000-350,000 years) definitely had fire. Deliberate fires for clearing land and accidental fires from lightning strikes and drought have all destroyed forests. Before settlers arrived in the western America there were few large fires—although large fires periodically occur in certain kinds of forests, e.g., in lodgepole pine forests every 300 years or so. Since then, large fires have become a regular feature.

Environmental factors have shaped the course of human history to a greater extent than had been realized. The decline of Rome is a study in forest ecology. There were previous catastrophes in the Tigris and Euphrates valley, Greece, Khmer, Maya, Midwest United States, and the Australian outback. Many peoples had to migrate to new lands.

Only in the 19th century, beginning with G.P. Marsh, did people start to realize that humanity has done as much to change the environment as the environment has done to mold human history. Marsh, the first American ambassador to Italy, was one of the first to study the role of humans in changing the face of the earth. When he visited the near east in the middle of the 19th century, he was shocked to find deserted cities, silted harbors and wastelands instead of flourishing civilizations. He concluded that ecological errors had led to the deterioration of agriculture in Mediterranean countries. To avoid future deterioration, he advocated agricultural conservation practices.

Land continuously occupied by humans may form analogs of natural communities, guided by trial and error, by unconscious values, and by random changes. The American tall-grass prairie is a case of the creation and maintenance of an artificial but desirable ecosystem. Unfortunately, it was dependent on a multiplicity of unintended accidents. Ecosystems evolved through natural events, then as an effect of human activities, now through deliberate social choice in some places.

The archaic universe was regarded as the creation of order out of chaos, with humans contributing; nature and man are harmonious. Now, there is arrogance from Plato to Dubos, that all human action improves the spontaneous course of nature. Dubos was disturbed that farms are overgrown and does not like to see vegetation revert. Dubos dreaded forest regrowth in New York as barren and uninteresting, but Leopold felt in Wisconsin it was a welcome prophecy of nature's second coming. This is the same Leopold who had once wanted to raise deer in a wolfless world, but later realized the necessary function of predators in a balanced community. Dubos and others have claimed that "nature knows best is wrong," that nature is inefficient and wasteful. But, ecosystems that seem inefficient and wasteful are many times extremely redundant, and therefore stable and flexible. Natural processes that seem destructive are cyclic and preservative also.

3.2.3. *Landscape Management*

Once a landscape has been exploited or modified, it has to be managed for as long as human use is considered. Of course, landscapes can be allowed to become wild again, but the process is lengthy. In the late 1970s, C. S. Holling described Adaptive Management as a response to natural disturbances at the landscape level. Matrix management (Noninterference) can be used to deal with designed landscapes, especially forested landscapes exploited with ecological techniques. Shortly afterwards Alan Savory applied his ideas of Holistic Resource Management to preserve the quality of the landscape. The 1980s also saw a comprehensive Integrated Resource Management (Mitchell), Permaculture as the expression of a permanent responsibility for the landscape (Bill Mollison), and the Wholistic Timber management (Herb Hammond), which was dedicated to maintaining the structure and functions of diverse forests.

We must pay attention to the processes that make up the habitat, for example, the role of herbivores on trimming vegetation (and diversifying it by predation). The design of the forest and its management must ensure that the processes operate to maintain a dynamic state. Furthermore, the context must be conserved. The forest, however, cannot be considered outside of the context of the entire landscape, including human images and institutions.

3.2.4. *Conclusion: Importance of Healthy Landscapes*

Healthy landscapes reflect a balance of processes, including extinction, colonization, and connectance. Colonization is necessary to equalize local extinctions. The loss of colonization, for any reason, can allow species in a local system to be depleted. Island ecosystems, surrounded by poor areas, may lose species without colonization. If the matrix is rich enough, there should be successful colonization.

Wild landscapes are affected by climate, soils, interactions, and disturbances. Domestic landscape is affected by land use as well. The greatest changes have been brought about by the destruction and creation of forests. With the predominance of artificial or managed forests, it is important to consider the qualities of naturalness in the landscape. Forests are expected to meet the needs of society by producing timber, creating wildlife habitats, and providing recreational opportunities for people.

How we treat large-scale communities is an important question. Deep ecology is one form for asking questions about landscapes, especially forested ones. For example: How can we design forests for neutral elements in interrelated processes in a landscape? What are we restoring when we restore an ecosystem without all the parts or good knowledge about the ones we have? These questions highlight the uncertainty we face in dealing with large, wild, complex, long-lived entities at the scale of landscapes. Managers have to live with uncertainty; this means that management decisions are essentially gambles. Gambling is a profession that acknowledges the operation of chance and makes conclusions in the absence of facts—few people are successful at it. This is an important admission, that we do not have facts to base our actions on, that nature is a stochastic process, and that landscapes and biomes always changing. Furthermore, we do not know for sure what effects our actions will have on landscapes, which live so long, in such diversity, in many places. Successful gambling suggests that the proper attitudes for gambling with nature are awareness, humility and courage, not arrogance, fear and maximum use.

Perhaps we do not have sufficient knowledge to manage a complex landscape because it is too complex to understand scientifically. But we can understand the pattern and drive it in a healthy direction with minimal intervention. Perhaps we lack sufficient courage or will-power to manage large-scale forms. According to Garrett Hardin, many of the ideas necessary to fit humanity into the pattern of nature are known but not yet popular. For instance, exponential growth cannot be maintained very long. Human communities cannot grow 4 percent per year without disastrous consequences to the infrastructure and the quality of life. Growth cannot be continued because the landscape is limited, in terms of productivity, energy, and resilience. Thus, we need to fit our population into the limits of a landscape or biome, although some limits can be expanded by technology or by lowered expectations. Redundancy at this scale, with local or regional self-sufficiency, keeps global limits less critical. The carrying capacity of the area is not only a function of the limits of the community, but it is equal to the number of people multiplied by the level of comfort (quality of life style). Changing the scale of concern does not solve any problems relating to overconsumption or drawdown; it just displays the regional limits sooner.

3.3. *Local Design Factors: Local & Planetary Cycles*

In a mature ecosystem, most nutrients and materials are held in cycles; very little leaves the system. A cycle is defined as a pathway along which an element moves through biotic and abiotic compartments. All the chemicals, nutrients, or elements—such as carbon, nitrogen, oxygen, phosphorus—used in ecosystems by living organisms stay in a relatively closed system, which means that these chemicals are recycled instead of being deposited or lost. Virtually every material cycles through the forest: phosphorus, potassium, calcium, sulfur, magnesium, and water. Nutrient cycling involves many of these materials. Nutrient cycles change with the succession of a forest.

Materials cycle above and below ground, between the atmosphere and trees, between trees and insects, and squirrels and fungus. Chris Maser is fond of saying that most of the cycling is invisible because it is underground or in the air. Many cycles are investigated through ecosystem analysis, where energy and materials are traced through transfers through compartments in an ecosystem. For example in the nitrogen cycle, the compartments are the atmosphere, vegetation, forest floor, and mineral soil, while the transfers are precipitation, throughfall, leaching, litter fall, mineralization, fixation, and denitrification. Each compartment keeps the nitrogen for a certain time, termed the residence time; for a hardwood forest floor, for example, residence time is about 17 years. If the compartment keeps the element for a long time in large quantities, it is called a reservoir, like the ocean; if the residence is short the compartment is called an exchange pool, like a cloud.

Cycles require the movement of elements. Some reservoirs, such as the atmosphere, allow rapid movement. For example, almost any gas or fine particulate matter released into the atmosphere can spread across the planet in days. And, because of the movement the atmosphere stays in a pattern of dynamic equilibrium.

Cycles are nonlinear systems, with limits and thresholds of which we are relatively ignorant. They allow unstable and improbable reactions to keep taking place. These cycles are not only interesting, but necessary. Consider the oxygen cycle, for instance: Without cycling, all reactions would take place, and the atmosphere would reach an equilibrium (as on Mars).

Cycles are connected; for instance, the water cycle contributes to the operation of the carbon cycle; in fact, both meet in photosynthetic activity of plants. Carbon dioxide is part of the carbon cycle, which is tied to the heat cycle of the atmosphere. Carbon dioxide is the source of carbon for plants and it plays a role in the weathering of rock. All chemical elements occurring in organisms are part of biogeochemical cycles. In addition to being a part of living organisms, these chemical elements also cycle through abiotic factors of ecosystems such as water (hydrosphere), land (geosphere), and the air (atmosphere); the living factors of the planet can be referred to collectively as the biosphere. These cycles form the metabolism.

3.3.1. *Major Individual Cycles*

Some cycles move at higher speeds than others. Some speed up seasonally or daily. Microbial activity speeds up an iron cycle. Some cycles grow or decline. Tectonic activity can renew some cycles, such as the phosphorus cycle. Some material cycles between other ecosystems or in larger patterns around the planet. Some of the cycles are daily; some are seasonal or annual; others are years or decades; a few, like the carbon cycle, are centuries or millennia long. Human beings do not pay much attention to very long cycles or to those we perceive as not affecting us. Sometimes we deliberately or inadvertently interfere with cycles. An excessive concentration of carbon dioxide in the atmosphere is an example of a disrupted cycle. The nitrogen cycle is being disrupted by runoff of fertilizers. Nitrogen fixation has doubled on the global scale, and this favors plants with higher nitrogen needs. Sulfur emissions to the atmosphere have doubled, also. Human interference in forest cycles can collapse the residence time; for example, clearcutting alder in Washington State causes very high nitrogen losses. Human interference in one cycle can affect other cycles.

3.3.1.1. The Water Cycle

Water, in its different forms, cycles continuously through the lithosphere, hydrosphere, atmosphere, and biosphere. The energy for the water cycle is supplied by the sun, which drives evaporation. Evaporation is the process in which liquid water becomes gaseous—precipitation is the reverse of this. Water evaporates into the atmosphere from the land and the sea. Plants and animals use and reuse water and release water vapor into the air. Once in the air, water vapor circulates and can condense to form clouds and precipitation, which fall back to ocean and earth. At one time or another, all of the water molecules on earth have been in an ocean, a river, a plant, an animal, a cloud, a raindrop, a snowflake, or a glacier.

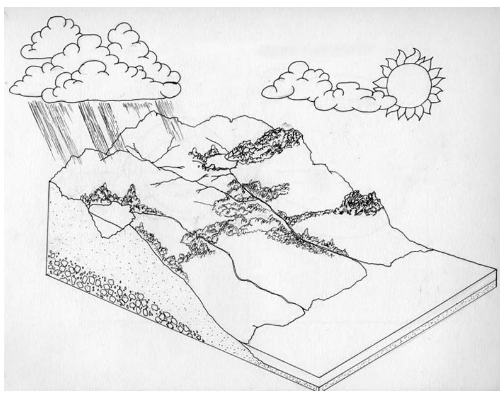

Figure 3511-1. The Water Cycle. Note possible design elements:
Forests, streams, ponds, swales, berms, and beaver dams (drawn by FS)

The sun provides the energy that drives the climate system, with its weather systems, which move the water vapor from one place to another, and from ocean to land. Once water condenses, gravity pulls water to the mass of the earth. Gravity continues to operate, as water flows across the surface or underground. It can be temporarily trapped in lakes or oceans. The main path through which water leaves oceans is through evaporation, which leaves behind salts and minerals. When water precipitates, it can pick up pollutants and acids and deposit them; over land, water can pick up minerals and pollutants—thus, evaporated water is relatively clean, but other water takes whatever is dissolved into traps or sinks. When water freezes, it can remain in a solid state for long periods.

Organisms participate in the water cycle, and most organisms contain a significant amount of water, although it tends to evaporate or transpire quickly. Animals and plants lose water through evaporation from the body surfaces, such as skin or leaves. The evaporation from leaves, is responsible for significant amounts of water entering the atmosphere.

3.3.1.2. The Carbon Cycle

The carbon cycle tracks the water cycle; water is the vehicle that carries the complementary biological reactions of respiration and photosynthesis. Respiration combines carbohydrates and oxygen to produce energy, carbon dioxide, and water. Photosynthesis produces carbohydrates and oxygen from carbon dioxide and water. The outputs of one are the inputs of the other and vice versa. The reactions are also complementary regarding energy. Photosynthesis stores solar energy in the carbon-carbon bonds of carbohydrates; respiration releases that energy. Only plants (and a few other producers are capable of photosynthesis, but respiration is part of the activity of every living being.

Neither oxygen nor nitrogen can absorb either infrared or visible radiation. Bigger molecules, like carbon dioxide (or methane or water vapor), vibrate at the same frequencies as infrared radiation, absorbing heat and reradiating it, warming up the atmosphere. The early atmosphere had a high percentage of carbon dioxide, estimated from 3 to 10 percent, much of it from volcanoes. The gas also reacted with rock to form limestone. Over billions of years, microorganisms and trees pumped carbon dioxide from the air and into the soil (it is only a 300th as common now—air spaces in the soil have 10-40 times the CO_2 as the air above). As trees die, much of the mass is oxidized by decomposers to carbon dioxide. As carbon dioxide dropped, plants responded to lower levels. Grasses, for instance, can photosynthesize with lower CO_2 levels. (As the solar output increases over the next billion years, less CO_2 will be needed to maintain higher temperatures—but, what kind of plants will be living then?) The carbon dioxide cycle seems to be a very slow cycle as the carbon ends up in limestone and chalk at the bottom of oceans.

The carbon dioxide produced by plants accumulates in a variety of reservoirs such as the ocean or rock formations. CO_2 dissolves readily in water, and can precipitate naturally as calcium carbonate (limestone). Corals and algae build up limestone reefs with the process.

Table 3312-1. Reservoirs of Carbon (in billions of metric tons)

Atmosphere	720
Ocean	39,000
Carbonates	100,000,000
Fossil fuels	4,000
Land plants	560
Soils	1500

The carbon in plants now has three possible paths. Some of the carbon is released to the atmosphere by the plant through respiration, where it can stay in the atmosphere, be taken up by other plants, or dissolve in the interfaces of water bodies; some is consumed by animals and can be kept in flesh or released through respiration; and some is in flesh when the plant or animal dies, and can be recycled by decomposers or buried. All carbon in biological systems ultimately comes from plants, usually from predation. In the animal, the carbon also has the same 3 possible fates. Carbon from plants or animals that is released to the atmosphere through respiration will either be taken up by a plant in photosynthesis or dissolved in the oceans.

Buried carbon, treated by tectonic processes, ultimately forms coal, oil, or natural gas (fossil fuels). The fossil fuels are recovered and burned by traditional or industrial human processes, releasing carbon dioxide to the atmosphere. Carbon in limestone or other sediments can only be released to the atmosphere after they are brought to the surface, and weathered or released by volcanoes. Increased carbon dioxide in the atmosphere can cause atmospheric heating by trapping solar energy; it also pushes more into the oceans, making them more acidic.

Because reservoirs are interconnected, the hyphenated short residence times are under-estimates. The reservoirs with longer residence times, like the ocean, release carbon back to the atmosphere, increasing atmospheric residence time is over 100 years. The anthropogenic flux of carbon, from fossil fuel burning and deforestation, to the atmosphere is 8 billion metric tons per year, but the atmospheric increase is only 4 bmt/yr. Where does the other 4 bmt/yr go? There are two possibilities: Land Plant Uptake (Excess Photosynthesis) or Ocean uptake. Because the residence times are so different however, it is important to know which. Storage on land is much shorter-lived than storage in the deep ocean. These fluxes are important to understand.

The flux from volcanoes is relatively low, but the clouds from volcanoes can contribute to global dimming, with their cooling potential. The amounts of carbon dioxide in and out of oceans are close to balance due to the biological processes, such as photosynthesis and respiration. Anthropogenic processes have a much greater effect than weathering or volcanic action. Fossil fuel formation is a very slow, constant process that can create huge reservoirs of carbonates over millions of years. Fossil fuel burning, however, is a very fast process and a new source of atmospheric carbon. It is a relatively small flux compared to plant respiration, only one-tenth, but it is an additional source, and carbon dioxide is a potent greenhouse gas that can trigger temperature changes in relatively small amounts.

3.3.1.3. The Oxygen Cycle

The oxygen cycle parallels the carbon cycle, since the atoms are often combined, as in carbohydrates and carbon dioxide. Oxygen of course is an important component of water. The oxygen cycle is driven by living beings. Oxygen is released from water to the atmosphere by autotrophs during photosynthesis and taken up by both autotrophs and heterotrophs during respiration. After two billion years of biological activity by autotrophs, mostly cyanobacteria, the oxygen content of the atmosphere increased significantly, allowing multicellular plants and animals to take advantage of the increased energetic reactions that oxygen allows.

3.3.1.4. The Nitrogen Cycle

The movement of nitrogen into and out of the atmosphere is a cycle. The nitrogen cycle is more complex than oxygen, for instance; there are many important forms of nitrogen, all created by the interconversions of organisms. Nitrogen is critical in forming the amino portions of the amino acids that form the proteins, which make up skin, muscle, and other important structures of organisms. All enzymes are proteins, and enzymes carry out many of the chemical reactions in the organism.

Because of its electron structure nitrogen bonds strongly with itself (N_2); the action of lightning can break this bond and allow nitrogen to combine with oxygen. The resulting nitric acid falls in rain and would eventually be locked up in the ocean as nitrates—except that nitrogen is fixed by bacteria in proteins and DNA (deoxyribonucleic acid); some bacteria break up detritus and return the nitrogen to the atmosphere. In fact, almost all nitrogen resides in the atmosphere, where it sustains atmospheric pressure and dilutes other gases.

The main reservoir of nitrogen is the atmosphere, which is composed of about 78% nitrogen. Nitrogen gas in the atmosphere is in the form of two nitrogen atoms bound to each other. It is a relatively non-reactive gas, that is, it takes a lot of energy to break it up, so it can be combined with other elements, such as carbon or oxygen. Atmospheric nitrogen gas can be fixed in two ways: Lightning provides enough energy to burn the nitrogen with oxygen and fix it in the form of nitrate. The other form of nitrogen fixation is accomplished by nitrogen-fixing bacteria, using special enzymes to fix nitrogen. These nitrogen-fixing bacteria come in three forms: some are free-living in the soil; some form symbiotic, mutualistic associations with the roots of bean plants and other legumes (rhizobial bacteria); and the third form of nitrogen-fixing bacteria are the photosynthetic cyanobacteria (blue-green algae) which are found most commonly in water. All of these fix nitrogen, either in the form of nitrate or in the form of ammonia (nitrogen with 3 hydrogens). Most plants can take up nitrate and convert it to amino acids. Animals acquire all of their amino acids when they eat plants (or other animals). When plants or animals die (or release waste) the nitrogen is returned to the soil. The usual form of nitrogen returned to the soil in animal wastes or in the output of the decomposers, is ammonia. Ammonia is rather toxic, but, fortunately there are nitrite bacteria in the soil and in the water, which take up ammonia and convert it to nitrite. Nitrite is also somewhat toxic, but another type of bacteria, nitrate bacteria, take nitrite and convert it to nitrate, which can be taken up by plants to continue the cycle. This cycle sets up in the soil (or water), but it takes denitrifying bacteria, which take the nitrate and combine the nitrogen back into nitrogen gas, to get it back into the atmosphere.

3.3.1.5. The Phosphorus Cycle

The phosphorus cycle is a more simple cycle, because the heavy phosphorus molecule can only be carried by water or living organisms. Combined with energetic oxygen atoms, it has a basic form, phosphate in rock; otherwise, it is found dissolved in water or as part of an organism. When phosphate is exposed to water, it weathers out of rock and goes into solution in watercourses or soil, where it can be taken up by organisms. Phosphorus is an important constituent of cell membranes, DNA, RNA, and ATP, the cell's chemical battery.

Animals obtain phosphorus by consuming plants. Fungi are efficient at taking up phosphorus and also form mutualistic relationships with plant roots, which gets more phosphorus and nitrogen into the plants. When plants die, the elements are returned to the soil. Phosphorus is a component of bones, teeth and shells. Marine birds compose an epicycle of phosphorus, eating fish, which contain phosphorus, in the ocean and defecating on land, transferring that element in their guano. When animals die or defecate, phosphorus is returned to the soil or water by decomposers. Some of the phosphorus stays in the water and ends up in the deepest parts of the ocean, where it becomes part of the sedimentary rocks forming there. Without living organisms keeping the cycle rapid, all phosphorus would end up there and only be released as the weather operated on the surface rock. Human beings now accelerate the phosphorus cycle by mining guano and phosphates to use for fertilizers, which can cause local abundances that allow algae overgrowth and eutrophication. With eutrophication, algae use up oxygen so fast that other aquatic organisms, e.g., fish, cannot live.

Phosphorus is a limiting nutrient. Because it has no gaseous form, it has limited availability as a nutrient—Isaac Asimov suggested it was the bottleneck for life—and is a good example of Liebig's law of the minimum, which states essentially that something always has to be in least supply. Its geochemical cycle is slower than the others. It is also vulnerable to being lost through erosion to the ocean. Phosphorus is a necessary constituent of protoplasm, but it is sometimes the element in least supply. Most of it is locked up in phosphates in rock, which is weathered and it "escapes" to the oceans. Sea birds play a large part in returning it to land. In fact, we mine guano deposits for fertilizers for our fields. Harvesting fish for food returns some to land, but we make little effort to recycle it. Although the phosphorus cycle is pushed by the water cycle to the ocean, the activities of animals, especially fungi, fish and birds, bring this element back to the land or into ecosystems.

3.3.2. *Interactions of Cycles with Other Cycles & Ecosystems*

The water cycle is linked to other cycles, especially the carbon and oxygen cycles. When the water cycle changes, as a result of naturogenic or anthropogenic actions, the other cycles change also. The interaction of cycles means that if one cycle is disturbed or interfered with by human activities, other cycles will also change.

Nitrogen is also a limiting nutrient in ecosystems. There are also cycles of hydrogen and calcium, as well as of trace elements, such as molybdenum, sulfur, magnesium, and iron. Other organic nutrients, such as sugars, cycle through ecosystems. There are even cycles of certain artificial exotic molecules, such as from plastics, which are broken down and end up in ocean gyres or spread throughout water columns, where they interfere with the food chain.

Croplands may sequester carbon for instance, although current models may overestimate the extent. Old growth forests also sequester carbon, although current models may underestimate that amount. The uptake of carbon by forests, however, is limited by the availability of nitrogen, as well as water and nutrients. The sulfur cycle regulates the phosphorus cycle by converting it from an insoluble to a soluble form usable to organisms.

The interactions of biogeochemical cycles with ecosystems and organisms means that disruption or interference of cycles can affect ecosystems and organisms; conversely, disruption or interference of ecosystems and communities of organisms, at a sufficient scale, can affect the global cycles.

Figure 1424-1. M.W. Fox & dogs form a 'love pyramid' in India

3.4. *Local Design Factors: Intricate Patterns*

What are the big patterns in local systems? At various times, ice has covered a medium to high percentage of the land and water area. The continents move over deep time and will continue to do so until the energy of the planet core is exhausted. At some time during the development of the earth, natural processes created a pattern that guaranteed the maintenance and reproduction of a system of processes. These processes were considered living. The forests move across continents following the patterns of water. Mid-range patterns include vegetation, from oceanic algae to terrestrial forests. Small patterns include food webs and worm tunnels.

3.4.1. *Distribution & Density*

A species population has unique properties, such as density, mortality, natality, potential, dispersion, age distribution, growth form, and structure (isolation, territoriality). Studies in secondary production are difficult; the species must be measured for population density, age distribution, food consumption and utilization, growth, and reproduction; bacterial, fungal and parasitic populations must also be considered. Trees penetrate the soil, which can be penetrated much easier than the parent rock, to get water and nutrients to grow. The nature of soil determines the kind of vegetation on a site and the distribution of vegetation between sites. Thus, soil limits the occurrence of a species within the range allowed by climate. Thoreau also spent a lot of time correlating land use and history with forest composition. He described differences between wilderness and forests disturbed by insects and fire. He studied the role of the soil in the distribution of trees. Soil moisture, even in a homogenous stand of trees, has a mosaic pattern, due to species and individual differences in water distribution. Thus, a diversity of microsites can govern the pattern of future tree establishment.

The distribution of forests is influenced by climactic, edaphic (soil), and physiological factors. The first two are also effected by the third, which creates microclimates and soil particularities. Physiological factors include configuration (such as mountains and valleys), altitude, slope, and exposure. The amount of water influences the occurrence, growth, development, and the distribution of forests, because water is vital for life.

Wildlife that inhabit the soil environment are sensitive to soil contamination. Air emission can cause reductions in soil organisms and shifts in trophic structures, such as insectivorous bird species. A reduction or change in decomposers can result in a decrease in litter decomposition and nutrient cycling. The distribution and abundance of salamanders may be influenced by soil pH. In the United States, approximately 50 percent of the species of frogs and toads and 30 percent of the species of salamanders use ephemeral forest ponds for reproduction. These small pools and ponds can be acidic because they receive snowmelt and spring rains that have little contact with the soil buffering system.

In their studies of biogeography (biogeography is simply the distribution of life over an area of the earth), MacArthur and Wilson hypothesized a general theory of island biogeography based on the observation that the number of species (species richness) on true ocean islands is lower than it is on the mainland. The theory states that, assuming all other factors are equal, large islands have more species than small islands (according to a species/area equation). The number of species on an island reaches an equilibrium between the extinction of existing species and the immigration of new species from other areas. The rates, however, are a function of island size and remoteness. MacArthur and Wilson suggest that small islands have a reduced habitat variety, reduced immigration of species, and higher extinction rates of species; furthermore, the climatic variability is altered. These variables affect the stability and longevity of populations.

It would be difficult to develop strategies to prevent the depletion of genetic information, especially with intense public and industry demands on forests, without knowledge of the diversity and distribution of genes in the tree population. Although study of gene flow and genetic recombination is needed, a lot of this knowledge can come from careful observation of the forest, the mating systems of trees—e.g., pine species require pollination as a mechanism for outcrossing—and the shape and size of a forest area. Smaller organisms with limited distributions tend to become extinct faster.

Diverse shapes for the preserves would minimize the dangers from physical and climactic changes. The greenhouse effect could drastically alter the species distributions in preserves, with the loss of many species. Placing the preserves on heterogeneous soil types and topographies increases the chances that the temperature and moisture requirements of species would be met. A range of elevations across areas would minimize the effects of climactic change—and the possibility of extreme change is rarely considered in wilderness design.

The biosphere varies considerably in its density, from deserts and tropical seas to marshlands and tropical forests.

3.4.2. *Surprise & Joy at Diversity*

There are emergent properties at each level of organization, such as the diversity of species and the structure of a food web. Furthermore, each level of integration has distinct attributes. A community has 'species diversity,' which is meaningless at the population level.

Ecosystems are what they are as the result of the diversity of life—all forms of life contribute some value to the system as a whole. The whole system is already self-ordering and self-renewing. Any ecosystem not subjected to outside disturbance changes in an orderly and directional way: The complexity of structure increases and the energy flow per unit biomass decreases. The physical environment limits the type of change. Homeostatic (or homeorhetic) mechanisms protect the system from many disruptions. Thus, maturity is self-preserving. When conditions change, the system may go to a state of lower or higher diversity.

This concept of maturity, as an attribute of a community, is related to structural complexity and organization. Maturity increases with time in an undisturbed community. The species diversity, that is, the information content, of a community also increases with maturity, leading to a more complex spatial structure. Diversity incorporates species richness (how many different kinds are present) as well as a measure of abundance—how many of each, as individuals or biomass. Other aspects of diversity, such as life cycles, are less often considered. The energy in a mature system goes to the maintenance of order and less for the production of new materials. In general, diversity is higher, and life cycles are more complex; symbiosis between species increases, and nutrients are conserved. Complexity and diversity offer advantages for living forms. Complexity allows increases in size, which allows the colonization of harsh environments. Diversity allows more effective behavior through specialization; for example, a specialized organelle may digest less common molecules.

The number of species in an area is related to the idea of diversity, which is a description of the variety of life forms (or the condition of being different in quality—the greater the number of differences, the greater the diversity). Diversity can also be related to the increase or decrease in ecosystem measures, such as productivity, biomass, and stability. Diversity is related to genetic information as well as to relationships of species, such as predation or mutualism. In fact species number may increase depending on interactions, resources, niche overlap, redundancy, or exploitation efficiency in a community (as in old-growth). For example, deciduous forests in Europe typically have fewer species than deciduous forests in Asia or North America (from ice-age effects).

Diversity, as a measure of genetic variability in ecosystem, is decreased by domestication and agriculture. Diversity is basically the bag of tricks for organisms facing environmental perturbations. Coevolution with humans reduces or destroys integration with other species; then, stability depends on human control. And human control is not always certain. Natural selection is the process for strengthening biodiversity, while the unnatural selection prompted by people artificially robs the Earth of its most important genetic resources.

The idea that diversity promotes stability has been defended and attacked elsewhere. Concepts of stability often include consideration of diversity. Using information theory, Margalef claims that higher information content and increased interactions promote stability. Margalef was the first to propose that diverse systems were more stable than less diverse. Robert May and L. Ashby argued that the opposite may be true. However, by many definitions of stability the former is true—there is still a problem with the term in ecology. The structure of food webs may enhance stability. May suggests that communities are more stable if they are compartmentalized (as holons, perhaps), that is, where subunits within a unit have stronger interactions than those between units.

Biomass seems to increase with diversity. The native animals in Kenya, for instance, are diverse and adapted and support a greater quantity of biomass than the domestic animals that are replacing them. Diversity is an expression of the dynamic properties of a complex system. It seems common that a complex of circumstances allowing a high diversity also permits high stability or constancy in taxonomic composition: "nature tends to become baroque in situations permitting high maturity, with little energy left for large changes," according to Ramon Margalef. Stability and diversity are not a matter of definition for Margalef, but reflect crude impressions of the behavior of physical systems.

Margalef states that biomass and primary production increase during succession; but the ratio of productivity to total biomass drops. According to E.C. Pielou species diversity decreases and pattern diversity increases during succession. There is also an increase in the proportion of inert matter, and an increase in structures like paths and burrows.

We are actors in a tremendous presentation. This metaphor formed part of the basis of a worldview where nature was a theater of violent competition. The frame where a metaphor originates carries the conceptual baggage of the time. So, over time the play supported the idea of superiority of "favoured" races in the struggle for existence and emphasized the role of competition in biological and cultural situations, at the expense of other interactions.

Alas, the metaphor needs to be expanded. All species play a temporary role in the local stage in the ecological theater. Herb Hammond notes that all the actors and acts are essential. We are foolish to think some species are more important than others—that is ignorance or wishful thinking. All species and things contribute to the functioning of the whole, including rocks and gaseous elements. But, some are invisible to us because of their size or longevity. Some play their roles in a clump of soil, others in continental landscapes. Some acts last less than a second; others take millions of years. Even if an actor seems to leave the stage or the act is over, they continue to influence the play with their corpses and elements.

There are many stages playing simultaneously in the theater, and it is not a one-act play. The human play has converted some of the stages, subverted others. The human actors are ridiculously egotistical and ignorant, pretending that the stages and theater is for them only, and others are support characters. They pretend that the less important people and freaks are in the audience, but the only audience is other stages with partial perspectives.

And, some plays are embedded in others. One play is the evolutionary play, where autopoetic beings drift through filters in the morphogenetic landscape. Another play is the human conversion of ecosystems and the urbanization of human communities (with some companions, familiars and pests).

We have trouble understanding the theater or the plays because of our physical, temporal and psychological and cultural limits. We see species and ecosystems as individuals, when most of them are in fact communities. We see walls and barriers, and not permeable filters. We see philosophical constructs of classes in isolated locales. We have problems dealing with motion, indeterminacy, ambiguity, and vagueness. We are seduced by logic and fallacies to believe that we can understand and control the play.

Although the scales involved in a planetary theater are linked by processes, in fact the scale of the planet and its evolving life forms is significantly larger and longer. As important as human changes are to us, and to the ecosystems from which we emerged and on which we depend, for the planet those changes may only bump the global system to another stable state, well within the range of those from the past 2 billion years. We are the stewards only of ourselves and companion forms, not of the planet.

On the other hand, Francis Bacon noted that we faced four major obstacles in understanding nature: The idols of the tribe, cave, marketplace, and theater. The perspective of the tribe is our inherent tendency to interpret and measure nature through our human senses, with their limits and scale. The idols of the cave refer to our personal peculiarities. Those of the marketplace refer to errors from language and culture. Most of the errors of the theater have to do with the fallacies of our philosophies and world views, even those based on good metaphors.

Where does joy come in? We feel joy that things are always new and different, that there is enough to continue to provide and to inspire. We are actors in a process, but we are genealogical actors in ecological roles in the evolutionary play in the ecological theater. As long as we realize we are not everything or the center of existence, we can continue to feel joy.

3.4.3. *The Reality of Patterns*

Process applied to components yields pattern. Nature is composed of patterns. Organisms have characteristic patterns, such as the branching of trees or the cloud forms of tree crowns. Lichens have lobes, wood grain under stress has spirals. The cracks in tree barks form nets.

Regularities in systems are patterns. Patterns can be seen in things or even cultures. For instance, laws of genetics are natural patterns; human customs are artificial patterns. Where the natural ratios of females to males are altered by female infanticide or other action, the pattern is semi-natural.

Bunge distinguishes four kinds of real patterns: Laws, trends, correlations, and rules. A law is a stable pattern inherent in things; it is discovered; laws like gravity are boundless; biological laws are bounded, he says. After the 'Big Bang,' gravity was bounded. There are examples of social or cultural laws: "The inertia of a social system is directly proportional to the number of components and inversely proportional to its cohesiveness." or: "Higher culture does not emerge in society until the basic needs of some of its members have been satisfied."

A trend is a temporary pattern, such as the globalization of capital or fertility. Trends can be reversed. A correlation, usually statistical, is a covariation of two properties, e.g., a correlation of sickness and education—but this correlation is problematic, due to fact that educated are wealthier and report their sickness more than the poor; the real correlation could be reversed. A better correlation is: Single-species forest stands can be correlated with standing armies in the northern hemisphere; standing armies were thought to be characteristic of people in tougher climates, which encourage large stands of trees. A rule (or norm) is a social convention set up by people, in force in a social system. The analysis of patterns is the strength of systems analysis.

Paul Shepard describes living natural 'objects' in terms of events that constitute a 'field pattern.' Relations are not prior to objects; they arise together. The wasp and the yucca coevolve; they are not co-linked by prior relations. Furthermore, a specimen is more than the sum of its species' relationships to an environment; it is an intentional being that, with other members of the species, can create niches, as well as adapt to them. Because the STEM field produces life, the qualities of life cannot be separated from its physical qualities. While it is true that living subjects are at a different level of description than events in field patterns, they should not be treated as ontologically subordinate. All of the aspects of the field have equal status. The ecosystem model, as a reaction to 'superorganismic' metaphors of early ecologists, attempted to be a field theory, but has been limited by its parentage, thermodynamics, and has been rejected by new practitioners.

Patterns are not still. A circular pattern through time can be recognized as a spiral (the earth's orbit for example). These patterns can be analyzed into events. Everything that exists has its place in the order of nature. This does not mean that reality is an organism or that everything is reduced to biological terms. It does mean that every thing resembles a living organism since its essence depends on the pattern in which it occurs, and not on its components. In some ways, patterns are prior to things, in helixes, light, fields, and ecology. Paul Shepard and others have written that relationships are as real as the objects that result from them. The science of ecology attends the overall pattern of relationships, beyond the details. The pattern should allow for surprises and discontinuities; it can do this if it is flexible.

3.4.3.1. Natural Patterns

Organisms are material patterns in space as well as energy moments. Even if energy is considered primary metaphysically, organisms are still composed of the atoms and molecules that energy forms under certain conditions of temperature and pressure, and they act differently than just `energy vortices' or `patterns of energy.' Furthermore, the organism must adapt to the environment, which implies having a memory and being capable of learning, and must reproduce, that is, duplicate its pattern in a separate being. Organisms are goal-seeking, and often stability is sought above change or complexity. Nor is the gene a permanent entity, although Dawkins argues that it is. The pattern lives longer than the molecule, and even the pattern changes with mating.

Nature consists of moving patterns whose movement is essential to their being. As a rope makes the knot visible, so the body is a pattern made visible. The body is a movement that maintains a topologically stable pattern; it is a vortex but not the water. The thing, the pattern, is a cross section cut through the movement. The mind is an invisible knot that is capable of recognizing both visible and invisible patterns, that is to say, a rope is not always necessary for the demonstration of a knot. Culture is also this kind of pattern. Culture can be analyzed into smaller blocks; the pattern of the whole organization is reflected at every division in differences of organization on either side of boundary. The wholeness of the character of a culture is reflected at every level. Patterning relates symbolic meanings in the context of a cultural system as a whole. The patterns form another level of meaning that has to be addressed in understanding a culture. Although the physical environment imposes limits and sometimes determines patterns and rates of change, the community controls the development of the system.

An ecosystem has a distinct pattern, related to health. According to E.C. Pielou species diversity decreases and pattern diversity increases during succession. Very small changes in complex, self-regulating systems, such as forests, that have large and important consequences, as when rainfall patterns shift after a forest is removed. Weather patterns on North America, for instance, have created 'nation states' (see Paul Colinvaux) of trees that surprised the first European naturalists because they were so different from the European forests. The large sulfur cycle is beneficial to marine and land organisms, important to the general pattern of production and composition. Some material cycles between other ecosystems or in larger patterns around the planet. Some of the cycles are daily; some are seasonal or annual; others are years or decades; a few, like the carbon cycle, are century or millennia long. Ramon Margalef proposes maturity as a quantitative measure of the pattern in which the components of an ecosystem are arranged. The life-form communities and physical elements are related in a definite pattern, which is a real but untouchable property (structure). In general, this structure becomes more complex as time passes, as long as the environment is stable or predictable. The structure acquires a historical character.

A Principle of Uniqueness can be recognized in living systems. History creates unique patterns, especially in forests. Each forest is unique in its parts and structure, in its matter, energy, forms, information, and in its dynamics and history. Some patterns in forests are scale-dependent; for instance, hemlock trees may dominate small clusters, but be scattered all across the entire forested landscape. Pathogens determine tree mortality, which drives forest and landscape patterns. That is to say, the pattern changes with the scale. This is true of processes in forests as well. A typical forest is composed of many patterns, including vertical layering (stratification), horizontal segregation (zonation), activity patterns (periodicity), food web patterns, social patterns (including reproductive), interactional patterns (from competition or mutualism), and stochastic patterns (from random events).

There are long-term trends in ecosystems, that is, patterns of: Primary productivity, organic matter accumulation, inorganic inputs and movements through soils and water, disturbances, and populations in a trophic structure. The actual substance of which the forest environment is made consists of patterns rather than things or individual species. The forest environment is generated by a patterning of ecological ebb and flow of energy, substances, individuals and species across a suitable landscape.

The forest ecosystem is a large-scale pattern of millions of minute events. The environment requires an enormous amount of minuscule local adaptations between the earth and its users. The landscape is a unique individual, a community, a dynamic system of interacting patterns—the human pattern is a part of it now and should be preserved as part of the whole pattern, but not necessarily as the only pattern or a completely dominant one.

The patterns of ecosystems are addressed best at a landscape level. Landscape ecology addresses the overall patterns of large-scale ecosystems (biota), thus considering the biogeochemical, atmospheric, and hydrological cycles in relation to the shape and extent of individual landscapes. The large images from satellites are exceptional for identifying landscape patterns, especially those related to the scale of species behavior, e.g., home range or breeding dispersion. Pattern can also be measured at the level of patch size and spatial relationships (that is, inter-patch distance), which is critical for relating the size of a habitat to the species in it—to apply the theory of island biogeography.

As Richard Hart mentions, patterns are the key to understanding the nature of ecosystems. Nature, for Alfred North Whitehead—this is one philosophical foundation for considering patterns—consists of patterns whose movement is essential to their being. These patterns are analyzed into events. Everything that exists has its place in the order of nature. This does not mean that reality is an organism or that everything is reduced to biological terms. It does mean that every thing resembles a living organism since its essence depends on the pattern in which it occurs, and not on its components. In some ways, patterns are prior to things, in helixes, light, fields, and ecology. Paul Shepard and others have written that relationships are as real as the objects that result from them. Ecology attends the overall pattern of relationships, beyond the details.

3.4.5.2. Cultural Patterns

Human beings create patterns, for food, places, events, and histories. Cultures create different patterns of living, from eating to building. Of language, relating, and changing. Many of the patterns are adaptive; some are not. Many patterns modify natural patterns. Humans have modified animal and plant associations in a different way, simplifying patterns of energy and chemical exchange, solidifying themselves at the end of many food chains as a dominant species. Patterns of eating have influenced the constitution of species and the very contours of the earth. Throughout their history, humans have used animals and plants for food and clothing. Animals were followed, herded, corralled, tamed, and finally bred. Plants were domesticated later. As technologies developed, human relationships with animals and plants changed. Hunting, grazing, and agriculture provoked large ecological disturbances.

The general patterns of living landscapes— Patches, Corridors, Matrix, Connectivity, Extension, and Geometrization—have been duplicated in some extent by humans in agricultural fields and cities. Places are patterns of things and webs of relations that can be understood by observing and participating. Human cultures have other big cultural patterns as well, such as: Overshoot, reproductive success, ecosystem conversion, stupidity and violence, stagnation, and the asymmetry of sex and handedness.

The problems of cultures, of natural ecosystems, and of modern, industrial, corporate, urban civilization, have been documented quite thoroughly. We have identified most of the problems in the problematique, from erosion, pests, and fertility loss, to population migration and diseases, and we have addressed them separately, using technological innovations or political adjustments. But, we have not dealt with them in a whole pattern. We have not understood them as complex large dynamic systems.

The intent of describing large-scale trends or patterns is to have human patterns fit with observed patterns in nature; patterns have a form, repetition, regularity, but each of these is caused by some limiting factor. Fitting the pattern can lead to both continuity and predictability, and both of these are needed to adapt human activities to natural limits.

3.5. *Defining Local Places Ecologically*

What makes a place good? Can we define good places? Are there qualities that can be distinguished in places so that we can describe good places? We live in places, that is, in place. We are embedded in places. We can examine places using the concept of ecosystems. Ecosystems, as a device for understanding, have advantages, in that they can be applied to various sizes and shapes of places. Defining good places is not simply listing a set of biological or ecological characteristics; because they are defined by people there have to be psychological and cultural dimensions. All or most of these dimensions are required if places are to be defined as good for human use.

We can define places as ecosystems in a specific locality. Within the concept of ecosystems, a number of properties, principles, and standards are presented. These are defined for clarity.

- Properties are qualities common to all members of a class. A property is an attribute proper to a thing or characteristic quality.
- Characteristics are qualities that distinguish unique individuals, systems, or patterns. Gregory Bateson calls them differences that make a difference.
- Principles are fundamental rules that we can use to create images or models.
- Variables are qualities with no fixed value, changeable
- Components are elements or ingredients of a whole; constituent parts.
- Attributes are characteristics or qualities of a thing.
- Qualities refer to a basic nature or characteristic element.
- Standards are models of quality that can be repeated.
- Practices are the actual doing or performance of work in place following standards.

Ecosystems are described with a variety of terms: Energy, matter, entropy and ektropy, productivity, cycles, diversity, complexity, stability, and trophic structure. Many terms in ecology, such as biomass, stability and diversity, however, are inexact. For instance, it is almost impossible to estimate the amount of degraded energy in an ecosystem—from transpiration, mixing of water, and many other factors. So, only qualitative descriptions will be used to define good places.

3.5.1. *Places as Healthy Ecosystems*

A place is understood as an ecosystem, a unit of organization undergoing an orderly process of development. Ecosystem principles (see also Section 2.5.5.1) can be derived from the study of ecosystems and applied to places: The ecosystem is the level of integration and the unit of organization undergoing a directional development (after E. Odum); in an ecosystem, energy is bound into organic matter, measurable as productivity; that quantity of matter and energy no longer of use to the ecosystem is wasted; the transfer of energy and materials through organisms is referred to as the food chain. It is of various lengths, depending on the system but is rarely more than 7 or 8 layers deep. Mature forests have longer food chains; the interaction of individuals in a food chain results in the trophic structure of communities (as ecological pyramids); and, the energy required to maintain an ecosystem is inversely related to the complexity of the system; succession decreases the flow of energy per unit biomass (Margalef's concept of maturity).

Understanding these principles, human beings can make good places. Because human beings live in ecosystems, the description of good places as healthy ecosystems has a human psychological dimension. Humans have definite psychological needs, as well as physical and social ones. Abraham Maslow described these human needs on five levels: Physical, e.g., food, shelter, clothing; safety, e.g., law, order, security; psychological, e.g., belongingness, love; esteem, e.g., strength, self-sufficiency, competence, freedom, attention, prestige; and self-actualization, e.g., achievement, creativity. These relate to the health and goodness of place.

Like human beings, human cultures also have specific needs to remain active and viable. These needs include: To be grounded in place, to be secure or partly isolated (too much isolation, for instance in the mountains of New Guinea, can lead to insulation and becoming static; too little isolation, for instance in the crossroads of western Asia, can result in destruction by aggressive conflicts); to have a dynamic order for human health—in some places, east Africa, for instance, humans have been kept out of ecosystems for centuries by noxious pests, such as mosquitoes—perhaps design could compartmentalize those systems, so that humans and mosquitoes could share the same region but not the same place; to be complex and sophisticated, with checks and balances; to be comprehensive, yet open, to allow change and diversity; and, to have and to manage adequate resources—a middle order of organic productivity seems to provide a good balance of innovation and plenitude. These needs are addressed specifically in the following sections.

Good places are set in ecosystems. To understand place, we must discuss the properties of working ecosystems. One problem with describing ecosystem attributes is that both quantitative (measurable) and qualitative (conceptual) factors are included. Resistance to external factors is a qualitative attribute. This may be more the result of succession than a factor producing an ecosystem. There is no whole system without an interconnection of its parts, and there is no whole system without an environment. The properties of good places—dynamic change, self-making, uniqueness, investment, regularity and renewal—contribute to and inform the properties that are characteristic of good places (Table 351-1).

Table 351-1. Contrasted Properties of Different Levels of Patterns

— Nature —		— Culture —		— Design —	
Field	*Ecosystems*	*Place*	*Culture*	*Good Places*	*Good Society*
Process	Course	Dynamicism	Conduct	*Action*	Method
Autopoesis	Self-making	Identity	Wholeness	*Individuality*	Extension
Differentiation	Diversity	Uniqueness	Flexibility	*Richness*	Variety
Integration	Construction	Investment	Adaptation	*Conviviality*	Cooperation
Constancy	Stability	Regularity	Endurance	*Consistency*	Loyalty
Development	Productivity	Renewal	Vitality	*Health*	Harmony

3.5.1.1. Action

An ecosystem with a dynamic order is open to modification by human activities. The ecosystem is open to natural processes as well. It develops diversity and variability on many levels. It tolerates fluctuation, irregularities, uncertainty, and disturbance, which are characteristics of open systems. Human action—finding or growing food and making habitations, for instance—can increase the diversity without increasing irregularities and disturbances. This can allow a place to be self-ordering and self-renewing.

3.5.1.2. Individuality

Ecosystems with human beings change and turn. As ecosystems mature, so do human beings. Human maturity allows the development of the narrow ego of a child into the comprehensive structure of an adult. Adults can develop a deep identification with all life forms; this concept is known in the history of philosophy under various names: the universal self, the Atman, or the absolute. Maturity is linked to the increase of identification with, and care for, others. Albert Schweitzer noticed the expanding circle of care from family to humanity to animals, although different cultures have different emphases. This leads to investment in other beings and their places. Paradoxically, it can lead to an expansion of self to include place.

3.5.1.3. Richness

Reality for an amoeba is less than for a fish and much less than for a human. The richness of experience seems to be in proportion to an organism's capacity to receive, decipher and influence the proximate environment. But the organism receives from reality what it puts in, that is, it enriches reality. What is impaired in the absence of a rich ecology is the individual's knowledge of herself, not only as a individual, but also as a member of a species. A deep relationship with a place is necessary. Without it, existence loses much of its significance.

Species richness may stabilize ecosystem properties, such as productivity. D.A. Frank and S.J. McNaughton (1991) showed that plant community structure (and productivity and biomass) is more stable when a greater richness of species is present. The richness of life forms contributes to the realization of human values and is also a value in itself (the Deep Ecology movement emphasizes this). Simple species contribute to richness and diversity of life. In designing good places one has to consider all aspects and levels of richness to cocreate and allow good places. A range of experiences can spring from a place, from depression to the peak experiences described by Abraham Maslow. The opposite feeling is possible where there is no richness of place; in the dullness of place, everything becomes oppressive and life becomes tedious. But, this, and the drudgery, is part of a commitment to place; it is acceptance of many of the restrictions.

3.5.1.4. Conviviality

Basically, conviviality means living together (from the Latin words), embedded in places. The making of places by living beings is an ordering of a distinct structure and center. The organization of perception, meaning, and thought is intimately related to specific places. Place becomes a focus of meaningful events and a platform for ordering a world. The individual image of a place is modified by memory, experience, emotion, imagination, and intention. Living in place orders experience (an aesthetic function). Living together results in an ethos, the moral and aesthetic aspects of a culture. It is the tone, quality, style, feel, mood, and character of their life. A place is a part of the environment claimed by feeling. Emotion binds together motion and perception. Emotion can transcend distance. Emotion creates an 'in-place'. A place, however, must be found and made; it cannot exist without inhabitants.

Attachment to place is a form of deep love, from which many other virtues for living well, such as frugality and humility, spring. Four elements in loving (from Eric Fromm)—care, responsibility, respect, and knowledge—define conviviality, as well as a loving relationship. The inexhaustibility of a living being or of our relationships constitutes much of the nature of love. Human beings are compelled to seek out other beings and love is the most rewarding approach. The evidence of this can be seen in good places.

3.5.1.5. Consistency

A place exhibits consistency or regularity in terms of stability or rhythm of changes. Cultures learn that regularity and anticipate the changes. Cultures endure the negative aspects of change, because they are committed to their places. The commitment to a place implies acceptance of its limits. We need to trust a place. One cannot trust by overusing resources, hoarding or spending. A place must be trusted, like all life support systems, to find its way to balance and compensation. Too much control is detrimental to all relationships. Control and surrender must complement each other. Simplicity and surrender are high values only in a world one trusts, to which one feels attuned at the deepest levels.

3.5.1.6. Health (Renewal)

Health is a dynamic measure of ecosystem organization, vigor, and resilience. Organization is described by diversity and connectivity; vigor is related to the amount and speed of productivity; and resilience is a measure of reaction to stress. Too much stress, for example, leads to unsustainable patterns of behavior; continuous stress leads to a breakdown of processes that becomes irreversible—the system collapses and dies. In a middle order of productivity, human productivity can focus on mature ecosystems or on perpetual pioneer systems—modern civilization limits itself to fast-growing pioneer ecosystems, from wheat fields to weeds.

3.5.2. *Place Health at the Local or Watershed Level*

The successful development of places has to be rooted in the watershed or region, in the shape of the land, its character, and its ecologies. The watershed is the unit of renewal (called a 'rene' in Section 7.8) at the regional level. All these places are the result of natural and cultural processes. Traditionally the watershed or region has shaped the patterns of building, helping to make places locally or regionally distinctive.

Development designed to fit the spirit and limits of its setting in the landscape is likely to avoid the industrial homogenization of places. Understanding the watershed is the basis for knowing essential details about what plant species will flourish, how drainage systems work, and how buildings can best be sited. Places that are designed with an understanding of watershed processes, and created with the participation of the residents, are likely to be enjoyed, cared for and valued.

Watershed design can create places in harmony with changing natural processes. Design is a strategy for directing a process of continuous change; its success depends on carefully managing what has been created and recreated. Design also has to consider whether uses are realistic in view of legal, economic and market conditions and limits. The market, however, should not be limited to the development of past forms and designs. Good design can have positive feedback on what is produced. The ultimate limit on good design has to be the health of the system.

One of the most important responsibilities of a regional culture is to maintain the health of the natural communities—because environmental health is the basis for human community health, and community health is the basis for economic health and worker health, which determine cultural health. The quality of life depends on the quality of the environment. If the environment is degraded to raise the quality of life, the effect will be very limited and never be self-sustaining. Fitting economic costs and needs to the limits of ecosystems, and monitoring the economic process, would reduce wastes and pressures on natural processes. The conscious restoration of degraded systems would contribute to the health of ecosystems. The health of the system would be guaranteed better if groups were accountable for ecological impacts, avoided interference with natural processes, by not dumping wastes for example, and integrated their buildings into the sites.

Perhaps health should be related to economic value. How much is a watershed worth? It is fairly simple to calculate the loss of potential crop income if a buffer is created. It is more difficult to calculate and contrast the costs of erosion if a buffer is not created. It is almost impossible to attribute a cash value to the enjoyment or displeasure of people living in or traveling through the area. When economic systems consider health first, many forms of productivity may become less important. For example, when biofuels concerns are raised, the health of the ecosystems may make their use impractical.

On a local project on Whitaker Bayou at Ringling College, the importance of boat access was weighed against the health of water. Students suggested denying boat access until water quality was restored using rafts of trees and shrubs; only afterwards would some boating be considered. Understanding of the principles of ecology can lead to better management. One critical message of ecology is that if we diminish variety in the natural world, we debase its—and our own—stability and wholeness. The Bayou ecosystem is simplified and degraded in its current state. Perhaps we do not have sufficient knowledge to manage a complex wetland because it is too complex to understand scientifically. But we can understand the pattern and drive it in a healthy direction. We can restore its richness and the natural processes that created the richness.

3.5.3. *Summary: Details & Framework*

Good places already exist, on every continent and in most every culture. There do not seem to be enough, however. They can be described. Some of the traits that make them good can be understood and repeated. It is possible to make a formal compilation of the general characteristics of good places. Perhaps the number of good places can be increased with understanding of traditional ways and with more effective metaphors. Many archaic societies employ a set of principles, different from industrial cultures, that may be more adaptive.

3.5.3.1. Details & Dangers

Places can be simplified by removing species. Places can also be simplified by making them smaller, that is, drawing in the boundaries, such that cycling cannot take place after connections have been severed. An ecosystem is multi-dimensional and pluralistic, with many necessary and redundant connections. Most systems are limited in size, to avoid problems of scale. Good places are being diminished.

Balanced development, rather than growth, is emphasized, so that the elements of the system work in harmony. Good places are characterized by harmony, the kind of harmony that comes from adaptive history. It is not the musical kind exactly, but more like the mutual restraint of groups of organisms. The details of how these organisms and elements interact are the subject of ecology. In naming a new science of ecology to study the relations of the living and nonliving, Ernst Haeckel combined two Greek words (eco-logos) meaning "the study of the house." Ecology relates to dwelling, to the frame that contains us as we live. The desire to refine a focus on our problems has allowed the frame of reference to be neglected. This metaphor has the capacity to turn our attention to the whole, but even that is limited. A region, ecosystem or planet is not a house any more than it is a spaceship. And, there is not just one house; there are many unique systems with individual characteristics and connections.

Humans have the ability to extend the diversity and richness of places. They can do this by respecting the limits of the ecosystems, and also by moving at rates respectful of the limits of renewal of places. This means being conscious of the ecological dimensions of place.

3.5.3.2. A Design Framework for Good Places

Design can combine the essences of ecosystems and places in a cultural context to make and maintain good places. Good place allows us to rediscover a participating consciousness and a symbiotic connection to the living region. Design can reduce the destruction of places and perhaps even bind people to, that is, reattach them to places. Design can accommodate the regularity to form a consistent approach that results in the creation of good places. Designs can allow a culture to endure droughts and disturbances. With appropriate design, both mature ecosystems and domestic pioneer systems can remain healthy with exploitation.

Design can balance the renewal of places with the vitality of cultures in the context of productive ecosystems. Design can provide the balance of exploitation and preservation. The poet Gary Snyder questioned whether complete compartmentalization is healthy. He suggested that some land is saved like a virgin priestess, while other is overworked like a wife, and some is brutally reshaped like a girl declared promiscuous. This distinction could be avoided with ecological design. The landscape needs to be zoned (compartmentalized) to provide a safe balance between protected ecosystems and used ones. Restrictions on land and water are one means of avoiding overpopulation or overexploitation. Compartmentalization avoids the need to compromise every ecosystem for human use. Some wilderness or archaic areas should have extremely limited access. Multiple use systems should only be part of the picture—after a protected environment of mature ecosystems, then productive systems, and urban areas. No land should be brutally destroyed.

The ideal landscape at one time became the middle region, the garden between the complete order of the city and complete chaos of the wilderness. The garden was cultivated from the wilderness as a middle landscape, but now the city expands at the expense of gardens. The garden is a human order, but not usually sacred. Design can balance these ideas.

Design needs to first preserve the health of systems—the health that can lead to productivity and renewal—and not just physical renewal but emotional and spiritual as well. A place is spiritually alive. Spirituality is a state of mind, of being, in which we experience a place as if it were endowed with grace, a mysterious, wonderful place to be.

We need an ecological and political framework for design. Eutopias, as a general framework, uses a root metaphor of many places (on the local and regional levels). This Eutopias is a framework for cultures, to preserve the unique image that a society needs to guide it and to make it different from others. To be effective, in contrast with the ideal characteristics of ideal designs, a Eutopian framework embodies attributes of designs that are compatible to the values and norms of living cultures.

Figure 361-1. Palouse grassland (western edge)

3.6. *Designing Local Patterns: Elements to Landscapes*

We could actually place landforms of various heights and shapes to precipitate or channel water, but we rarely consider those things. We could create forms to channel wind and noise, as well as change shade patterns and water flow (in fact, we have already done this in cities with blocks of large buildings). We could set up conditions where natural processes modify the structures over long periods of time (in fact, this is what happens when we restore streams and forests). Natural processes, such as building up and breaking down structures, development, disturbance, animal movement, inter-element flows, human interaction, and shifting mosaics, need to operate freely in landscapes.

3.6.1. *Designing Elements and Processes*

Most stable elements have been around for billions of years. These elements have been incorporated in biogeochemical cycles that are crucial for life. Although we can create new elements physically or chemically, they have limited lifetimes and limited use. Molecules have been combined chemically to replace many resources that were rare or located elsewhere. Many of these molecules are exotic and have not been incorporated into diets or cycles. They tend to behave like inorganic molecules, even those based on carbon. We need to try to design molecules that can be used as nutrients or resources, yet can be broken down into elements by natural processes such as wave action or digestion. Plastic nurdles is a good example of a molecule that needs to be rebuilt (see Section 6.8). Many processes do not need to be designed, but we need to design human behavior around them, so they can continue to operate. Surprisingly, this would include: Decay, soil production, litterfall, temperature or precipitation changes, which are highly variable, tectonic flow, climate change, fires, and earthquakes. We should design monitoring and warning systems to avoid catastrophes. Other catastrophes could be avoided by not building on unstable or dangerous areas, such as floodplains or the sides of volcanoes.

3.6.2. *Designing Ecosystems and Landscapes*

Design itself has many dimensions. The size and scale of reserves have already been mentioned. The shape of a reserve is also of critical importance.

Edge effects started out being considered as centers for diversity. Now, many edge effects are considered to be destructive. In the 1940s, it was thought that edges should be increased to provide bountiful game crops. Edges have proven to be good for both game and weed species. Edge effects, however, are detrimental to populations adapted to forest interiors. Too many edges reduces forest diversity at local and regional scales. Different species perceive edges differently. So, how deeply should edges penetrate forest stands? Overall, within 50 meters—but this may be too general.

The pattern of a design is also important to control patchiness and fragmentation and to allow for future change. For example, for a Palouse grasslands preserve, a spider-shaped area was recommended to incorporate many north-facing slopes and to allow for possible greenhouse effects (Wittbecker, ICE 1986, and Wild Earth 1995). A good pattern should also anticipate temporal change. Conservation biology suggests some general principles of reserve design (see Section 3.8 for definitions of principles and practices):

- Species that are well distributed across their native range are less susceptible to extinction than those confined to small areas.
- Large blocks of habitat, containing large populations of each species, are superior to small

blocks with small populations
- Blocks of habitat close together are better than blocks spaced far apart.
- Habitat in contiguous blocks is better than fragmented habitat.
- Interconnected blocks are better than isolated blocks.
- Corridors can function to make small blocks function as large blocks, although some corridors may be too narrow for many species.
- Roadless blocks are better than accessible roaded blocks.
- Human disturbances that are similar in scale and timing to natural disturbances are less likely to threaten species than those disturbances that are radically different.

Naming the elements of a landscape, such as ridge, hollow, or river, helps to identify the priorities of design. Lucas suggests that the less dominant features can be unobtrusively changed with good design. Forest fragmentation, for instance, can be reduced through the design of forested areas, taking into account the genetic diversity of the trees, catastrophic conditions, minimum viable populations, corridors, and edge effects. The survival of organisms usually depends on one of two factors in the web of relations. These factors can be modified by design. Conservation biology can make several specific recommended practices that would preserve diversity and complexity in forests (and avoid numerous extinctions) and in ecosystems in general.
- Stop logging old growth and mature natural forests. Grant timber leases that are contingent on the maintenance of productivity and diversity of the land.
- Promote cutting practices that respect the productivity and complexity, leaving snags, logs, and many-aged forests.
- Maintain natural habitat structures in a surrounding wild matrix.
- Reduce fragmentation through the design of forested areas, taking into account the genetic diversity of the trees, minimum populations, corridors, and edge effects.
- Maintain and restore natural connections. Avoid artificial connections. Stop constructing new roads; close and revegetate old roads; integrate new roads.
- Retain the structures and processes (which produce the complexity and diversity) of the system, including legacies and special areas. Soil is an important structure.
- Restore clearcut areas; replant with native species.
- Restore damaged streams and wetlands.
- Recommend that reserves be made large enough for minimum viable populations and minimum viable ecosystem areas.

Because current reserves are usually too small to hold viable populations, corridors must be planned to intersect with the larger areas set aside, and highway routes and underpasses must be modified. According to Harris, highways are a major force in fragmenting habitats. Conservation biology recognizes the need for planning at a landscape level. The design of forests is vulnerable to surprises because nature is chaotic (unpredictable) and science itself is uncertain (by definition) about patterns of change in forests. Social and economic activities that complement and enhance, rather than oppose and degrade, ecological processes are to be preferred and encouraged (Norton, 1992).

3.6.3. *Designing Patterns*

The word 'design' means 'marking off a pattern.' Our effort should be to make sure that we are using the whole patterns. Characteristics are qualities that distinguish unique individuals, systems, or patterns; Gregory Bateson calls them differences that make a difference. Principles are fundamental rules or laws. Standards are models or examples of quality or value established by authority or consent. Practices are behaviors in line with the aforementioned. A sample practice would be: Retaining appropriate shapes and corridors for pattern unfolding. Designs can be applied in five stages (Wittbecker 1987):

- First, review the situation, observing patterns of movement, population change, land use, building and development, boundaries, limits, and life. Conduct ecological and functional analyses.
- Then record all of the resources, from physical resources to cultural resources. Survey the area and create base maps, from geological to zoological maps.
- Next, evaluate the interactions in terms of impacts, needs, goals, and limits. Assess the whole system and create a series of plans, from the site plans to value plans.
- Start to design, which is a community process requiring the participation of all people (including the elderly, handicapped, and poor, as well those ultrahuman beings who cannot voice their concerns). Synthesize simulations and models (conceptual, capability, and suitability). Make another series of plans, from landscape plans to policy plans, within a master design.
- Finally, implement the design together and start to maintain it. Use appropriate measures and techniques, emphasizing native species over an adequate time period to ensure the stable processes of transformation. Provide services for continuity and management.

In appraising the landscape, forest design must work within the components, structure, and function of the ecosystems. Unless it does, it will not be long-lasting or satisfactory. Because design has to work with ecosystems, whose aspects are often ambiguous, fuzzy, changing, and general, design has to be able to work with these aspects. Furthermore, the design has to work within the constraints of the larger system.

Designs provide a framework for natural and artificial processes to work in. The patterns in design are echoes of patterns in nature. Good designs learn to embrace error and failure, so necessary in open systems. The intent of describing such patterns is to have the human patterns fit with observed patterns in nature; patterns have a form, sometimes repetition, and sometimes regularity, but each of these is caused by some limiting factor. Fitting the pattern can lead to both continuity and predictability, and both of these are needed to adapt human activities to natural limits. A model is pattern or object representing another object; it is a tool that permits thought to be extended.

The pattern of a design is also important to provide minimum viable areas and to allow for future change. For example, for the North Slope of Alaska, a large amoeboid shape was recommended to contain as much area as possible within the limits of the range of caribou (Wittbecker, 1995). A good pattern should also anticipate temporal change.

By consciously creating meaningful ordered patterns, we can develop ways of producing widespread community wealth while positioning the community for a long, sustainable future in a healthy environment. Designs and computer-based models can permit complex explorations, as well as suggest new patterns and further hypotheses. Through thought experiments, many of the dangers and expenses of our activities can be avoided.

4.0. Designing Nature

On the assumption that nature might be more amenable to large-scale ecological designs, we can start by addressing water problems and water flows. Our planet is a water planet. Life is water; water is life. Life is water dependent. Living beings average 75-90% water by weight. Trees are standing water. Water is a molecule, a perfect solvent, a medium for dispersal, a resource, a commodity, and a habitat. Water defines a sense of place; its state and form can measure seasons and time. It can be a solid, a liquid, or a gas. Water as a critical element of life; it is a means of renewal and regeneration. Water is a link to other ecological issues. Water is also a useful metaphor for designing.

4.1. *Local Problems: Water*

Water defines and shapes habitats. The quality, quantity, form and fluctuation of water significantly influences the species and population of a watershed. The interaction of air, water and energy shape the weather and storm patterns of the planet. Water is critical for survival. Water is a crucial, although little-understood, resource. Human economic survival depends on water and its interconnections of place. Water ways and water sources have historically defined the locations of cites, communities and cultures—and been a limit of their prosperity. Water furnishes recreation, enjoyment and awe.

There is an uneven distribution of water on the planet. Water occurs in lakes, pond, streams, rivers, rapids, pools, currents, bayous, bays, oceans, estuaries, glaciers, snow, ice, frost, clouds, mist, fog, humidity, tides, floods, storms, springs, aquifers and ground water. It impacts the physical and ecological environments. It defines and connects ecological systems. It is collected and ingested by every living being.

Humans require water. In Abraham Maslow's needs pyramid, water is a basic physiological need, although it can contribute to safety and esteem needs in various ways. Water has to be in the connections at all levels for people and systems. That is, people have to be connected to the source of their water, as well as to other people to provide social comfort.

Human beings may have developed as a semi-aquatic species, according to E. Morgan. We may have used it for birthing as well as protection. We have used water for transportation, from swimming to boats and ships. We have used it for drinking and washing food. Most environmental issues are water issues. Like land, water can be owned in a legal system; rights can be assigned, fair use can be allowed. There are issues with salt water intrusion, storm water runoff, yard and agricultural run off, nonpoint source pollution issues, waste water treatment, freshwater and marine habitat loss, aquifer recharge, ground water protection, desalinization, water diversion projects (dams and conduits), causes and impacts of changing water table heights, world wide water supply issues and projections, water demand issues, changing water use patterns, alternative water treatment options, alternative water catchment options, alternative irrigation techniques, watercourse restoration, aquatic habitats and watershed management. All of these issues and problems have economic and political dimensions.

4.1.1. *The Water Cycle Restated*

The water cycle is mostly driven by climate, meteorology, and geology—from evaporation to movement down hills. The sun provides the energy that drives the weather systems which move the water vapor (clouds) from one place to another—otherwise, it would only rain over the ocean or plant communities. Gravity continues to operate, either pulling the water underground (groundwater) or across the surface (runoff) until it reaches the ocean or the lowest land basins. Geology and topography influence the cycle, by slowing or accelerating it.

Water can be trapped. Frozen water may be trapped in cooler regions of the Earth, e.g., the poles or glaciers on mountaintops, as snow or ice, and may remain as such for very long periods of time. Lakes, ponds, and wetlands form where water is temporarily trapped. The oceans are salty because any weathering of minerals that occurs as the water runs to the ocean will add to the mineral content of the water, but water cannot leave the oceans except by evaporation, and evaporation leaves the minerals behind. Thus, rainfall and snowfall are comprised of relatively clean water, with the exception of pollutants (such as acids) picked up as the water falls through the atmosphere.

Organisms play an important role in the water cycle. Water moves out of organisms quickly in most cases. Animals and plants lose water through evaporation from the body surfaces, and through evaporation from the gas exchange structures, such as lungs. In plants, water is drawn in at the roots and moves to the gas exchange organs, the leaves, where it evaporates (and is called transpiration) to the atmosphere. In both plants and animals, the breakdown of carbohydrates (sugars) to produce energy (respiration) produces both carbon dioxide and water as waste products. Photosynthesis reverses this reaction, and water and carbon dioxide are combined to form carbohydrates.

The amount of water on the planet is relatively constant. Juvenile water, which originates deep in crust, does not add much to the biospheric water cycle. Little water is lost to the reduction the water molecules.

4.1.3. *Problems with Disrupted Cycles*

The biogeochemical cycles of oxygen, carbon, nitrogen, phosphorus, sulfur, water have stayed within certain limits, and the environment has been constant enough for organic evolution, but variable enough for natural selection to be challenged. The key term is limits. The carrying capacity of the ecosystem can sustain only a given amount of life, and there are other limiting factors that may not have a short time scale.

Humans are modifying the cycles. We are changing the rates of nitrogen fixation, which skews the plants, especially due to leakages, applications and losses. We are increasing phosphorus 12-fold in systems. Waterborne phosphorus and nitrates cause eutrophication of streams and lakes, and even some estuaries and seas. We are changing the albedo of regions and the planet, draining aquifers, diverting rivers (with dams and canals), changing evapotranspiration (from deforestation). Water withdrawals, globally, have increased 15-fold, although the population only increased by six fold (the same kind of increase holds true with energy use, also). These actions affect the integrity of the biosphere and global cycles. And, they do so rapidly. They may alter the course of biosphere development, away from the human comfort zones. How can we appraise the possibility or probability of change?

There are problems with water scarcity and water stress, not just in Africa but in Europe, especially Spain, Italy, and Germany. Some of these scarcities are hidden under national reasons. The demand for water increases as population grows. Cities may become more vulnerable to drought and heat waves. Water reservoirs are being drained. Water reservoirs are a significant feature of the planet. Water reservoirs take up an area of 0.5 million km^2 (less than 1% of ice-free land area). Stocks of water are part of systems. They usually change slowly. They can act as drags, delays, lags, buffers, ballasts and "sources of momentum in a system." Changes in stocks can set the pace of the dynamics of a system. The stock is a source that has in inflow and an outflow. A reservoir is a stock that lets farmers get water in dry times.

Systems can have more than one stock.

The temperature or shape of water is important. Could the Gulf Stream stop? Vaclav Smil states that the Gulf is not driven by thermohaline circulation. Like the Kuroshio and the Agulhas, it is a wind-driven (due to solar radiation) and torque-exerted (from the rotation of the planet) flow. He further says climate does not require a dynamic ocean. However, local weather does. Although the Gulf Stream may continue, the proportion of fresh and salt water would determine how much heat was moved or how many nutrients were brought up from the ocean depths. Regardless of the average, the details determine habitability and crops.

4.1.4. *Valuing Water*

Donella Meadows notes that any growing system runs into some kind of constraint, in the outflow or inflow or in the stocks. The higher and faster a population or system grows, the farther and faster it can fall. With exponential growth of a nonrenewable resource, even a doubling or quadrupling of finds of the resource, such as water, offers little added time for developing alternatives. Also, the more the growth loops evade the control loops, the worse the fall after production.

In any commons system, there is a resource shared. If it is eroded, then it can become a tragedy. The tragedy of the commons arises from missing, or long-delayed, feedback from the resource to the users of the resource. Some systems are thus allowed to get worse; this is a drift to low performance. Rivers get dirtier, the tragedy slows, and we adapt to it. All of the ways to avoid the tragedy are cultural ways, whether through education or privatizing to regulation. Rich countries transfer technology and capital to poor, never questioning that capital or technology might not be the limiting factors. It may be clean water and ecosystems.

We need to learn to value water. There are three use values for water. Direct use value refers to goods that are consumed or enjoyed, such as water, food, or views. Indirect use value refers to environmental services, from ecosystems rather than individual animals or resources, such as climate or river flow. Option value has to do with the possibility or potential of getting benefits later. Nonuse values—there are three also—derive from the benefits of ecosystem services without using them in any way. Bequest value means passing on ecosystems to future generations of humans. Existence value is what people derive from knowing that something exists regardless of potential use. A final category of value, self-value is the value of nonhuman beings for themselves and their needs.

Simple conservation makes the most sense, as we just reduce the flow and have less to bury or deep-place in the ocean, or avoid with solar screens or aerosols. Efficiency alone promotes more consumption. Conservation may include additional rules on the size and efficiency of vehicles, no different than other restrictions on speed or driving laws.

We can identify nontrivial risks with water. We can identify areas of ignorance and fill a few in. But, we have to be willing to live within certain ecosystemic and biospheric limits. We also have to accept precedence of the health of the whole system. We have to accept multigenerational equality and commitment to general dynamic goals for health and fitness of the whole system. And, of course, have to deal with current inequities between groups and nations, as part of the program to fit in the planet.

Cheating is a trap; it is avoiding the rules. The solution for cheating is to redesign rules in the direction of achieving the purpose of rules. The trap is seeking the wrong goal. The way out is identifying goals that reflect the real wealth. Focus on result not effort. Leverage points. Where and when to intervene. Meadows cites Forrester's leverage point of growth, economic and population.

Systems goals are parameters, which can be leverage points, and can make big differences. Buffers are leverage points. Buffers are large stabilizing stocks. Delay length is a high leverage point. Balancing feedback loops is a leveraging point. Governments and corporations are drawn to a price leverage point, but sometimes push it in the wrong direction, according to Meadows, so the direction has to be understood.

Meadows suggests that strengthening market signals, such as full-cost accounting, does not go far due to the weakening of another set of balancing feedback loops—those of democracy. The self-correcting feedback has been disrupted by leaders who control information. Designing alternative forms and rules of government might help. Taking away the power of the persuaders to influence representatives with money might work.

4.1.5. *Designing Water Flows*

In Mesopotamia, farmers dug canals from the rivers to irrigate their wheat. In many places around the world, farmers built up terraces to control the flow of water downhill. In Bali, temple systems controlled the complex allocation of water. Some civilizations dug canals between rivers. Others created reservoirs to hold water; lately industrial civilization has created huge, automatic dams to hold drinking and irrigating water, as well as to generate electricity. Some cities, like Colfax, Washington, built concrete river beds through the city. Other cities, like Providence, Rhode Island, covered the rivers with concrete roads and plazas.

How could we save the water of a river system, like the Colorado? Perhaps by assigning ownerships at each reach. Then, in each ownership, allocate 50% to the river, 30% to the first owner, then smaller percentages down stream. How can we save the ocean? Zoning or national ownership?

An artistic approach to designing water courses and water systems might help to express the sense of water in a community, as well as its role in reminding us of our individual connections and responsibilities with this resource and its continuity. When it comes to water, most of us consume it and discard it. But, droughts remind us that water is never guaranteed. Pollution shows us that water carries the history of its passage. Art can display the world as a whole.

All places are linked by global cycles. Of course each place has unique species and sets of species that function as parts in the whole planet. The whole matrix needs to be managed with water in mind. Matrix management weaves people back into the fabric that supports them and in a sense makes them subject to the constraints of ecosystem processes.

A noninterference approach to water management—the essence of a Taoist way—is to let water take its own course with plenty of room to spread. Therefore, once temporary constructs were in place, the path of water would be allowed to develop without interference. Since flood control would be accomplished by a healthy watershed, artificial constructs such as dams and concrete channels, recommended in some studies, would be unnecessary.

People can overestimate the power of systems thinking and think that it is a way to predict and control problems. But, self-organizing, nonlinear, feedback systems are inherently unpredictable. They can be understood generally, especially with knowledge of the goals, but sometimes need overwhelms knowledge and sense. This kind of need is a good illustration of why chickens cannot walk to the end of a fence and go around it, even when they can see the grain on the ground and have the end of the fence in sight.

Water is the kind of thing we should not try to control completely, perhaps just encourage it in other directions or prepare for its misbehavior with landscape designs that seem designed by the flow and overflow of water. Meadows says we cannot control systems or even figure them out completely, but we can dance with them. And the secret of good dancing is awareness of the music and matching the motions of the partner.

4.2. *Designing Local Wetland Ecosystems*

Although ecosystems are orders of magnitudes higher than simple tools, we feel that we can design them by creating an aggregation of species and elements that we want to exploit later. Then, all we have to do is let the pieces sort themselves out according to their biological interactions. We can then influence the pieces we want with water, fertilizer, and biocides. It has not worked that way very often.

Wetlands are areas where the soil is saturated with water, seasonally or permanently, and covered by water or only temporarily covered. They are very widespread, extending from the poles to the tropics, and from ocean coasts to mountains, and productive as systems, so we tried to modify those systems for our own advantage by draining swamps, marshes and bogs for farmlands or home sites (by 1993, half the wetlands on the planet had been drained). Wetlands have unique characteristics. They are now considered to be the most biologically diverse of all ecosystems, where dryland species and aquatic species blend with unique wetland species. Mangrove forests and floodplains can reduce the impacts of storms. In many nations wetlands are being restored, to bring back lost diversity, or being used as water purification systems. Wetlands are recognized as valuable for their ability to store water and for the ability to sequester carbon.

4.2.1. *Designing a Local Ecosystem: Paradise Creek*

The design of ecosystems has to consider problems of interference and destruction, before the systems can be designed. Interfering with cycles on a global level is a threat to the health of the local ecosystems. We need to have specific goals for designing ecosystems, whether the goal is protection or restoration. We need to have more comprehensive goals to keep the integrity of the biosphere strong by keeping local ecosystems healthy.

Ecosystems are larger entities made up of other beings—large patterns made up of smaller ones. An ecosystem is a constant where every component changes, disappears and reappears. It is a pattern like a whirlpool. The pattern forms from a torrent of light, energy, molecules, air, water, and even larger things. Comprehending patterns is necessary to protect the scale of ecosystems, which is too large to see, except by satellite, the parts of the system that are too small to see, dominated by fungi and viruses, the parts that are too-long-lived for us to observe, the long successional time of evolutions, and the parts about which we are ignorant. Normally, we are aware only of what we see working in the ecosystem during a very short time. By making a special effort, by addressing the various properties of an ecosystem, we can incorporate some of those patterns in a design.

Ecological design has to consider all of the properties of ecosystems at different levels, as well as their structures and functions. The six basic properties at the highest level are method, self-extension, variety, cooperation, loyalty, and harmony. Method is a way of considering motion, course, dynamic change, and conduct. For Paul Weiss, the field was a symbolic term for the dynamics underlying the ordered behavior of a "collective"; the term denoted the properties lost in the process of analysis. The body of a grassland, forest or any entity is a dynamic pattern supported by dynamic processes that include other entities. We need to remember how difficult it is to identify and understand all of the properties and interactions of a self-creating system.

The self-creating system renews itself as its contents change, as disturbances change the parameters. As a mature system, it continues to move to a point of high maturity, recovering from disturbance to its original trajectory, where productivity declines and stability increases.

Although ecosystems are considered renewable resources, they are slowly renewable, requiring hundreds or thousands of years to renew from catastrophic disturbance; this time is far longer than any economic plans and really nonrenewable on a human life scale. This has important implications on sustainability. We trust that our plans and designs will ensure that the ecosystem will remain as a healthy entity for a very long time so that many generations of us can gather our needs from it.

4.2.1.1. Setting the Creek

Paradise Creek is an intermittent stream that runs from Moscow Mountain through the city of Moscow, Idaho to the South Fork of the Palouse River in Pullman, Washington. Changes to the watershed in the last one hundred years have changed the character of the creek, eliminating many fish and animals and plants that depended on the creek. In order for the creek to be returned to the whole community of plants and animals (including human ones), the processes that keep it healthy and flourishing must be restored and protected. This design outlines specific steps to allow the middle-reach sub-basin to become self-sustaining. The middle-reach, however, cannot be considered outside of the context of the entire creek, grassland ecosystem, and human institutions.

Every place has certain characteristics that enforce the spirit of place, for instance, a strong definition of place or indicators of great age—such as legacy trees or ancient rocks—or where a place distills the essence of larger landscapes. A sense of wildness and water also contribute greatly to the spirit of place. The spirit of Paradise Creek has changed greatly in the past 200 years, but it is still easily defined with elements of water and wildness. The creek is a more intimate place, less dramatic than Steptoe butte or Palouse falls, but more diverse than the surrounding grasslands. The spirit of a place is often the best guide to design.

All the elements of design can be combined in an image. Every organism creates an image of its place from what is meaningful to it. This image is what fits the organism to its place. Suckers and caddisworms have simple images; coyotes and humans have more complex ones. Boulding (1956) notes that the image as a cognitive construct of the world has several aspects: spatial, temporal, personal, relational, value, and affectional (emotional) for each individual. Cognition is an active relationship that is creatively shaped by the participants. Participation is not an option by the way—every scientist or inhabitant becomes part of the system of observation. The total sum of individual images is a world. Some of the images we impose on nature result from idealized notions of pastoralism or technological futures. Thus, landscapes abound in nostalgic or consumptive trends on many levels of explication—some are iconic, some invisible. We originally perceive the landscape symbolically, but the landscape has other functional dimensions that increase according to use.

Centuries of land uses have broken the landscape into patches of natural areas and technological artifacts. Sometimes the patches overlap, as in the case of Paradise creek, which is a natural stream corridor with unique vegetation and boundaries, and the linear landscape of a human transportation route with a highway and railway track. This corridor has the function of connecting two cities. It is also an aesthetic change from the humanized and architectural environments of the cities themselves. The tendency has been to think of the corridor as an expanding transportation unit. Possibly, the highway could be moved over the hills and away from the creek. Under no circumstances should it be doubled; as we know from decades of experience, building larger roads only encourages larger traffic jams. What we should be doing is providing alternate means of transportation in the form of light rail, buses, or bicycle lanes within the limited area. Wildlife may use the corridor for movement at different times of day. The role of wildlife could be expanded instead of contracted.

The environment provides its own metaphor for design. The landscape is a unique individual, a community, a dynamic system of interacting patterns—the human pattern is a part of it now and should be preserved as part of the whole pattern, but not necessarily as the only pattern or a completely dominant one. Most products of an ecosystem are produced and consumed and recycled within the ecosystem. Humans need to minimize the external inputs in the form of energy and exotic substances. The community must be restored to health. This means balancing human needs with bird or fish needs in a sustainable pattern. Each element in a pattern relates to others and to the whole. To create a design, we have to start with an inventory and analysis of the watershed.

4.2.1.1.1. Physical Inventory and Analysis of Paradise Creek Watershed

Paradise Creek is a Riverine system (Subsystem: Intermittent; Class: Streambed) in the Palouse Hills area of the Columbia Basin physiographic region. Based on physiographic setting and hydrological conditions, Paradise Creek created a riparian wetland—a composite wetland that depends on floodwaters and groundwaters—and in the dry season, to a large extent, on sewage treatment outflow.

The specific boundaries of the Paradise Creek wetlands are confirmed on a site basis. Functions of wetlands in general are: Floodwater retention, runoff detention, sediment entrapment and filtration, absorption of organic nutrients, water purification, groundwater recharge, stream flow maintenance, bank stabilization, and provision of wildlife habitat. All of these functions are performed to some degree by Paradise Creek.

Wetlands north of the highway are Palustrine emergent, characterized by grasses, cattails, rushes, and sedges, either saturated or seasonally flooded. Riverine wetlands are found along both sides of the creek. Positive identification of wetlands has not been made of several sites on the north side of the highway due to drought conditions (when the study was conducted in 1992). Originally part of the historic floodplain, these wetlands have been isolated to some extent by highway and driveway construction. Wetlands on the south side have been altered by grazing and agriculture.

4.2.1.1.1.1. *Geological origin and Physiological setting*. The geological foundation of the area is basalt, from lava flows that occurred 15 million years ago. The crystalline base under the basalt is metamorphic rock about 60 million years old. Lighter deposits of volcanic ash fell from Glacier Peak (12,000 years ago) and Mt. Mazama (6,000 years ago). The eruption of Mt. St. Helens (in 1980) added a 2-8 centimeter deposit to much of the Palouse. Heavy depositions of loess, originating in arid lands to the west continuously since the early Pleistocene (300,000-500,000 years ago), resulted in fertile soils of loam and silt loam texture, which developed in a semiarid Mediterranean climate.

The landscape has moderate to high relief; elevations range from 180 to 1,200 meters. The climate is dominated by westerly airflows, although arctic air may intrude from the north or tropical air masses from the southwest. The Wanapum Basalt (named after a Palouse village) and Grande Ronde Basalt aquifers serve the Palouse River basin. The Wanapum lies on top of the Grande Ronde. The boundaries of the recharge area for the aquifers have not been definitively determined.

4.2.1.1.1.2. *Soil*. The depth of the loess varies from almost zero in Pullman to about 77 meters (255 feet) on the outskirts of Moscow. The loess was shaped, most probably by wind and snowmelt, into asymmetrical hills enlongated from west to east. The northeast sides are steeper (8-12%) than the southwest (7%). In general, the soils surrounding the creek and in the uplands are moderately permeable, with a fairly high available water capacity. Roots of the plants can go 1.5 meters (60 inches) or more deep. The soils have high erosion potential.

Erosion is a natural process that contributes to the creek, but erosion has been accelerated by tillage erosion from upland farming and by construction on upland sites.

4.2.1.1.1.3. *Hydrology.* Water in Paradise Creek watershed first falls as precipitation. A percentage of the precipitation runs into soil storage, is intercepted by plants, or runs to overland flow directly into streamflow. The rest infiltrates the soil to groundwater storages (and eventually deep aquifers) or flows through the soil to the creek. A portion of the creek flow is interflow possibly from ground-water storage to the creek or even a base flow from the aquifer. The creek flows into the South Fork of the Palouse River, which empties into the Snake River, Columbia River, and the Pacific Ocean. Wetlands beside the creek are associated with the water level in Paradise creek, but also receive runoff from agricultural fields and highway. On the north side the wetlands are influenced by overland flow and a seasonal rise in the water table.

4.2.1.1.1.4. *Topology and drainage characteristics*. Paradise creek is a fourth order stream almost 32 km (20 miles) long from its source on Moscow Mountain to its confluence with the South Fork of the Palouse River in Pullman. The headwaters start at an elevation of over 4300 feet and drop rapidly to 2900 feet. The creek then drops from 2700 feet in Moscow to 2360 feet at the mouth. The watershed drains over 88 square kilometers (21,760 acres or 34 square miles). The creek is a youthful stream with indistinct drainage channels up to 1/2 mile wide. The stream starts out as a first-order intermittent stream and attains a medium dendritic form, draining first, second, and third-order tributaries; Idlers Rest Creek, for instance, is a first-order tributary. In the middle reach, the creek has 16 intermittent tributaries, most of which dry up by July. The middle reach drains a subbasin of approximately 6700 acres.

The natural meander pattern of Paradise creek is the result of numerous factors: Geological conditions, slope of the streambed, amount of sediment, erodibility of bed and banks of the stream. In the past hundred years the creek has been straightened to fit property lines and roads or for flood control.

The Paradise Creek corridor controls water, mineral, and nutrient runoff, which reduces flooding, siltation, and soil fertility loss. The flood plain can hold water at various depths, depending on the severity of a flood. Floods occur, during winter or spring, around 35-year intervals. A key characteristic of the corridor is connectivity. The corridor hinges two sides of upland, with sharp microclimate and soil gradients and with a unique bottom habitat.

4.2.1.1.1.5. *Lotic Ecosystem Interactions*. Creeks, along with streams and rivers, are one of the primary links between terrestrial ecosystems and lentic (aquatic) ecosystems, dissolving chemicals and materials in the drainage basin and contributing it to the “down-hill” flow into the Pacific Ocean. The creek receives chemicals and water from the up-hill of winds, rain, and animals. Paradise Creek stores, transforms, and releases fluids and materials. The creek contains a unique and diverse assemblage of organisms and abiotic components. The creek is a lotic (moving water) ecosystem. It is an open ecosystem since its metabolism and chemistry reflect the inputs of energy, water, and chemicals from other systems. The functioning ecosystem is not just the creek, however, it is the drainage area surrounding the creek as well as the local atmosphere above it, from which the creek could not be isolated and survive.

4.2.1.1.1.6. *Physical and Chemical Characteristics*. The sun drives the water cycle in the Paradise Creek watershed. The hills limit the amount of radiation received—compared to a flat surface. The combination of evaporation and precipitation with gravity allows water to move to lower sites. Water is an excellent solvent, dissolving more gases and solids than any other liquid. Rainfall in the middle reach is about 560 mm (22 inches) per year. The input to the stream from precipitation is estimated at 4325 cubic meters. Most of the input, however, is from runoff from the basins; this figure is estimated at 3.45 million cubic meters.

The annual streamflow is about 4.4 million cubic meters. The difference is accounted for by outflow from the sewage treatment plant. Evaporation from the creek is relatively low; the greatest evaporation occurs at the lowest flow. Deep seepage into the aquifer from the creek is unknown. There is substantial contamination of the water quality by phosphorus, bacteria, suspended solids, and ammonia. Toxics from paints, paint thinners, cleansers, degreasers, medicines, cosmetics, and dyes enter the creek from homes, businesses and parking lot run-offs. Point pollution is from the sewage treatment plant and toxic sites; nonpoint pollution enters from agricultural fields, livestock (high nitrate concentrations), highway runoff (gas, oils, heavy metals), construction sites, and septic systems.

4.2.1.1.2. Biological Inventory and Analysis of Paradise Creek Watershed

As the stream order changes, species change also. The bioassessment of the creek varies with location. The upper reaches of the Creek have in-stream vegetation, sedges, reeds, and cattails. The mayfly and caddisworms are very sensitive to stress and are good indicators of perturbation or pollution. These and other macroinvertebrates prefer a strong flow of cool water over a moderate gradient of cobble and boulder substrates with adequate crevice space. The upper habitat is not particularly good, however, for surrounding vegetation, according to Fred Rabe et al.

4.2.1.1.2.1. *Biological Characteristics of the Habitat*. The habitat improves somewhat near the residential limit of Moscow, although a few riffles exist and undercut banks are present. Downstream a steeper gradient results in a faster flow, clearing away deposited fines and showing a gravel bed. By the time the creek leaves Moscow (passing the sewage treatment plant) the water quality is at its poorest, with few macroinvertebrates, no fish and no aquatic macrophytes. The lower reaches have some rooted plants. Ducks use it seasonally; a family of muskrats live 300 meters below the treatment plant. The habitat improves relatively, however, with stable banks and shallow meanders. As the stream flows along the highway and railroad, species richness increases. Rabe et al. have judged that most of the creek gets poor marks for habitat conditions: Width of riparian zone, canopy cover, bank vegetation and stability, velocity/depth, and bottom substrate.

4.2.1.1.2.2. *Species Composition, Diversity, Distribution, and Biomass*. Life in the creek depends on solar energy, moving water, and basic nutrients. The energy, water, and nutrients flow through organisms structured as a food chain. Each segment of the chain is a trophic level, from primary producers to tertiary consumers and then decomposers. In a healthy creek the food chain is not only longer but the amount of material reaching each level is many times higher. In an impacted creek (such as Paradise Creek) herbivory falls slightly while detrivory falls significantly, according to Eugene Odum (1971).

Paradise Creek has two sub-communities, rapids communities and pool communities. In both of these the type of bottom—sand, pebbles, clay—determines the population and density of the community. Different areas of the creek have different inhabitants. For instance, in a healthy creek, the headwaters are usually a fast-water area holding cold-water species such as trout. The fast-water section of the creek (riffle) is the greatest food-producing area because of the replenishment rate. The middle reach of Paradise Creek, with its relatively slow-moving flow and increased pollution, is favored by more tolerant species like suckers.

The native macrophytic vegetation for a riparian zone should be sedges and rushes, including cattails, bulrushes, sedges, and rushes, with some trees and shrubs. Paradise Creek lies in the fescue-snowberry vegetation zone. The native vegetation is mostly absent from this range. Rexford Daubenmire notes that on moist nonsaline soils, the climax vegetation is Hawthorn-snowberry habitat type. The hawthorn forms a thorny thicket with an under-growth of snowberry shrubs. The hawthorn stands also support a rich avifauna, including magpies, long-eared owls, thrushes, and vireos. There is also a Quaking Aspen phase of the habitat, in which aspens grow through the hawthorn canopy then decline from heart rot; after a period of time the aspens return. Daubenmire suggests that aspens, being fairly large trees, would have been used heavily by European settlers. In places, quaking aspen would have bordered the creek. Black cottonwoods, and to a lesser extent, willows and alders, would also have been found along the creek. The dominant at this time is an invader, reed canary grass. In a similar habitat type, cow parsnip grows underneath the hawthorn, primarily in valley floors (called 'flats'), bordering intermittent creeks like Paradise Creek, with deep soil and favorable moisture relations. A shrub habitat then occurs on the upper north-facing slope and a bunchgrass habitat type on the south-facing slope.

Over 240 wild vertebrate species are still found in the watershed. The riparian habitat is still relatively intact. The shrub steppe that surrounds the creek has been altered, however. The meadow steppe that characterizes the upland has been mostly converted to cropland. Pheasants and rodents use cropland and their predators, including coyotes and hawks, live there also. Deer are regular visitors. Badger and reptiles can be found in the shrub steppe area. Muskrats, gopher snakes, and grouse live in the riparian habitat.

Most of the fish in Paradise Creek are pollution tolerant fish like suckers, dace, and squawfish. Some of the mammals are tertiary consumers that feed on fish—muskrats and raccoons, possibly beavers. Bats feed on insects above the creek. Other mammals use the riparian for drinking, cover, or hunting—white-tailed deer, coyotes, mice, chipmunks, shrews, rabbits, and possum. Ground squirrels live on the banks. Mice are probably in greatest abundance. Hawks and (seasonally) ducks seem to be the most commonly observed birds in the middle-reach, although starlings center around the sewage treatment plant to the east.

4.2.1.1.2.3. *Productivity and limits*. The natural productivity of temperate grassland, such as the bunchgrass prairie of the Palouse, is approximately 1,225 Kcal per square meter per year, less than many other grasslands, especially subtropical and tropical. By contrast, the cultivated acreage, that is, all but 200 or so hectares, can yield three or more times the productivity (3,000-12,000 Kcal per square meter per year), due in large part to additional inputs of energy in the form of fertilizers and pesticides. The energy and protein of the usable portion of significant crops, wheat for example, is significantly less (1,400 Kcal per square meter per year) than the gross productivity.

Natural carbon budgets feature some inflow and outflow, but balance over the long-term (many centuries at least). Agriculture has the effect of increasing the inflow (fertilizers) and outflow (crops, mulch), disrupting the natural flow and requiring a constant artificial support.

4.2.1.1.3. Ecological Interactions

Under natural conditions, Paradise Creek collected water from the land surrounding it. Trees, shrubs, and plants intercepted some of the water and grew along the banks. Various animals and fish frequented the creek. Human cultures gradually dominated the system, mining the rock and soil, planting the uplands with grains and legumes, and using the floodplain for home sites, transportation, and recreation (inappropriately, alas).

The basalt outcroppings near the highway have afforded a less expensive area for mining companies to cut and grind the basalt for gravel and road fill. There are currently two companies working the corridor, although several other areas that have been already cut are now acting as storage areas. The steady removal of basalt for gravel also creates a steady source of stress on the ecosystem, especially at the sites.

Virtually all of the uplands, over 1215 hectares (3,000 acres), has been put into agricultural production. Agricultural land is defined as that which is primarily devoted to "commercial production." But agricultural land depends on and is supported by wild lands, which are in short supply. Wild vegetation occurs only on steep northeast slopes, if at all.

There is one state highway (SR270) running through the corridor. Two other county highways parallel it on the north and south. There are no formal recreation areas along the creek. By the loop of old highway to the south after Milepost 8.5, people have been shooting cans and signs, however. A number of items, including an old sofa and several metal cans, have been dumped by the old road. People have been bicycling along the highway in the breakdown lanes for decades, although heavy traffic and air-born grit and gravel make the trip less pleasant now.

4.2.1.1.4. Historical Story

The riparian communities along the creek are characterized by grasses and forbs, similar to the upland vegetation, but also by deciduous trees and shrubs, including willows and wild roses. Corridor vegetation affects the creek in many ways, including shade, litter, and seeds; it also retards the input of particles and substances into the stream. The corridor vegetation has a direct impact on the characteristics of the creek. Trees provide shading, which cools the water temperature (encouraging some fish like trout); trees also deposit litter. When trees fall, the logs form pools and contribute nutrients. Beavers can also contribute to the flux of vegetation by forming dams and shallow ponds, which are periodically washed away. Trees and beavers alter drainage characteristics (by slowing runoff) and increase habitat and species diversity. Most of the trees and shrubs were removed during road building or to improve farm or grazing potential.

4.2.1.1.4.1. *Ecological History*. When vegetation is removed, more water flows into the creek because of a decrease in transpiration to the atmosphere and because less water is impeded. Nutrients once absorbed by the vegetation pass into the water directly, where they are usually flushed away. The microclimate is also changed. Surface temperature increases, along with wind speed and evaporation rates.

There are no records of the undisturbed plant communities. The creek has been greatly altered by human activities, including a highway, railway, and agriculture. Modern agriculture changes the patterns of vegetation in the uplands to large homogenous geometric parcels. Intensive cultivation and grazing has constricted the stream corridor, increasing nutrient loss, bank erosion, sedimentation, water temperature, and the potential for flooding. It has also increased concentrations of nitrogen and phosphorus in drainage waters. Agriculture causes species diversity to drop. Disturbance tolerant species like canary reed grass and suckers dominate the creek; many fish have disappeared. The contents of the creek is linked to the health and status of the land surrounding it.

Removal of tree and shrub cover has likely decreased structural and species diversity, and degraded the ecosystem, in the corridor. Reed canary grass, an invader, is the dominant wetland vegetation at the moment. The stress and change increased in parallel with the growth of Moscow and Pullman and the increase in agricultural production.

4.2.1.1.4.2. *Cultural history*. The first people to live in the area were small, mobile bands of the late Pleistocene who hunted large herbivores as part of their subsistence strategy. These people had to adapt to large-scale environmental changes, from animal extinctions to volcanic eruptions and climactic changes. They were eventually replaced by Palouse Indians, who called themselves "Na-ha-um," people of the river, and who inhabited the area for several thousand years. Most villages were located near the river or stream mouths.

The Palouse fished from the shore of the Palouse River, taking trout, whitefish, squawfish, sturgeons, suckers, chubs, and eels. From platforms and canoes, using dip nets, seines, spears, and hooks, they caught blueback, Chinook, and steelhead. When not fishing, groups would move to root-digging grounds, where the women would use hardwood sticks to collect over 20 varieties of roots, including biscuitroot, bitterroot and camas.

The Lewis and Clark expedition traveled along the Snake in 1804, noting that the bunchgrass prairie supported herds of horses very well and predicting that if it were cultivated it would provide in great abundance. Explorers were followed by trappers, then travelers. The first wave of travelers was aiming for Oregon and did not consider the plateau to be prime farming country. War resulted after gold miners overran the land, disregarding Indian rights, and several were killed. Sections of the creek were ruined during the labor-intensive mining.

The area around Paradise Creek was originally named Hog Heaven, because the pigs fed well on camas bulbs. Later the whole valley was renamed Paradise valley. The cattlemen kept to the bottomlands, until people realized that the grasses were a natural and nutritious feed. When farmers discovered the fertility of the hills they moved in and pushed the cattlemen toward the scablands. The ranchers and farmers altered the natural habitat of the Palouse and destroyed the economic life of the Palouse Indians.

Agricultural development was the first intensive use of the region. The first large crop was flax; wheat came later. In the last 100 years, dry-land farming has almost completely replaced the original vegetation, although fragments can be found in fence corners, right-of-ways, cemeteries, and inaccessible slopes (mostly facing northeast). As agricultural technology became more advanced and the demand for crops increased, less desirable segments of the prairie were tilled. Smaller islands of native vegetation, regarded as waste places, were left for livestock grazing, since the native vegetation was palatable and nutritious. However, native vegetation was easily injured by close cropping and unable to compete with introduced exotics on disturbed sites. Even the few remaining natural stands, on the steepest slopes and boundaries, have been influenced by fertilizer and herbicide drift.

The Paradise Creek watershed has become more populated, with thousands of people in urban locations like Pullman and Moscow. Population increase in the area for the past two years has been estimated at 4 percent. This increase surely will outstrip the human infrastructure and put more stress on the creek. Agriculture has produced monumental yields, but only at the cost of tremendous erosion, great subsidies of fertilizers and pesticides, and the farm subsidy program. Watercourses and uplands have been changed, altering the creek and fishing grounds. Changes have been made without regard to the long-term impact on the ecosystem or on its human population.

4.2.1.1.4.3. *Current State.* On both sides of highway SR270 the extent of agriculture is obvious. Basaltic outcroppings near the highway have attracted 2 gravel pit operations. The majority of land ownership is private. Agriculture uses 83% of the land area of the watershed; urban use is 8.5%; and heavy industry is less than 1 percent. Traffic between the cities is heavy. Visitors also have a desire to reach the water's edge and walk along the banks.

The creek used to regulate biochemistry much better, when inputs from agriculture were lighter. The border of the creek had the capacity to buffer many pollutants, including lead, hydrogen, and nitrogen. The amount of lead and hydrogen and acid rain from atmospheric pollution, as well as the amount of nitrogen and phosphorus from runoff, are probably all 500 percent (at a guess) of the premodern watershed runoff. The ability of a green buffer around the creek could absorb many atmospheric and chemical pollutants, but its capacity is not known, and it is a limited capacity.

4.2.1.2. Existing Planning, Management & Uses of the Watershed

The effort to rehabilitate the creek or to plan recreational paths currently involves over 30 local and state agencies, including the Latah County Soil Conservation Service, Pullman-Moscow Water Quality Commission, Pullman Civic Trust, Palouse-Clearwater Environmental Institute (PCEI), and Palouse Conservation District. The state of Washington classifies Paradise Creek as a class 'A' water body, which is to be protected for all uses, including agricultural, habitat, and recreation. Many of these uses are not currently supported. Economic activities, such as businesses or land use, are determined by zoning and planning. Zoning and planning can encourage more uses.

4.2.1.2.1. Zoning

Most of the Middle Reach is located in Whitman County Washington. The Whitman County Planning Commission District permits a multitude of activities, including crop production, nurseries, food processing, veterinary clinics, stables, forestry, and mining, prohibiting only feedlots and fertilizer and biocide production. Recreational uses promoted for the future include trails, gold courses, tennis courts, playgrounds and campgrounds. Regarding the industrial and retail uses permitted, the District does not want those uses that generate large volumes of traffic, so they forbid automobile-oriented uses and institutional uses that generate heavy traffic, such as hospitals and universities.

Site design is the primary means of meeting aesthetic and environmental goals. Landscaping requirements are for the purpose of screening the view of industrial and commercial and for providing buffers to protect sensitive areas, slow erosion, and shield properties.

Several conditions are identified as being incompatible with heavy commercial development: Areas with historic or archaeological features eligible for registers; a designated floodway; places where the average slope exceeds 20%; and areas that are environmentally sensitive according to the Washington State Environmental Protection Agency (SEPA). Despite this incompatibility, mining continues along the highway.

4.2.1.2.2. Comprehensive Plan

The Whitman County Comprehensive Plan describes proposed land uses for Whitman County. Land use in the county is characterized by large land ownership for agricultural use. Habitat for wildlife is limited to noncultivated areas, e.g., valleys, canyons, and the margins of surface waters. Conservation measures are necessary to keep the habitat from being degraded by human activities. One goal of the Whitman comprehensive plan is to preserve agricultural land; it states that uncoordinated nonagricultural development has serious impacts on farmers' ability "to carry out farm practices without threat of restriction."

The Commission states that encroachments on the floodplain are "prohibited." However, exceptions are made for recreational facilities and minor projects such as signage and fences. As part of the District Conservation Areas, the corridor is to be designated an environmentally sensitive area; this restricts development and establishes a 200-foot buffer area on the south side of the boundary.

The amendment on heavy commercial land use site criteria states that among factors to be considered are productivity of soils, efficient use of land, conflicts with adjacent uses, and environmental or cultural factors. Furthermore, heavy uses are "encouraged" on sites of marginal value, such as thin soils or in the "vicinity" of floodplains.

The Ground Water Management Plan (Pullman-Moscow Water Resources Committee, 1992) records that Pullman and Moscow rely almost entirely on groundwater for their municipal, university, and domestic water supply. Most of the water supply is pumped from wells penetrating the basalt aquifer. There is concern over declining ground water levels in the area. Water levels started declining virtually from first use. Water level decline from pumping has averaged as much as one meter per year. Dryland farming, however, does not require irrigation.

4.2.1.2.2.1. *System Goals.* People have had goals for the Creek for a long time. These have ranged from fishing in the 1800s to transportation and resource extraction in the 1990s. These last goals have been formalized by the local and state governments. Residents of the area also have personal goals for the creek. In a large sense the ecosystem itself has goals, although they are unconscious and informal.

For the Watershed itself, survival could be considered one goal; health is another. Recently the Environmental Protection Agency (EPA) has enlarged one of its stated goals from protecting human health to protecting ecological health. Ecosystem health is one of the goals of this design. Health is related to stress, both good stress and bad stress. Stress may be related to the rate of change for the system, in addition to loss or gain of components or changes in structure. Health is the overall ability of a system to maintain itself under a normal range of environmental conditions. The dynamics of the creek is irregular within limits; for instance, quick snowmelts may raise the level of water dramatically, but not so much that it scours the banks of vegetation. In one sense the system may be perturbation dependent, as when droughts occur consistently in the summer. In some wetlands, periodic drawdown is a requirement for the successful regeneration of plant dominants. We do not know what the ranges of the parameters are. Fire is not one of the perturbations, however, and still should be suppressed around the creek.

4.2.1.2.2.2. *Human Goals*. Professional planners tend to regard the creek as a problem to be solved. The first goal of the Whitman County Comprehensive Plan is to promote economic development in the Pullman-Moscow Corridor Enterprise area with a mix of strategies. The second is to promote safe traffic conditions. Goal 3 recognizes citizens' desire for a bike path and is to encourage construction of a recreational bike path along the highway. Goal 4 is to enhance the scenic and environmental quality of the corridor. And, goal 5 is to protect land uses through landscaping and screening and to prohibit further residential development.

The Environmental Quality and Conservation Element of the Comprehensive Plan is an optional element for plans under Washington statutes; it is used as a basis for policies under SEPA. The goals listed in the plan are to maintain or improve air and water quality, minimize degradation of existing natural areas, such as riparian vegetation near surface waters, and implement flood hazard zoning based on the area of the 100-year base flood.

The Pullman-Moscow Corridor Enterprise District was formed to implement the goals of the Comprehensive Plan Amendment. The District recognizes that the primary purpose of the area is as a transportation corridor, and to implement measures to promote safe movement through it. A secondary purpose is to create opportunities for orderly development which will "be of long-term benefit to the community as a whole, while protecting and enhancing the environmental and aesthetic characteristics" of the district. A third purpose is to allow for recreational opportunities.

The main goal of Whitman County is to preserve agricultural land. What does this mean? Habitat is already confined to leftover lands. Agriculture should not be allowed to destabilize natural systems on which it depends, even for shot-term (and short-sighted) economic gain. The preservation of agricultural land depends on long-term economic changes, as well as conservation measures.

People themselves may have subconscious or conscious goals for the creek. People are attracted by running water. They find it most desirable to live near running water or to view it. But, people also find the condition of Paradise Creek to be displeasing. Algae and weed growths, as well as tons of litter and industrial wastes, discourage participation or recreation.

4.2.1.3. Watershed Design

The goals of this design combine ecosystem, professional, and popular goals critically. For instance, zoning in Whitman County allows everything from mining to stables and golf courses. Mining and stables could be removed from the area to benefit the creek, since their untreated wastes are dumped directly into the creek. Such activities are detrimental to the health of the creek. Golf courses and tennis courts could certainly be excluded; golf is much too water use intensive, and tennis requires too great an expanse of asphalt. The District does not want to permit uses that generate volumes of traffic, yet warehousing, mining, and retail markets generate not only traffic, but slow moving and potentially hazardous traffic. The District neglects to address the inter-university traffic for classes, socializing, and shopping.

Based on understanding of the ecosystem and human goals, the combined objectives of this wetland plan are to: Preserve the natural character of the area. Improve the aquatic habitat by increasing diversity of habitat types, adding deep pools and vegetation cover. Flatten the channels cross section to stabilize banks (only where people interact) and increase use of the floodplain. Permit human functions in the area for transportation and livelihood, by redesigning routes. And, integrate the physical and biological inventories with economic uses and recreation paths.

The creek becomes healthier when it uses its floodplain. Local recharge is increased, channel scour is reduced, and downstream peak flows are reduced. The recharge is increased because the stream is covering a larger area, which is then further from the channel and draws out the flow.

The design must address the system of which wetland is part; It must define the principal sources of water, especially untreated sewage outflow, as well as controls on water flow, and evaluate the vulnerability of flow to alterations from land use. The design must consider the visual quality of the landscape.

A complete inventory of elements in the creek starts with the shapes of the features in the area. The large volumes are rounded and natural hills—even the agricultural evidence is almost natural, that is, from the roadside not the air, the fields appear not to be squares, triangles, or circles; a small number of geometric shapes exist in the buildings by the road, but because of their scale are not too intrusive. Although the road itself has been flattened, it is not perfectly straight and does not conflict badly with the curving planes of the hillsides.

The diagonal shape, as opposed to horizontal and vertical, of the Palouse hills is both dynamic and pleasing to human senses—some explorers commented on the almost maternal aspect of gently rounded hills. Diagonal shapes give the impression of energy and movement, which is quite true as the hills are still being shaped geologically by erosion and wind. The eyes of travelers are drawn down one slope and up the next, then along the series of slopes. As people respond to one element and then another, the elements are perceived as parts of the whole. The sinuous path of the road through the corridor draws the eye toward the end of the corridor. The curves of the fields react to the shapes of the hills. The skyline is made more interesting by the shape of the hills.

The scale of agriculture and development should be related to the scale of the landscape. As it is, the creek area is diminished even more by the scale of cultivated fields. The buffer zone should be increased up the hill, perhaps to a ratio of 1:3 or ten times the meander width. Of course, seen from the air the ratio would decrease radically, as most of the landscape is farmed. The scale also seems greater on hilltops. Because the highway is in the creek corridor, the scale of the landscape is reduced, and because it is smaller scale, finer textures can be discerned and therefore must enter the design. Details are more obvious.

Ecological diversity in the corridor has been reduced by human activities, such as planting or grazing. The overall landscape diversity has not fared as badly, due to the addition of human artifacts, which increase it. An increase in ecological diversity would lead to an increase in diversity of the landscape, however. It would also tend to reduce the scale, but this would not be a problem in the corridor. Adding billboards or business buildings to the corridor would increase the visual diversity to the point of disruption, while further lowering ecological diversity. Diversity could be increased by alternating tree cover of the creek with open habitats; different species would be encouraged to use the creek. Psychologists have recognized the need for diversity for people's quality of life and emotional well-being (Kaplan 1973). The light color of existent buildings contrasts starkly with the landscape; even simply painting them darker colors would let them blend more with the landscape.

4.2.1.3.1. Overall Design

This wetland design is not a restoration, because of the uncertainty about the kinds, extents and associations of native vegetation. Furthermore, humans are now a large part, although not yet an integral part, of the system; therefore it could not be restored to a premodern or prehuman state—and even if it could, which state? This design is not the biotechnological design of a new ecosystem, either; we cannot accurately control and predict ecological events in a system. However, we can steer some of the events in a known direction—known because we have historical records of the system, even if not complete. We can also reduce those human activities that we know alter the conditions of the creek, such as erosion and chemical dumping. Although the design attempts to restore some kind of balance, the balance does not exclude human activity. Rather, it integrates it into the larger community. A moderate number of human impacts can be absorbed by the system—too many impacts could destroy the system's capacity for self-maintenance. The design should be open to the evolution of the creek and to human technological and social development. The design is based on a model of ecosystem functions, considering diversity, complexity, and the maintenance of natural process—natural here meaning a self-sustaining system composed of elements now lost through human disturbance.

This design involves designers and people in reshaping and recreating a self-sustaining community. Individual quests are limited. The relationships to strive for here are community relationships. Furthermore, there are limits for human manipulation of other communities. Total control has limits. We should not try to control the Creek and its habitats completely. We have to trust that natural processes are self-correcting and organizing.

This design is the creation of a clear vision of the creek that is aesthetic, useful, and self-sustaining. Some of the relationships can be captured by maps and drawings, but not the dynamic four-dimensional qualities of the creek itself, which can only be understood by living there for a year or more. Nevertheless, a simulation of the view from an auto or bicycle is more compelling than a recital of the statistics or species lists. Included are a series of landscape treatments showing two phases:

1. The creek is fixed and replanted. Any kind of replanting is going to substitute human selection for the natural selection that built up genetic integrity over thousands of years of evolution. Therefore, we must be circumspect in the choice of species as well as in the pattern of planting. The highway is supplemented by a bicycle trail and light rail.

2. The highway is removed to the other side of the hills. Bicycle and rail are moved to the north side of the old highway. The creek is totally rehabilitated.

The land use of the watershed would change with each of the two phases. The total acreage in crops would be reduced by the size of the buffer, for instance. The characteristics of the creek as a habitat would also change during the implementation of the phases. For instance, as the creek was encouraged to meander, bank undercuts, favored by fish, would increase; as trees and shrubs were planted, the water temperature would drop.

A healthy creek might restock the aquifer. Aquifers, water-bearing rock strata, are important for a healthy water regime. Furthermore, water in an aquifer is protected from evaporation and contamination. The aquifer is cheaper and self-sustaining.

4.2.1.3.1.1. *Creek*. The creek now is too straight, too exposed, and too warm after decades of human improvement or neglect. The substrate is too silty; it needs to offer a variety of materials, including gravel and rocks. At least three things must be done to revitalize the creek: 1. Recreate meanders, 2. Recreate creek bed diversity of elements, and 3. Recreate natural shelter areas.

More meanders need to be added. Because the slope is low, meanders are the natural form of the creek. Meanders offer variety for wildlife. Meanders benefit diversity by different flow rates that form pools and riffles; without the meanders the creek is characterized by shallow pools and glides. Deeper pools support small fish in low summer flows or cold winter freezes. Migrating ducks and geese and Great Blue Heron also use larger pools. In earlier times, the creek was occasionally dammed by beavers or fallen trees. These obstacles created scour holes and pools. The increased current removed silt and some rubble, leaving the larger rocks that insects and fish favor. Putting logs in the creek or concrete gabions would have an immediate effect on the creek (concrete would degrade more gracefully than wire gabions). Falling logs and bank undercuts also created preferred environments for fish. In-stream vegetation providing anchoring places for insect larvae. The vegetation of the creek bed needs to be restored. Creek bed-rooted plants, such as sedges (*Carex* spp.), would be planted in slow-current areas.

Figure 421312-1. Horse-broken-down stream bank

4.2.1.3.1.2. *Bank*. The bank has been degraded by unlimited access by people and domestic animals. The activities of people have also removed most of the trees and shrubs on the banks. Trees and shrubs are needed to stabilize the banks. Therefore, bank stabilization is a high priority, which can be accomplished with two immediate changes: 1. Plant native trees, shrubs, and other vegetation discriminately, and 2. Restrict livestock with barriers.

Probably 50 percent of the stream should be open to sunlight and the rest under intermittent shade from trees and shrubs. Open spaces could be 100-200 meters in length.

This would have the effect of controlling access of deer. The impact of grazing is considerable in riparian areas. Cattle and horses should be fenced from approaching the creek directly. Cattle, and to a lesser extent horses, require water (8-10 gallons a day for cattle). To get water from Paradise Creek the cattle must get down to the creek; this physically changes the shape of the bank and the conditions of the creek, from narrow, clear, cool streams to wide, muddy, warm ones. Anchor vegetation is eaten or dislodged. Cattle and horses contribute to erosion and eutrophication.

Figure 421313-1. Paradise Creek Proposed Restoration with Willows & Pines

4.2.1.3.1.3. *Green Buffer.* Even with changes to the creek bed and the banks, the creek cannot be effectively protected from runoff, pollution and disturbance until the use of the corridor is modified. Three things can be done: 1. Extend the buffer, 2. Replant the buffer, and 3. Build swales and channels near the highway.

In order to effectively perform its functions of controlling water and nutrient flows, the creek corridor should cover the edges of the stream channel, flood plain, banks above the flood plain, and part of the upland above the banks. When the corridor is extended to the uplands, the runoff and subsequent flooding are both minimized. Rainwater storage would be increased, which would reduce flooding. Bank erosion is also minimized and the amount of sedimentation is minimized, resulting in higher stream quality. Extending protection of the corridor to upland would also permit movement of upland interior species inhibited by flood plain conditions, and include the edge effect. The District states that major drainage ways are to be protected by a buffer area with a minimum width of 25 feet beyond the high water mark. Twenty five feet, or even 200, is not enough. The buffer should be at least 350 meters (1100 feet) from the center of the creek with extensions to protect tributaries.

The Palouse Conservation District has experimented with willow poles in upland areas to stabilize the hillsides above creeks. Vegetation should not have too high water requirements in order to be more self-sustaining and less needful of human labor and inputs. Tree planting and open areas should be related to bays in the hills; a bay would allow a greater amount of light to reach the stream. Tree planting in riparian would be a state and county responsibility; for private land, incentives to plant could be offered.

Swales, for biofiltration, could minimize impacts on the wetlands. Swales are long, level excavations intended to intercept overland flow and store water in underlying soil, but not to hold water flow. They can be created across slope, in low slope landscapes or on bottom lands. They are also useful to control roof runoff around buildings. Temporary swales could be used until the full design is implemented. For the farmland above and outside the buffer, incentives could be offered for conservation practices to reduce erosion and field runoff.

4.2.1.3.1.4. *Farming*. Wheat and pea farms are considered productive in terms of yield-per-acre, but if productivity is measured in other units, such as yield-per-Kilocalorie of energy spent or yield-per-unit of soil lost, they may be less productive. At times, farmers have plowed right up to the creek and very close to the roads. A buffer must be allowed, in the form of fallow fields or even hedgerows. Proven soil conservation methods should be employed, including contour plowing and seed drilling.

4.2.1.3.1.5. *Transportation*. The Pullman highway (SR270) was designed for safe travel with moderate traffic loads. The grading of the road was designed to carry vehicles at a constant speed. The road was not considered part of the environment so much as a transportation overlay.

The enjoyment of moving travelers is an important consideration. The sequence of views from the road should be interesting. Natural features should be emphasized. Interesting views of the creek should be used. Much of the aesthetic feeling of the road is determined by the speed. At 55 miles an hour, fewer details are needed for motorist's enjoyment. There should not be some many details that driver's eyes are drawn from the road. The audience of most of the design is captive, fast-moving, and often inattentive, due to the nature of their movement in enclosed vehicles. Much of the sounds and smells will be lost on them, emphasizing the visual. The frequency of change for optimum interest of such fast-moving people is between 4-8 seconds. Furthermore, the area closest to the road receives most of a driver's attention. The scale of landscapes is reduced by speed. The faster the speed, the narrower and longer the cone of vision; thus, the eyes are drawn to the distance. The landscape design closest to the road should be restricted to the perceptual space of the people in motion. Or the speed limit should be reduced to 35-40 miles an hour. The number of man-made structures should be reduced to a minimum to let natural features achieve prominence. Distance views or water views should be emphasized.

Many of the harmful effects of the road, such as runoff and toxic waste, can be solved by having a wide buffer on both sides. Reducing traffic, through mass transport or other measures, would reduce those effects, also. Roads generate many times the sediment discharge as the grassland, disturbed or undisturbed. Roads also have costs associated with killing deer, coyotes, mice, and frogs trying to cross them. The quality of the road would be enhanced by additional plantings and by the edge treatment. The aesthetic impact of the road would also be increased.

The current rail line was also designed for efficiency of movement. The line moves over a number of meanders, which increases its negative effects. Its contributions to the creek include oils, wood preservatives, and refuse.

To minimize impacts from highway and railway, swales and channels can be built to direct water, reduce its speed, and increase its absorption into the soil. Rather than expanding the road, the highway could be left in two lanes and eventually traffic could be moved to the Old Pullman Highway or the Airport Road, which parallel it (in Phase 2).

Light rail would permit more detail in the foreground, since the travelers would be going slower and most of them would be passengers instead of drivers, which means that their eyes could be drawn to more distant views as well.

4.2.1.3.1.6. *Recreation*. As the demand for recreation increases there will be increasing pressures on land use along the creek. A recreational path was designed earlier to provide safe transportation, recreation, and education in the natural and cultural resources of the region. However, it would use a lane parallel to the highway. Vegetation would be used to screen incompatible uses, such as mining, rather than eliminate them. The path would result in more extensive development, offering more intensive recreational opportunities and a conservation greenbelt. A recreational path is an important part of the corridor. But recreation should be limited to the path, which should be north of the light rail. Recreation should be restricted to two creekside parks; more areas could have negative impacts on the creek.

4.2.1.3.1.7. *Industry & Sewage.* Heavy industry, mostly mining, is located in the corridor for convenience—it is close to the highway. This results in heavy, slow-moving traffic that is dangerous to the faster commuters. It also creates mountains of gravel and torn down hills. The mining could be moved to less visible sites with outcroppings of basalt. Both the Airport road and Old Pullman Highway have such outcroppings. Therefore, mining could be moved from SR270 and the sites rehabilitated.

The Moscow sewage treatment plant discharges 2-3 million gallons (7-12 ml) of water per day, significantly increasing the flow. This results in too much untreated materials being released in the creek. A system used in Melbourne Australia, Switzerland or Israel might be a good model for Moscow. The sewage water can be screened (primarily a settling treatment) and then fed to biological treatment ponds, where bullrushes, cattails, reeds, duckweed, and water hyacinths can purify it, feeding it to tertiary ponds to support more plants and fish. Most nutrients dissolved in sewage, such as nitrogen and phosphorus, are difficult to remove with conventional processes. This whole system transforms sewage into gas, algae, crops, and food for fish and wildlife. The remaining water would be released to Paradise Creek.

4.2.1.3.2. Methods

Most of the methods recommended for the creek are low-tech and labor-intensive. This would encourage participation and minimize the effects of high-technology.

4.2.1.3.2.1. *In-stream*. In-stream alterations are an effective means for increasing sediment transport, which improves fish and insect habitat. For rehabilitating a silt-polluted stream, there are many types of hydraulic structures for modifying the flow characteristics of the creek, including drops and dams, deflectors and divertors, and constrictors. Log drop structures, gabions, and beaver dams have similar effects: to hold back some water in a dammed pool, make plunge pools, and increase the pool-riffle ratio. Log drops are made of logs anchored across the creek. Gabions can be concrete bars or rock-filled wire cages. Beaver dams are made of sticks and branches primarily. A more natural appearance is preferred by the public; wire and steel bars can be dangerous and unsightly.

Channel divertors and deflectors flush the fine sediments from runs and pools. In-stream structures, such as wing deflectors or porcupines, can be used to force the channel into meanders if it has been straightened. Wing deflectors are triangular rock-filled intrusions into the stream from one bank; the deflection of the current causes bank wear on the bank opposite the deflector—due to current action, the deflector should never be just angled around 0 degrees. A porcupine has the same effect, but it is made from stakes in the stream bed that hold brush and branches in place and cause the flow to be directed towards the farther bank. Constrictors increase the current. They can be made of logs or concrete (previous criticisms apply to the materials). Community changes from in-stream alterations include an increase in diversity of species and an increase in total numbers of insects. Numerous log drops, restrictors, and porcupines are planned for the middle reach of the creek.

4.2.1.3.2.2. *Bank*. The purpose of a bank is to channel water; it needs to be stable to be effective. The bank can be stabilized through several procedures. For instance, where public access is desired and the bank is too steep, it can be lowered by cutting away. In order to encourage fish, the bank can be extended over the water artificially as an artificial dock that fish can live and hide under. This is a short-term method to create habitat until planted trees and bank wear can provide the suitable conditions.

Trees and shrubs, based on native plant associations, would be planted on the bank to stabilize it and provide shade, cooling the water, and debris, a source of food for creek residents. Maintaining grasses, forbs, and shrubs is also vital. This may limit trees to lighter-foliated kinds, such as willow, birch or aspen; pines should be planted further from the creek. The trees should be planted in an irregular pattern, with different ages and sizes as much as possible. Eventually, all of the reed canary grass will be replaced with native species. This is an expensive and labor-intensive process, which would involve removing the canary grass stem and roots, then planting native seeds or plugs (from some other impacted wetland). On a tract by tract basis, the canary grass will have be replaced by bunchgrasses or sedges.

4.2.1.3.2.3. *Buffer.* Sediment pollution from numerous sources subjects the creek to excessive loading. Until the sediments are reduced, physical and biological rehabilitation will be retarded, regardless of in-stream alterations. Siltation frequently occurs downstream from gravel washing, mining, logging, cultivation, and highways. Siltation can be precipitated out of the water by biological buffers. Just having a wide buffer of 200 meters (600 feet) will cut down much of the siltation; 350 meters (1100 feet) should eliminate most of the siltation. The shape of the buffer strip should parallel the landform, spreading upward to include intermittent tributaries. If the width is too great, the sense of enclosure would be lost. Too narrow and the road and farmed upland may seem oppressive. If it is too straight, it will seem too artificial. Swales can be built on steeper slopes to slow the flow of water and encourage percolation into the ground. On the upland slopes of the buffer—it should extend that far, especially to protect first-order streams that empty into Paradise Creek—willow poles and other native deciduous trees can be planted to halt erosion.

Figure 421323-1. Paradise Creek with Bunchgrass & Quaking Aspen

4.2.1.3.3. Design Relations

The design of the creek has to accommodate reasonable human needs for transportation and recreation. Therefore, the design should have certain characteristics pleasing to human perception (and possibly to nonhumans as well), such as interest, movement, and surprise; other characteristics include change, appropriateness of place, self-ordering, maintaining, edges, and natural cycles. Movement would be basic by rail and highway, but interest and surprise encourage movement by foot and bicycle. Surprise is the result of unexpected vistas or views or arrangements of landscape elements.

The creek design must also be appropriate. Native species plantings would ensure that exotic animals like hippopotamus would not appear around the corner, although in one sense that would increase the element of surprise. Surprise is unavoidable; it is the unpredictable emergence and novelty that characterizes ecological systems. The Palouse Indians were surprised because they did not have enough information about the Europeans. The degradation of Paradise Creek is a surprise because the system was chaotic and complex, and we did not predict the decline, or, worse, did not care about it.

The creek design must also be as self-sustaining as possible. This occurs when natural cycles of native plants and animals are restored. Otherwise, the landscape will be artificial, requiring large amounts of human intervention by labor and money just to keep the landscape intact. Good management would allow the creek to be self-sustaining.

Figure 42133-1. Paradise Creek with Hawthorn & Pines

4.2.1.4. Management of the Creek

Good management can be an anticipation of good trends. For instance, highway policies should be limited to the needs of planned development. Public transportation in form of buses, light rail, and shared-rides is a promising trend, as are smaller more efficient personal vehicles, and alternate forms of personal transportation, such as bicycles and microvehicles. Housing could be designed to be more high density; perhaps even a Palouse arcology on the north side of the creek would be a solution to the daily trades of employees between universities on the highway. Construction sites should be mulched and isolated. The conversion of power to indigenous sources such as sun or wind for heating and cooling is feasible. For areas already built, remediation of parking lots and impermeable covered areas by perforating compact lawns and using permeable asphalt or drainage channels would be desirable. Individuals could employ conservation practices such as terracing, contour planting and sod waterways in gardens and yards. The communities could attempt self-sufficiency in food and basic manufactured goods. The management of Paradise Creek involves establishing a management unit whose focus is all aspects of the creek, from creating a protective buffer to minimize erosion and sedimentation of the creek to safeguarding water quality.

4.2.1.4.1. Ecosystem Context

The Paradise Creek ecosystem is part of a larger Palouse Hills region in the Columbia Basin province. The region has been converted from a natural self-sustaining one to one that is artificially maintained by energy subsidies. A large part of the Palouse grasslands should be restored to a self-sustaining reserve (Wittbecker 1986). Riparian areas like Paradise Creek should be restored to self-sustaining systems as much as possible. This goal would not exclude human activities, but would let natural processes operate without destructive interference. The carrying capacity of the ecosystem can sustain only a given amount of life, and there are other limiting factors that may not have a short time scale. The diversity and stability of ecosystems are necessary; diversity buffers the influence of a single perturbation in the system.

Human population is now a critical part of the context. The population of the cities of

Moscow and Pullman has been driven by the growth of their two universities. The daytime population of both cities also swells from the activities of the malls. Moscow's population is 18,519 (Bureau of Census 1992); Pullman's is 23,478 (1993). The universities contribute 25,772 people (UI—10,250; WSU—15,522). Growth is expected in both communities. The most recent growth rate for Moscow is 4% for the past 2 years (1992-3).

This much local population growth is unreasonable and dangerous. It is a threat to the stability and health of the creek. A booming population means booming requirements for homes, recreation, and transportation. The population must be related somehow to the carrying capacity of the local ecosystems. For example, each person needs about 6.3 acres of land, including support and wild areas (after Odum, 1970 and Wittbecker, 1983). Given the fact that the Paradise Creek watershed is only 88 square kilometers (34 sq. mi), it can only support a population of 3454 people. In order to support the 40,000 who live here now, it is necessary to use a much larger area, which of course is being done. Adjusting human populations to an area would limit human impact and align it with the natural processes necessary to support it.

4.2.1.4.2. Noninterference Matrix Management of Paradise Creek

Paradise creek exists as part of matrix that includes the ponderosa pine forest near the headwaters in the northeast and the Palouse grassland. Any activity in the matrix can have some effect on the creek. The whole matrix needs to be managed with the creek in mind. Matrix management weaves people back into the fabric that supports them and in a sense makes them subject to the constraints of ecosystem processes.

4.2.1.4.2.1. *Economic Considerations*. Every business depends on the stability of the environment and on the stability of social institutions. The environment provides air, water, land, and renewal (both physical and psychological). It is therefore in the interest of industries and businesses to preserve the natural as well as the social infrastructure. One of the most important responsibilities of a business is to maintain the health of the natural communities—because environmental health is the basis for community health, and community health is the basis for economic health and worker health, which determine business health. If the environment is degraded to raise the quality of life, the effect will be very limited and never be self-sustaining. The health of the system would be guaranteed better if businesses were accountable for ecological impacts, avoided interference with natural processes (by not dumping wastes), and integrated their buildings into the sites.

Perhaps health should be related to economic value. How much is Paradise Creek worth? It is fairly simple to calculate the loss of potential crop income if a buffer is created. It is more difficult to calculate and contrast the costs of erosion if a buffer is not created. It is almost impossible to attribute a cash value to the enjoyment or displeasure of people traveling through the corridor. A restored Paradise Creek with a wide native buffer would certainly valued more highly by residents. The cost of restoration would be very reasonable considered as part of a 50-year plan, but not many banks or lending agencies have that long a horizon.

Perhaps if the creek were considered part of a total ecological accounting system, 50 years would be the appropriate time frame. Such a system would balance cash income with costs, and consider the energy cost of oil, machinery, and fertilizer, as well as energy produced, crop fuel oils, and food calories. The components of the ecosystem could be considered to be part of an accounting framework, with interconnecting flows and inputs and outputs. The value of each component could be said to be the human cost of replacing that component with human labor and inputs, as sometimes happens when the natural process has been damaged. An ecological accounting would consider soil loss, efficiency of water storage, and pollution, as well as genetic richness, soil life, wildlife richness, employment on farms, food quality, human and environmental health, and quality of life. People have needs, animals and plants have needs, the site does have constraints, and these things can be married into a good pattern. Economic activities should be limited so that they do not destroy the capacity for self-organization of the system. This capacity for self-organization requires a minimum level of complexity and flexibility.

4.2.1.4.2.2. Political Considerations. We must pay attention to the processes that make up the habitat, for example, the role of herbivores on trimming vegetation and diversifying it by predation. The design of the wetland and its management must ensure that the processes operate to maintain a dynamic state. Furthermore, the context must be conserved. Some species, like muskrat, require one habitat for shelter and another for forage. Paradise Creek, which links two developed areas though a relatively natural area, is the context in question. It is almost entirely embedded in artifact landscapes shaped by human activities. The sprawl and spread and conversion of lands have had unfavorable consequences to the creek. The history of the system is to be considered, also, with its range of change, episodic change, and long-term processes. This will make the limits of the system explicit.

In the creek, it is important to respect limits and to maintain the integrity of ecological processes that generate the Paradise Creek habitat. To this end, we should establish a position as Keeper of the Creek, perhaps as an elected office. The Keeper would take a personal interest in all the activities that involve the creek. The Keeper would represent the interests of the creek in political, business, and public meetings. The Keeper would be responsible for public education to setting up land trusts—the function of a Land Trust is to identify and protect lands that have biological or cultural significance; it could work through acquisition, conservation easements, cooperative agreements, and education. The Keeper would give educational presentations on the value of the creek and ecosystem protection, and work to involve stakeholders in their legacies. Economic and political means would provide incentives to preserve land from development, preserve diversity of habitats, and reintroduce native species. Personal commitment is the most effective means of protection.

4.2.1.5. Summary for Paradise Creek

Urbanization of the Paradise Creek Middle Reach seems inevitable. If present trends continue, the corridor will become a strip mall with light and heavy industry using once-through water systems, interspersed with single-family dwellings surrounded by impermeable parking lots and by bluegrass lawns and exotic plants.

The creek cannot be protected over the long term unless we stop growing and slow down our industrial output. We cannot accept damage to the creek as part of the price for our comfort and overproduction of food. The Palouse can afford to change to a soft energy path by gradually weaning itself from fossil fuels to alternative sources of energy. The waste that ends up in the creek and by the roads would be better incorporated in a complete cycle of production and use and reuse.

The creek is part of our common heritage and common environment, from the beavers and coyotes to the waves of invading humans, recently the Palouse and Nez Perce and most recently dominating Europeans immigrants. Until we have a vision, an image, of what our lives would look like lived frugally and sensibly, we will continue to want cars and trucks that get 10 miles per gallon, we will want more and more televisions and lawnmowers and wider highways and bigger malls. The creek ecosystem is simplified and degraded in its current state. Perhaps we do not have sufficient knowledge to manage a complex landscape, because it is too complex to understand scientifically. But we can understand the pattern and drive it in a healthy direction. We must do all that we can to restore its richness and the natural processes that created the richness.

The transition to an established conservation area increases the overall benefits to the system and the human part of the system. Although it is still a transportation corridor, it is also a refuge for many species and part of an aesthetic experience for the travelers. We will have rehabilitated part of a degraded habitat as part of a complex living environment that is partly human. This design yields the optimum combination of flow, function, and yield, while conserving important ecological resources, that is, the creek itself and all the beings who use it.

The goal of this design is not to restore, but to revitalize and reinhabit the watershed. We do not want to live in the dead bones of a mechanistic failure. We want to live in a healthy environment with aesthetic appeal; aesthetic appeal is a requirement for human health. The Paradise Creek watershed has physical, biological, economic, and political characteristics. The design, planning, and management for the creek describes the system in a comprehensive interdisciplinary approach, using dynamic concepts such as feedback and stability, recognizing limits to change and sustainability with different levels and scales of structure and function in an anticipatory, flexible planning approach, recognizing human and nonhuman goals, and incorporating personal and institutional interests. This design recommends the creek be designated a conservation area.

Figure 4215-1. Unrestored Paradise Creek with exotic grasses and fields 1992

4.2.2. Woodford Creek (Glendale, Oregon)
(Being edited)

4.2.3. Spit Brook (Nashua, New Hampshire)
(Being edited)

4.2.4. Upper Lake Myakka (Myakka, Florida)
(Being edited)

4.2.5. Noname & Four-mile Creek (Viola, Idaho)
(Being edited)

4.3. *Designing Local Cycles*

A locale is a set of fractal ecologies that are linked by cycles in nested spheres, which developed over billions of years. Land and ocean areas change over millions of years, as part of tectonic cycles driven by the internal heat of the planet. Is it reasonable to talk about designing continents, spheres or cycles? Certainly it is a fertile science fiction topic and within the realm of possibility. What we might be able to do, instead, is to design human artifacts and behaviors that influence cycles and spheres.

4.3.1. *Designing Cycles*

A pattern is a regularly array of similar units. The units do not have to be exactly the same shape or size, and the regularity does not have to be perfect. Many of the laws of physics are nondeterministic laws (or stochastic) and they influence natural and human systems. Our ignorance of them lets us get caught by surprises. These laws create patterns in space, as well as in human history. There are simple kinds of patterns. A linear pattern tends to be interpreted as progress or regress. This is the dominant concept of modern history, unending progress. Despite the chaos of individual events, there seems to be a direction.

The circular pattern, suggested by the myth of eternal recurrence, depends on regular repetition, as with the seasons. It allowed disintegration to be replaced by regeneration. The helical pattern is innovatively cyclic and the cycle is additive and seem to each reach a higher stage. Finally, there are nonlinear patterns. These seem to have more surprises due to the acceptance of complex nonequilibrium systems. They may evolve in a definite direction, but move by leaps and turns.

The definition of stability is related to linkages, especially flows and cycles at different scales, with other species and scales. This is why human improvements are often not stable. Nothing is fixed or static. Everything is changing and flowing. But that is not the result of design. That is bottom-up flowing and forming in nature. Nature has no design or intent.

We need to design our modifications and outputs so that they do not increasingly perturb biogeochemical cycles. In addition to impacting the carbon cycle, we have doubled the natural global sulfur emissions to the atmosphere, doubled the global rate of nitrogen fixation, enhanced levels of phosphorus loading to the ocean, altered the silica cycle, and perhaps, most critically, altered the hydrological cycle. Relative to many natural perturbations, the effects of human activities have been extremely rapid. We can design cycles by mimicking natural volumes and flows, and by reducing the anthropogenic flows of many elements, such as nitrogen and carbon.

4.3.1.1. Designing Atmospheric Cycles: Carbon Cycle

Vaclav Smil notes cycles that we probably cannot alter. They include the evaporation-precipitation cycle dominated by the ocean or the nitrogen cycle in the atmosphere. Nitrogen used to be fixed by lightning and natural biofixation, but now synthetic fertilizers and the combustion of fuels adds another 100% of reactive nitrogen to the biosphere. This creates tremendous interference in the global nitrogen cycle. Can we wean ourselves of fertilizers? We can decarbonize energy, but cannot denitrogenize life and organisms and ecosystems.

We do have the ability to influence carbon sequestration or carbon emissions in carbon dioxide. To stabilize carbon dioxide concentrations in the atmosphere to 450 ppm, various models suggest they must be reduced by 50 percent by 2050 and 80 percent by 2100. We need to make changes to avoid human and other suffering, rather than try to balance the planet. Do we know enough about how the planet moderates the atmosphere? Should we try to trigger these? Gregory Benford suggests two strategies: Hide the carbon by burying it in the Gulf of Mexico; and reflect away sunlight. Anthropogenic changes to the atmosphere are usually limited to trace compounds such as carbon dioxide or aerosols from biomass burning or fossil fuel combustion.

In combination with carbon conservation, an excellent way to hide carbon might be by planting. We are not sure of local change in phytomass in deep history. It might be only a half of the preagricultural amount. Vaclav Smil concludes that our understanding of the larger scale remains poor. We could start by planning local extents of forests; this would require setting aside large areas and restoring large areas, so that regions would have an optimum tree cover, based on largely native ecosystems. We could design paths and preserves for many species of animals and plants. Many of these areas would have limited human access or use, since they would provide 'services' to regions and the planet and animals, as well as to humanity. This is a different kind of design, based on natural processes, but aided by human operations. It may be a more taoistic approach, characterized by benign neglect and minimal intervention in natural flows.

4.3.1.2. Designing Water Cycles

The water cycle is driven by climate and geology. We are influencing the water cycle by increasing the rates of evaporation. This is through the drawdown of ten-thousand-year-old aquifers. Too much water in a system or cycling through a system leaches nutrients, resulting in a nutrient-poor environment, such as tropical rainforests. Although the rainforests have a tremendous biomass, they need rapid nutrient-cycling to survive. Cutting trees and burning shrub areas can result in erosion, which depletes nutrients faster, so that the environment is not capable of supporting regrowth of rain forest nor even swidden farming. Cutting trees on a large-scale or over a large area in a rainforest is to be avoided. We need to keep the reservoirs for water, like the ocean, healthy and clean. The exchange pools for water, such as clouds, need to be in active turnovers.

4.3.1.3. Designing Solid Cycles/Nutrient Cycles

Some material cycles between other ecosystems or in larger patterns in regions. Some of the cycles are daily; some are seasonal or annual; others are years or decades; a few, like the carbon cycle, are century or millennia long. Human beings do not pay much attention to very long cycles or to those we perceive as not affecting us.

4.3.1.3.1. Designing a Phosphorus Cycle

Phosphorus also plays a key role in the cycles of such biologically essential elements as nitrogen, oxygen and sulfur. One can characterize phosphorus compounds in water and soil, estimate how fast phosphate cycles through natural reservoirs, estimate long-term phosphorus burial in the oceans through geologic time, pinpoint phosphorus sources in different ecosystems, determine fluctuations in phosphate concentrations at certain times and places, and study the effects of phosphorus pollution in estuaries and lakes.

Part of the phosphorus cycle is a nutrient cycle through ecosystems. Nutrient cycles change with the succession of an ecosystem. Design for optimum phosphorus has to do with keeping it in cycles, but out of the ocean. And it is equally important not to concentrate it in agricultural systems or water bodies.

4.3.1.3.2. Designing a Nitrogen Cycle

In the nitrogen cycle, the compartments are the atmosphere, vegetation, forest floor, and mineral soil, while the transfers are precipitation, throughfall, leaching, litter fall, mineralization, fixation, and denitrification. Each compartment keeps the nitrogen for a certain time, termed the residence time; for a hardwood forest floor, for example, residence time is about 17 years. Human interference in forest cycles can collapse the residence time; for example, clearcutting alder in Washington State causes very high nitrogen losses. The nitrogen cycle is affected by pollution, especially from the addition of nitrogen to the soil in fertilizers. Fertilizers can be reduced in scale through the promotion of healthy soils.

We have to make sure that nitrogen is abundant, but not overwhelming. The nitrogen flux is not particularly high. For the nitrogen cycle, we need to keep the transfers, such as precipitation, throughfall, leaching, litter fall, mineralization, fixation, and denitrification, moving. We need to make sure the compartments of the nitrogen, that is, the atmosphere, vegetation, forest floor, and mineral soil, are optimally full.

4.3.1.4. Designing Ecosystem Cycles

The scale of the system defined, for example, wooded patch, ecosystem or temperate broadleaf forest, depends on the scale of the phenomenon being addressed. Mangrove forests are in phase with the frequency of hurricanes, although hurricanes may not influence the life histories of short-lived organisms as much as daily or seasonal cycles. Microbes, for instance, are affected more directly by short-term cycles of precipitation and temperature.

4.3.1.4.1. Savannas & Elephants

To keep many cycles operating, we could restore key species, such as elephants, that shape whole landscapes and push the cycles in a healthy direction. At this time, however, we are threatening elephants with extinction. Tens of thousands of years after humans saw and coveted the ivory of elephants, people are still hunting elephants, until the species is threatened with extinction. Ivory is still use for medicine and art, for paperweights and billiard balls. Poachers take pictures of the dead elephants, perhaps as memories or trophies in themselves, since they sell the tusks. Conservationist take pictures and make films of the dramatic living elephants to show how impressive they are, not just physically, but emotionally and socially. We recognize the emotions in them, as well as their struggle to survive our nonstop invasions of their habitats to plant fields and build houses for our communities.

It has proven to be impossible to stop the demand for elephant tusks. There is a thriving trade in these tusks. It is supported by the fact that poachers can make much more money killing and harvesting elephants than they can by farming or making artifacts or tools. Partly, this is a flaw of the economic system. When everything can be traded for money, that is, symbols of real wealth, there is no connection to the sources of wealth. Partly it is a flaw of culture, that values 'real' ivory, although the plastic and chemical forms are quite the same. And, partly, it is because people believe that they need the 'real' thing to be fertile or artistic. We have tried ways of saving elephants: United Nations Animal program; International law; International opinion; values related to cultures; penalties for ivory trade; restrictions on hunting. Rationing might be tried. But, none of those seem to have been effective. Regardless of our design sophistication, elephants cannot be saved if humans do not stop spreading out into their territory. Elephants cannot be saved if there are too many people making demands on them. Elephants cannot be saved if humans approach them with inappropriate images as pets, slaves or machines). The image of a machine with interchangeable parts is ridiculous and incomplete. Elephants cannot be saved if we cling to our detachment and remoteness, watching violence and misery behind a glass wall of television. Elephants cannot be saved if humans cannot acknowledge and enforce limits and rules.

Elephant saving campaigns are not really constructive in the sense of architectural or educational campaigns because they are defensive. Furthermore, what is defended is, first, in the process of change, so it can not be saved as it is; second, it will always be vulnerable; third, it is an ambiguous concept misperceived by opponents; and fourth, it is ultrahuman. What is to be saved is the potential for evolution of uninhibited development of the in its ecosystem. Animals do not need to be saved from natural death, a great regulator of life, but from unnecessary suffering, experimentation, and premature extinction. We do not seem to have the will to protect elephants. Until there is a dramatic shift in perspectives and awareness, until elephants have legal or ethical standing, until dangerous historical traditions can be discarded without destroying a culture, elephants are doomed.

At end of the recent Ice Age, elephant-like mammals roamed on every continent, except Australia and Antarctica. But, they disappeared from 90 percent of their range later, with climate change and human hunting. In Africa there may have been ten million elephants, 20 times recent numbers. In India, there may have been 2 million, again many more times the remaining numbers.

African elephants eat anything, preferring tree leaves. They can destroy trees quickly, trampling seedlings and small Acacia trees. And they maintain the savanna with their dislike and exploitation of trees. By late 1800s, elephants were almost totally wiped out from the Serengeti by ivory hunters. Much of the Serengeti was dense forest. The Masai had abandoned it because of the tsetse fly. Colonial administrators set it aside as a park. When elephants returned in 1955, the forests started to retreat and grasslands advanced. The Masai returned with their cattle. It was thought there were too many elephants. But, elephants are ecosystem engineers, reshaping their landscapes. This results in changes of species. Lizards lose out, but antelope and zebra prefer elephant savannas; and lions and other predators prefer antelope and zebra. Elephant droppings are rich in undigested plant seeds and elephant-made waterholes help other animals.

Despite adequate rainfall and good soil, elephants kept trees from encroaching into the savanna. Likely megaherbivores shaped the grassland character of much of the planet towards the end of the Ice Age. Elephants tamp hard paths that other animals used. Elephants can make caves to mine salt; the caves are later used by leopards and bats. There are ripple effects (cascades) with animals in a food web. Leopards that get porcupine quills are more likely to hunt humans. Most involve predators. Without Elders to keep them in line and show them water holes and routes to food, young elephants can get violent and lost. Elders are necessary for animal social structure, and memory of the best paths for food or migration. Young elephants relocated without elders started killing Rhinoceros (their musth period had also extended). Until recently, there were Indian elephants (and tigers) in the Western Ghats in India. Many of these elephants are captured in the wild and used for heavy moving and carrying. There has not been enough time for the systems to react to their absence and shift away from mature vegetation.

Because of their size, food intake, and social structure, elephants define the savanna, bush or forest ecosystem where they feed. They need extensive land areas to browse for food. The population of African elephants has been halved in the past 30 years as farmers take over their territory and hunters kill them for parts of their anatomy. Habitat loss and poaching are severe threats. Territory needs to be set aside for or shared with elephants, with as much coverage of African habitats as possible, and with corridors connecting individual reserves. The population should be encourage to be at least 1.3 million, about the population in 1970, and possibly 2 million to rewild significant areas. Likely, tourist income would more than make up for farm destruction in shared lands.

Indian elephants could be doubled from about 28 thousand to 56,000; they could continue traditional movement patterns and shift vegetation, especially in southern India, where groups could be combined. Smaller numbers in southeast Asia might be increased to 20,000, but smaller populations are vulnerable to habitat conversion and might need formal parks, especially in Myanmar, to avoid further fragmentation. We need more elephants working for a healthy planet!

4.3.1.4.2. Ocean Patterns & Whales

Instead of trying to create certain patterns of cycles in the ocean, it would be more prudent to restore animal populations and let the animals recreate the desired patterns. For instance, whales could geoengineer parts of the ocean. And, this would have effects on carbon dioxide as well.

In some coastal areas, such as Norway, whales could be reintroduced to their historical ranges. Minke, Humpback, Sei and Orca were native to the North Sea. Algae blooms provide nutrition for zooplankton and pelagic crustaceans—copepods, amphipods, and shrimp, which supported whales, as well as seals and birds. The Norwegians hunted whales for thousands of years. By restoring whales to their waters, after so many decades, Norway could take pride in restoring a healthy ecosystem that people, including tourists, could really see and admire. And, the resulting richness might allow some small amount of exploitation of many other species, especially of fish. Some species, such as whales, might not be used at all, but that was an ethical decision that only the Norwegian people could make.

Whale populations could do more than any artificial geoenginneering scheme to respond to carbon dioxide increase. When Antarctica's great whales were nearly wiped out by the 1960s, the krill population plunged instead of swelled. Whales produced the conditions for krill to survive; their excreta supported the plankton that krill ate. Furthermore, whales excrete iron-rich plumes near the surface, where the plankton fix CO2 in large quantities. The plumes sink downwards; the iron filters through the food chain. Other whales like Sperm whales eat iron-rich prey like squid and drive a similar cycle.

This natural cycle of predation anticipates a geoengineering suggestion for fertilizing the ocean with iron, so diatom plankton would take up the iron and carbon dioxide, bloom, and die and sink to the bottom, sequestering 1 billion dollars of carbon trading, but with geoengineering costing $2-500 per ton of CO2.

The current 12000 sperm whales draw 50 tons of iron to the surface, J.B. MacKinnon calculates, and in a year remove 260,000 tons of carbon. When many whales die they sink to the bottom, and are fed on by scavengers in a bottom cycle, keeping the carbon out of the upper cycle for hundreds or thousands of years. There are ten more species of great whale, including right, humpback, and grey. Depending on accurate numbers they could fix possibly 30 million tons of carbon. Adding large fish like whale shark and sunfish, and predatory fish like shark, cod, and tuna, many of which also sink at death, greatly increases the amount of carbon fixed.

Prewhaling numbers were roughly 120,000 Sperm whales, which would have removed 2.4 million tons of carbon (worth $20 million MacKinnon figures). Prewhaling numbers of Blue whales were possibly over a million; they would have captured tons of carbon. Precatch numbers for the other whales and large fish are estimates, but the numbers are very high. All of these animals would be fixing carbon, and many would be returning it to the sea bottom, although the actual numbers are fuzzy, due to beachings and human takes. In carbon trading terms, a rough guess is $13 billion per year (at a much lower cost than geoengineering and a much higher return).

Obviously, we should rewild the oceans and hire the whales and fish to fix carbon. It would be cheaper, although a ban on most fishing for 20 years could cost (out of a gross of $85 billion, estimated by the Pew Group), $60 billion a year in temporarily lost income—a heroic sacrifice to be sure, but then our industrial vacuuming caused the problem. Eventually a healthy renewed ocean could easily support an estimated 1.75-2 billion people on an indefinite basis (this is a calculation for an optimum, not a maximum of 3.45 billion). It would be impossible to support the current population of 7 billion or even 3.5 billion at a minimum survival, much less a generous level of luxury. The value of the fishing in a healthy system should go above $50 billion per year, although that could be higher with more valuable fish in an ecological economic system.

It is also more ecologically sane and naturally renewable for the long-term. The aesthetic value of whales and fish is apparently much higher than the ecological value. Tourist interest translates into additional billions of dollars for community economies. Total tourism dollars for 2009-2013 was over $1.3 trillion USD (World Bank numbers); Since the bulk of human population lives within 135 kilometers of the ocean, a healthier ocean could generate conservatively over $200 billion USD per year. We need more whales!

By reintroducing whales, we can bring back some of the functions and some of the colors of the ocean, but it will involve sacrifice. We will have to change our diets. We will have to restrain our appetites. We may go hungry sometimes and live on less wholesome and reduced varieties of food.

Because, in order to rewild the ocean, we will have to stop 90% of our fishing. That means no factory ships. It means no ocean aquaculture or mega-engineering of ocean fisheries. It will be hard on cultures that depend on the ocean, but if we don't do this now, the oceans themselves will be harder on those cultures; there will be nothing to catch!

We have almost ruined the ocean, as we used our finder technology and mining techniques to strip entire fish and bottom communities. At one time, Grey whales swam in Vancouver Harbor; within 40 years they had all been killed. Eighty species of fish are absent from the New York area. The first species to disappear from the Wadden Sea were whales. Grey whales in Atlantic were wiped out. Then northern right whale. When Antarctica's great whales were nearly wiped out by the 1960s, the krill population plunged instead of swelled. Whales had created a good environment for the krill. In the North Atlantic, biomass has declined by 97 percent. As stocks collapse, fishing collapses.

Paul Watson says we are eating the ocean alive, although fish harvests are not growing anymore. We are polluting it with toxic chemicals and wastes, that also cause acidification, which is hard on shelled animals and plankton. In the 'Economics of Extinction,' it pays to kill everything to justify the technology investment. Furthermore, fish like Bluefin Tuna become more valuable as they become rare. The last fish will likely fetch a million dollars. The concern is profit, not a living sustainable resource.

The damage is so immoral that denial of our slaughters is useful for us to retain our sanity. We are innocent of recognizing the truth. The sense of loss from destructions and extinctions would be hard to bear. But, the knowledge seeps into consciousness slowly. And, the only way to assuage it, is to allow the ocean to rebuild by removing our catastrophic interference. Unlike the land, we do not need to live in the ocean and we do not need build new ecosystems. All we have to do is let it repair itself. We could, and should, restore most of the reefs and shorelines. This is only intelligent self-interest.

No one has developed a model of the historical abundance of the entire world ocean.

No way to guess how many fish could be taken below limits of decline. Perhaps in the future, we could inventory the oceans and determine how to exploit a percentage of a population without destroying it or its habitat. In this case we have to conserve the entire ocean ecosystem by withdrawing. Moreover, rivers play an important part in regional and global biogeochemical cycles, by transporting materials to the ocean. Ninety percent of the landmass drained by rivers. Since river systems discharge nutrients, we would have to restore the rivers, many of which barely reach the ocean. This means increasing the water flow to previous levels, by allocating use and if necessary rationing water use.

In ten or a hundred or more years, depending on the ages of some fish and aquatic mammals, we might start taking fish carefully, noting which populations are stimulated or depressed by the percentage of harvest. The catch over the entire ocean may be less than half of the current mass vacuuming. We will have to reduce our waste and value the fish that are eaten. Perhaps, we have to deny fish to domestic animals as a food supplement.

4.3.2. *Conclusion: Designing to Adjust to Change*

We could design our impacts on cycles so that the cycles would continue. We could design civilizations to avoid collapse. Such designs would have to determine optimum areas for wilderness and food-producing areas, then relate the human population and intensity to that. That would involve setting goals. Then we would have to survey and monitor resources and ecosystems. We would have to figure out how to make budgets for all foods (maybe in terms of kilocalories), then make their budgets and follow them.

For instance, to address atmospheric warming, we could create a series of local carbon budgets, within a planetary one. First we would set up an emergency budget, using carbon totals from 8000 YBP. This would sharply decrease carbon emissions. Then, figure a second budget with carbon emissions from 1400 or 1800 CE for 10-50 years later. Finally, we could install a permanent budget, by calculating a world cultural carrying capacity (CCC), based on ecosystem productivity and population goals. We would sum all capacities and assign that to be 100%. For example, if China has 13% of the CCC, then it would get 13% of the carbon use at 8000 BP levels or at whatever level was decided on.

We could revise corporate rules to increase the benefits for people and ecosystems. All corporate CEOs have things in common, even those of energy companies: Responsibility to a board, shareholders and employees. The benefits of Contraction & Convergence, a suggestion by UK politician Aubrey Meyer, is this: Everybody has an equal right to pollute with greenhouse gases. This right could be traded, similar to those outlined in Kyoto. Under a global C&C agreement, citizens of the US would have to buy or trade carbon credits from poorer countries where people use a hundred times less. Meyer suggests three steps. Reach an international agreement on a cap on atmospheric CO_2 concentrations. Then, estimate how to cut back to that goal, Then, divide the budget among the worlds population on per capita basis. But, that last step would not work; that is why it should be based on a carrying capacity number, as above—otherwise the system would reward fast breeding. Furthermore, the target number should be set much lower than the goal, in order to reduce increased use.

We understand that many factors can potentially cool the earth: Growing trees take up CO_2; the sedimentation of plants in water or soil; dust and jet contrails, and DMS (dimethylsulfide) evaporation into the atmosphere from ocean algae. DMS is the most abundant single biological sulfur compound emitted to the atmosphere. Emission occurs over the oceans by phytoplankton. These atmospheric DMS aerosol particles or droplets are oxidized to sulfuric acid and act as cloud condensation nuclei. Through this interaction with cloud formation, the massive production of atmospheric DMS over the oceans may have a significant impact on the Earth's climate.

We need a push for immediate action. Right now, we have problems agreeing on anything. Will a grave emergency alienate those who do not recognize it or care? Or will it galvanize them into acting? There are many things we can do, from small things, to effective things, to heroic things. We can regulate our lives, especially the three Cs: Cattle, cars, and chain-saws. What kind of things can we do? There are five small things, of course, and these are heavily recommended and advertised: Save energy with better light bulbs; Drive less, travel less; Consume less, consume smarter, and stop using CFCs; Conserve more land; Suggest changes, and participate in making changes.

In addition, there are five effective changes that are more difficult on a personal level: Stop eating meat; Share tools and machines; Stop deforestation and plant millions of trees; Reduce conversions of wild systems to croplands or pastures; Change the tax structure.

Then, there are five heroic changes: Reforest regions; Turn off the air-conditioning; change energy generation to alternate sources like solar or wind; Stop building new houses; and Participate in a Jeffersonian revolution.

Reducing human population would make everything else easier. We could start by having a year of consideration, where no children are planned. We could base population on the constraints of ecosystem and cultural carrying capacities.

We could cut our wastes dramatically, simply by using less and sharing more. We could place waste in the context of industrial ecologies.

To reduce the chances of anthropogenic atmospheric heating from carbon dioxide, we could start a carbon budget for the planet, by decarbonizing the power grid with solar, wind, and other sources; we could ban new coal-fired plants and regulate existing ones; we could extract CO_2 from the atmosphere by planting trees under permanent agriculture. We could allow major fish species to recover, for health and to fix CO_2; we could rewild grassland biomes with major mammal species for the same reasons.

We could retract many of our transportation networks, especially parallel roads and logging roads. We could cut transportation by half, by not travelling as much or as ignorantly. We could optimize transportation; cars could get 50 mpg or better, by increasing the number of hybrid or solar cars. Trains could be solar or electric. Ships could return to sailing, perhaps the clipper ships, especially for cross-ocean trips. Airplanes could be grounded for two days a week.

We could stop expansion of urban and agricultural areas. We could severely reduce the conversion of wild ecosystems and preserve larger wild areas; and, we should preserve wisely, with north-south ranges, as well as regular, wide corridors to connect wild areas and allow animal populations to exchange individuals, even through cities and fields.

We do not need to protect regions or the planet as much as fit within its limits and healthy cycles. The cycles are connected in many ways, such that we need to refrain from interrupting them. Making natural cycles and processes visible brings the designed environment back to life. Effective design helps inform us of our place within nature.

4.4. *Local Design Factors: Forests*

By Twila Jacobsen, Mike Barnes, and Alan Wittbecker

Forests emerge from the planet and make it a forest planet. Most of all biomass is in forests, and forests hold a large percentage of all species. Forests participate in biogeochemical cycles and moderate the climates of the planet.

4.4.1. *Local Goals for Forests*

Forests have been treated badly for the past 11,000 years. We have destroyed them for their resources and replaced them with fields (on purpose) and deserts (by accident or stupidity). Now that we realize how important forests are for the health of species, systems and the planet, we must set goals so that we can know what to conserve, preserve, or restore.

Local goals are appropriate for watersheds and habitat types. Educational and manufacturing are presented on the local level, due to cultural differences. The following goals are not exhaustive; please add to them when you can.

- Measure the productivity of all forests to contribute to a regional or global inventory, from which to make intelligent decisions
- Reforest formerly forested local lands
- Preserve all small old-growth areas
- Protect the long-term health, integrity, and ecological balance of forests, that is, the ecological and evolutionary processes that make forests
- Work with indigenous peoples to get control for them of their forests, which are often an important part of their culture
- Protect local water and air sheds
- Provide habitat for all species, since all species contribute to the functioning system, even agents of disease
- Develop and maintain, through monitoring and intervention, demonstration forests so that people can see working models of ecologically responsible forestry in wild forests
- Manage commercial forests for permanence and sustainability

- Provide exclusive areas for recreation and aesthetic appreciation
- Achieve true multiple use by strict regulation and rationing
- Set up land trusts for intergenerational protection
- Abolish clearcutting; end overcutting; focus on selection systems
- Restrict cutting on private lands to less than natural reproduction
- Test and promote appropriate harvesting methods for selection
- Research and implement optimum combinations of roads and trails
- Rehabilitate land under unnecessary roads

- Protect the health of human communities
- Open communications with all groups working in the forests
- Develop paths for public participation in forest land use decisions
- Broaden local economies from timber cutting—timber employment fell 15 percent between 1979-1989, a time of record cutting levels and record income
- Set up cooperatives to refer and share work
- Combine forest and agricultural crops where appropriate (tree crops or permaculture)
- Calculate wood needs (for building, cooking and heating) for a stable local population

- Tax timber and products so benefits stay local
- Expand local capital in forests
- Diversify local institutions that deal with forests
- Encourage survival of small, forest-based communities

- Increase manufacturing efficiencies above 75 percent (50% world average, 67% in Japan, 40% in Thailand)
- Promote the full use of forest products; support small-scale businesses that produce new, high-quality wood products
- Recycle wood products, from furniture to utensils
- Reduce the demand for wood products, especially paper and discardable items
- Reduce the demand for wooden buildings, the source of most demand, by encouraging native building products, such as adobe, stone, ice, and thatch (better adapted to conditions anyway)

- Present ecocentric forestry (with its paradigm shift and new metaphors) to institutions, groups, and individuals
- Educate all people to feel their connections to the forest, because, until they feel them, they will not act ethically or ecologically
- Educate people to realize that long-term sustainability requires healthy forests, and that protecting forests protects jobs
- Educate and train practitioners in the science, art, and techniques of ecoforestry (literacy, numeracy, ecolacy, and imagacy)
- Develop criteria for ecologically responsible forest uses, as well as standards for certifying ecoforestry practices and products
- Work to incorporate findings from practical and theoretical sciences into a unified knowledge of forests
- Resacralize forests—desacralization is a defense mechanism against loss of meaning—by emphasizing the meaning of wild forests.

4.4.2. *Design Considerations for Forests*

Shapes are as important as coverages. Location is critical, as soils are important. To restore the extent of forests before a nonarbitrary time, e.g., before 40,000 years before the present (before extensive fire use) or 10,000 years before the present (before extensive agriculture) or even 500 years before the present (before industrialization), decisions about replanting, or even relocation of cities and roads, have to be made.

4.4.2.1. Location

Forests thrive on good soils; some forests can do well on fragile, unproductive soils that are too thin, cold, wet, or rocky, if they have time to develop. Unfortunately, many cities and other human habitations have replaced forests on good soils. By building cities on poor, rocky soils, and by expanding agriculture into cities, especially rooftops, a greater area of good soils could be left for forests

4.4.2.2. Shapes

The shape of a forest can influence the numbers of tree fall from storms, the amount of active interior space, and many other parameters. The shape can determine the total area. Currently most shapes are the result of cutting and conversion; even plantations seem to be rectangular to simplify future harvests. Designing the shapes according to the topography and with regard to the goals of the forest could improve the health of forests. The space between trees influences the kind of wood growth and branch patterns. The space between forests influences the amount of genetic exchange.

4.4.2.3. Restoration

Many of the local and global goals require restoration. But, is that a good idea? What is weak about restoration? What are we restoring? An ideal? Richness? Context? Function? Patterns? The past configurations? Are there too few parts? How large an area is needed? Do we need places for DNA, zoos, parks, and cryogenic labs, if we cannot save the entire forest?

We need to start to plan for future biotas that may be less beneficial for humanity and more necessary for forest and planet health. Many of these will be restored or assembled from exotics, reintroduced natives, or engineered species. What are we restoring when we restore an ecosystem without all the parts or even good knowledge about the ones we have? Ecosystems are not built by selection in the same way that organisms are. Their irregularities are caused by external forces and constraints. Although the components may appear erratic, they seem to be organized in predictable overall patterns. So, we can guide restoration.

Restoration projects have the potential to save entire ecosystems. The intensive management of (usually) small areas could restore sets of species critical for forest functions. Landscape ecology and island biogeography can identify candidate ecosystems for restoration, and candidate ecosystems for preservation, conservation, or reservation. Conservation biology and ecoforestry recommend how to restore clearcut areas: Replant with native species; restore damaged streams and wetlands; restore natural connections and corridors.

Radical ecology can calculate the optimum amount of wilderness to preserve the natural cycles indefinitely. If the current wild area is less than the calculations, restore the difference and set it aside as a preserve. Restoration areas, which are set in a pattern by human activity, but may not need further intervention.

Forests start from bare land or reestablish their range at various scales (after an ice-age for instance) or continue through the death of individual trees or shift into different kinds of forests. Natural forests often contain small relatively even-aged stands of trees. This can be observed regularly with old-field restoration, where planting continues over several decades and, where a forest surrounds the fields, natural regeneration continues.

Part of any management scheme must be to improve local and global supplies of wood by replanting and caring for forests. Ecoforestry management could help re-establish forests on heroic scales. R.A. Houghton (1990), for example, has suggested that there might be as much as 3 million square kilometers of once-forested, now-degraded land in Africa, 1 million in South America, and 1 million in Southeast Asia. Even North America could probably benefit from a million square kilometers or two of restored forests.

Even industrial forestry is concerned with restoration. Management is now considered necessary to restore trees to previously forested areas, to preserve the genetic information in forests, and to iron out the boom and bust cycles of wild nature by controlling environmental factors, such as mineral deficiencies, as much as possible. Furthermore, federal management assumes that it must set standards for knowledge and development that local communities might not have.

4.4.2.4. Design Cost Considerations

Design may be costly. Restoration may be more costly. For example, grassland restoration costs about $1500 per acre per year, based on the first two years. Forest restoration costs more. The cost of the design itself could be significant, at $300-400 per acre. Design may take a long time—longer than human lifetimes. How does this cost compare to expenditures on ice cream, make-up or medication for erectile dysfunction?

The forest may be too complex to design. Consider a thought experiment about how to design a forest using artificial pieces, such as giant sponges or shade cards. The experiment could make people uneasy, possibly because it was absurd or too complex. How do we design a forest, a complex, self-making, self-sustaining wild forest? Management has to recognize the limits of design. Limits of ecological design include:

- Forests are wild, we have no real control
- The scale of forests is too large to manage everything
- The longevity of forests is too long, we will never complete the design in human lifetimes
- The costs may be prohibitive—indeed, we have depended on the free goods of forests for economic advantages
- Other human limitations apply to our ability to see and understand the forest.

Most forest designs will not be restorations, because of the uncertainty about the kinds and associations of native vegetation. Furthermore, humans are now an large part, although not yet an integral part, of the system; therefore it could not be restored to a premodern or prehuman state (and even if it could, which state?). This design is not the biotechnological design of a new ecosystem, either; we cannot accurately control and predict ecological events in most ecosystems. However, we can steer some of the events in a known direction—known because we have historical records of the system, although not complete. We can also reduce those human activities that we know alter the conditions of the forest, such as overcutting and pesticide use.

Although ecological design attempts to restore some kind of balance, the balance does not exclude human activity. Rather, it integrates it into the larger community. A moderate number of human impacts can be absorbed by the system—too many interferences destroy the systems capacity for self-maintenance. The design should be open to evolution and to human technological and social development. The design should be based on a model of ecosystem functions, considering diversity, complexity, and the maintenance of natural process—natural here meaning a self-sustaining system composed of elements now lost through human disturbance.

The goal of ecological design is not to restore, but to revitalize and reinhabit forests. We do not want to live in the dead bones of a mechanistic failure. We want to live in a healthy environment with aesthetic appeal, which is a requirement for human health. Every forest has physical, biological, economic, and political characteristics. The design, planning, and management for a forest describes the system in a comprehensive interdisciplinary approach, using dynamic concepts such as feedback and stability, recognizing limits to change and sustainability with different levels and scales of structure and function in an anticipatory, flexible planning approach, recognizing human and nonhuman goals, and incorporating personal and institutional interests.

4.5. *The Restoration and Destruction of Altazor Forest*

On a large scale, Altazor forest is situated in the low mountains and foothills between the Okanagon Highlands and the Bitterroot mountains. The forest occupies part of the ecotone between the Palouse grasslands to the East and the montane coniferous forests to the west. The forest is located in northern Idaho between Viola and Potlatch (once home to the largest sawmill on earth—in fact, one building and a porch at the office were built from that mill after we helped tear it down). Altazor has a unique combination of geomorphology, soil, climate, flora, fauna, history (of disturbances and development), and cultural ecology. The forest is on the north slope of a small range than includes Moscow Mountain and The Twins, with north-running ridges, in the Northern Rocky Mountains physiographic province. The elevation ranges from 3100 to 3650 feet. Soils are loamy, with loess that have been strongly influenced by volcanic ash, which has made them productive. Precipitation occurs mostly as rain in the winter, with regular snow. June through October is dry. Humidity is low year round. The climate is maritime-influenced, with the Mediterranean climate on the Palouse grasslands to the west. Adequate soil moisture is generally present during the growing season on all but the most severe sites. Annual average temperatures range from a minimum of 30 to 58 F (-1 to 14 C), with a mean temperature of 44 oF (7 C). The warmest months are July and August. The growing season generally lasts for 45 to 120 days.

4.5.1. *Ecology of the Altazor Forest*

The forests are dominated by fir, with a diversity of pines. Principal tree species include Douglas-fir, hemlock, cedar, and grand fir. Vegetation is characterized by the Douglas-Fir series at lowest elevations followed by the Grand Fir series, Western Hemlock and Western Red Cedar series, and the Subalpine Fir series with increasing elevation. The Douglas-Fir and Grand Fir series occur on xeric soils, with the Grand Fir series occupying slightly cooler and more mesic habitats. The Western Hemlock and Western Redcedar series occur on soils with udic regimes. The Subalpine Fir series occurs on cryic soils. Quaking aspen, willow and scrub oak occur near streams. Large shrubs, such as ninebark, are common, especially under Ponderosa pine. Very few areas of 'virgin' forest still exist, due to recent harvesting and to thousands of years of native use and modification. There is a profusion of wild flowers throughout the growing season. Grasses common. Foothills prairie with wheatgrasses, fescues, and needlegrass occurs in the drier west slope valleys.

Animals include white-tailed deer, elk, black bear, moose, bobcat, and mountain lion. Rare mammals, largely gone, include woodland caribou, gray wolf, lynx, beaver, fisher, and wolverine. Numerous resident birds can be observed, including several raptors and hawks. Some seasonal migrants appear. Birds are typical of the forested portions of the Rocky Mountains. These include rufous hummingbird, Steller's and gray jays, common raven, varied thrush, mountain bluebird, solitary vireo, Townsend's warbler, western tanager, and red crossbill. Birds near their extent are spotted owls (sometimes replaced by barred owls), hawk owl, boreal chickadee, red-eyed vireo, American redstart, and white-winged crossbill. Herpetofauna include the Coeur d'Alene salamander, the spotted frog, wood frog, Pacific treefrog, western toad, and long-toed salamander.

Most conifers do not rely on insects, birds, or mammals to distribute their seeds, so there are fewer plant-animal interactions than with flowering plants. However, insects, birds, and mammals create and maintain strikingly diverse interactions in coniferous trees habitats. Most insects in conifer forests are considered pests. Moths and butterflies are highly destructive, as are spruce budworms, although their activities drive the selection and health of the forest. All coniferous forests have some level of insect infestation. Vigorous trees use sap and other compounds to defend themselves and are rarely damaged. Fire suppression and poor management make trees more susceptible to insect outbreaks and lead to forest decline.

Birds in coniferous forests eat seeds and inadvertently help to plant trees. Clark's nutcrackers and Steller's jays usually collect more seeds than they eat and the leftovers can germinate. Insect-eating birds such as chickadees, nuthatches, and woodpeckers help to control insect populations; often they live in dying or dead trees. Owls and hawks live there.

Mice and squirrels are the most common mammals. During the summer, these animals eat buds, berries, seeds, and even bark. Squirrels collect cones. Not all these seeds are eaten, and some can germinate into new trees. Deer, elk, mountain lions, bears, and other large mammals do not consume significant amounts of seeds or foliage, although bears can savage bark in the late winter. Porcupines can chew completely around a tree and interrupt the flow of sugars from leaves to roots, killing the tree—the only nonhuman mammal known to do so, and at Altazor, they kill 6-10 trees per year.

Coniferous forests have a natural fire cycle. The recent policy of total fire suppression has resulted in changes to the composition and health of coniferous forests. Without fire, open stands of ponderosa pine were invaded by dense thickets of Douglas-fir and lodgepole pine, which has happened at Altazor. The Ponderosa pine is a pioneer species on the western slopes and in the ecotone with the grasslands. Insect outbreaks became common and fuels began to accumulate on the forest floor. Fortunately, there is no evidence of unmanageable and devastating fires in recent times here.

Historic fire events have changed a large portion of the forest. Native peoples, such as the Coeur d'Alene or Palouse used the area for hunting; they also burned to select some plants such as willow and False Morel mushroom. Changes are periodic and range from high intensity, high severity, continuous fires to low severity, infrequent fires. The composition and successional sequences of some communities changed due to harvesting practices of timber companies from the 1910s to the 1950s. Some domestic animal species, such as cattle and dogs, were introduced into the lower slopes and valleys. Wide fluctuations in moisture and temperature for periods of years result in significant changes in biological communities. Insects and diseases, especially of pines and firs, are frequent disturbance features.

In deeper time, pollen cores support the recent arrival of some species, such as western hemlock (*Tsuga heterophylla*) in northern Idaho in the northern Rockies within the last 2000 years. The presence of Douglas-fir (*Pseudotsuga menziesii*) in Idaho suggests that they have been around a long time. In the drier regions, Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) are common. Population histories of endemic species like Constances' bittercress (*Cardamine constancei*) suggest that Northern Idaho was a refugium for plants during the last ice age, and Northern Idaho may resemble a museum of such plants. Populations in the different river drainages, such as the Clearwater and St. Joe, just north and west of Altazor, are different from each other and represent separate refugia that maintained disjunctive variations throughout glacial and interglacial cycles. This endemic variation should be conserved by a combination of preservation and forestry practices.

4.5.2. *Altazor Human History*

Human groups have occupied this area possibly for 12,000 years. For the last 5,000 years, groups spent much of the year in river-oriented pithouse villages of 30 to 300 people, who caused small-scale, local ecological effects. Hunting, salmon fishing, and root and berry collecting were the primary economic activities. They were also the backdrop for much of the social organization and spiritual beliefs. Hunting and fishing were important not only for the sustenance, but for their style and meaning. Burning (both intentional and otherwise) to improve plant growth for berry crops and big game forage was common; however, hunting pressure prior to Euro-American settlement may have contributed to the extinction of the Columbia Basin bison population (never a large population at any time in prehistory). Later, bison populations moved east of the Rockies and never returned.

Trees were used by archaic peoples for houses, canoes, toboggans, and containers. Firewood was used for cooking and warmth. Trees were used respectfully. The same attitudes and practices of hunting applied to the use of trees, which, like animals, had spirits with the power to help or hurt humans. The leaves, for instance, were voices. The voices could cry out and seek revenge or speak to the Great Spirit. Before taking anything from a tree, an offering—thanks or tobacco—was given. Indians gathering bark, for example, were careful to strip only one side of a tree, so that it would not be girdled and killed. Firewood was taken from dead trees.

Archaic peoples (or first nations or aboriginals) used forests for shelter, clothing, and fuel, most likely without great impact. They also used forests without having an explicit division of thought devoted to forestry. Then again, they did not need to. Their attitude and behavior toward "standing peoples" was based on their cultural rules for "living together" with other beings—or what philosophers and academics call ethics.

Euro-American settlement and exploitation of the area began in the mid 1800s and intensified between 1875 and 1925. Historic activities—including lumbering, railroad construction, dam building, grazing, wheat ranching, and irrigated farming—have all created ecological effects on plant and animal species and other resources that far exceed most of those from prehistoric times. Parts of the forest were cleared for agriculture in the 1930s. Crops such as wheat and barley were planted in fields next to the forest. This required pesticides to keep the forest pests, such as aphids, from consuming the crops.

4.5.2.1. Recent Economic History at Altazor

My tree-farm partner, Jacob Hagen, worked for Ohio Match in the 1920s in northern Idaho when they were cutting white pine for clear, strong match sticks and was able to provide direct knowledge of Ohio cutting practices. This local forest was cut in 1930s and again in the 1950s or early 1960s. This last time, the cut was to pay taxes, before Hagen bought it in 1966 (the bank refused to lend him money for 'waste land' at that time, so other arrangements had to be made). A 20-acre contiguous addition was purchased by Carolyn Hagen in 1973, when the original owner needed to pay for his divorce. I became a partner in 1974 and bought an additional 5-acre contiguous addition and rented 15 acres from a neighbor to the west. I had intended to apply radical (from the Latin word meaning 'rooted') ideas to this forest, but as I worked slowly, I realized that many of my ideas were inappropriate. When the three of us were surveying the land, we found three separate mill sites with large slabwood piles (which we later used for firewood). We also found a trove of mill and saw parts.

Based on the evidence of stumpage, cutting patterns, and mill sites, the harvests between 1931 and 1960 used single tree or group selection. Certain trees, such as white pine, were cut first; some large western redcedar and Douglas-fir were also cut. Many legacy trees, often with some flaws, were also left. There is evidence of downed woody debris. Snags may have been left—it was difficult to tell. By 1974, there were many snags existing.

We started cleaning the forest in a haphazard way, cutting snags for firewood and rebuilding several trails. Occasionally, we cut trees with mistletoe. We did not have a plan for cutting for a certain size or health. We made a nice picnic area upslope from the pond.

4.5.2.1.1. Building a Mill

Jacob used many tools, including hacksaws, wrenches, bench planes, pry bars, and screw drivers, that were made by his father, Anton Hagen, a master machinist with the Ohio Match Company—everything he made had perfect wooden handles, even the pipe wrench. He also used some of the tools he built himself, including a cut-off saw and a planer (from an old jointer). Some of the tools were built from other tools; others using steel, wood, and recycled pieces from old cars, tractors, and mills. Unfortunately, I did not continue this tradition very well so far. I did make a crowbar and machete out of car springs from a 1938 Austin that had been rolled over the hill. We built our own mill, with those tools, over three summers. Our mill was first driven by a steam tractor that he had helped to rebuild (Figure 463211-1), then by a tractor diesel, and finally a 1970 Ford 390 engine. We also rebuilt two smaller steam engines that we used to generate electricity.

When we first started cutting together, we used a two-man crosscut saw that we found in a slabwood pile at one old (1930-60) sawmill site—in this area people built many small mills, at least three on our 75 acres—by the way, felling with this saw is basically the same as with a chainsaw, only you use an ax to cut out the notch after the undercut is done with the saw. Although it was much quieter than the old pioneer chainsaw we used, we got too old, tired anyway, to use it on a regular basis. I bought a Swedish bowsaw (also called a log saw) so that I could cut small diameter trees without the noise of the Echo chainsaw I had bought about the same time. I also used pruning shears (several kinds), loppers, cross-cut saws, wooden ladders, chains, ropes, and axes. I had a number of axes, including a Double Bit Axe, Hunter's hatchet, and a Wedge Felling Axe—the back of the ax is a square wedge called an American wedge—other classic wedge patterns include Canadian, Jersey, Kentucky, and Michigan.

Tools need attention and care. A tool, remember, is a technological extension of the human body. As it is an extension of your body, you should treat it with as much respect (as we are an extension of the land, land also deserves such respect). This means constant attention and care. The ecologist Garrett Hardin noted that an exosomatic (external to the body) adaptation brings a corresponding degeneration in the endosomatic function, e.g., knives permitted us to hunt animals, dig deeper roots, and cut our food, but the long-term anatomical result is a partial degeneration of the human jaw. Possibly feller-bunchers contribute to our remoteness from the forest. To some degree tools change us. Axes have an ancient history; saws are venerably old, chainsaws are a generation old, and feller-bunchers are new—each innovation seems to decrease our contact and feeling for the forest as well as increase the potential for impact (the caterpillar tractor, for instance, gives anyone the power to crush the soil, damage more trees, and rip up whole stands).

Figure 452-1. Operating the steam engine (mill at right)
(Photo by J.I. Hagen 1977)

Every November, we put the mill to 'bed.' We filed, then swaged or replaced the double-circle D-style teeth of the inserted-tooth 48" circular headsaw, and realigned the saw with gauges, dressers, and jointers. Then we realigned the single-carriage headrig, cleaning, oiling all the metal parts, covering the electrics, taking the handtools up to the shop ... and boarding it up. The chainsaws had to be sharpened, adjusted, drained, and put away. Anything with wooden handles, like peaveys and axes, had to be put away after the handles were treated. The tractors, an Oliver caterpillar and a Kubota (16 hp), had the gas (or diesel) and water drained, and the clutches pressed in—although the Kubota was used in low-snow winters. A quick way to clean outdoor tools, such as axes and shovels, was to build an oiling/cleaning pit box, filled with a sand/crankcase oil mixture (suggestions like these were found in old and sometimes new magazines such as *Popular Mechanics*).

Many purchased tools had booklets describing their proper operation and care. For chainsaws there are numerous books on chainsaw use and repair. Tools are designed for specific uses and should be restricted to those uses as much as possible. Although, for instance, it is possible to cut down a small tree with a shovel or use a chainsaw to take a tractor tire off, the effort and waste may negate any possible benefit. Getting the proper tool may mean making more trips in and out of the woods, but if you walk, you get all that extra exposure to the delightful ambiance of the forest.

4.5.2.1.2. Starting a Tree Farm

Forests start from bare land or reestablish their range at various scales, after an ice-age for instance, or continue through the death of individual trees, or shift into different kinds of forests. Natural forests often contain small relatively even-aged stands of trees. We saw this regularly with old field restoration, where we planted over several decades and, where a forest surrounded the fields, natural regeneration continued. In a reclaimed field on our tree farm, we had trees that range from 1 year to 16-years old (we started planting old fields after 1980). We decided to make it a registered tree farm in 1978. We joined the American Tree Farm System as the Windy Hill Tree Farm; immediately afterwards, after taking a course in Ecoforestry in Oregon, I convinced Hagen that we should call it Altazor Forest, to reflect our goals to keep the land functioning as a forest, rather than base it on an outdated agricultural model. This inspired us to start planning better.

4.5.2.1.3. Surveying the Property

Most natural boundaries can be identified by sight. Legal boundaries, however, are composed of imaginary lines through the landscape. Modern surveyors using the first method must depend on old field notes or titles for guidance. Forest surveys can be made with only a general knowledge of boundaries furnished by the owner. Boundary lines, such as roads and fences, which have long been accepted by owners on both sides, become legal boundaries only if neither party objects. Often owners must agree arbitrarily on a boundary line.

Boundaries of forest land were marked at section corners (and some times at quarter corners) by iron or concrete posts capped with a brass marker indicating their specific location. The earliest surveys were marked with wooden posts, piles of rocks or blazed trees—either witness trees facing corners or bearing trees showing direction to an established corner.

To create a forest-type map of Altazor, the first step was to obtain base maps for the general area of the property. These maps were obtained from records in the local county court house. In map making on forest lands, the primary concern was with sections and forties within sections. It will be recalled that groups of four forties are called quarter sections. Forties are described as NW-SW or SW-NE, for instance. The legal description of one parcel of our Tree Farm was: “Beginning at a point on the Section line common to Sections 3 and 4 a distance of 738.6 feet North of Southwest corner of Lot 6, running thence east 2842 feet to the center line of Section 3, thence North along said center line (300 feet) thence West 2842 feet more or less to the Section line common to Sections 3 and 4, thence West 6 rods (99 feet), thence South parallel to the Section line 300 feet ...”

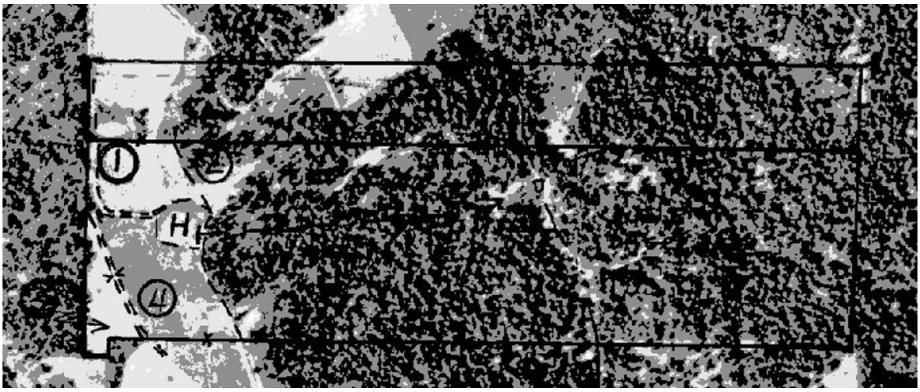

Figure 45213-2. Aerial Map of Altazor. Photo taken September 1969. North faces top of page. Scale is 1” = 1 mile. Numbers 1 and 4 are croplands rented to area farmer from 1967 to 1980. “H” is the new home site.

4.5.2.1.4. Mapping the forest

Accuracy in direction and distance is the most important part of mapping. Direction is determined with a compass; distance is measured with a surveyor’s tape or by pacing. Perfect accuracy is not required, but the limit of tolerance in error should be the limit of the instruments. A forester’s compass is accurate to the degree but not to minutes. We did a lot of pacing. Pacing is reasonably accurate if checked with stride on various terrains. Compass and pacing are the most common methods for forest mapping. Since accurate surveys can be made only when starting from a known point, knowing established sections or quarter-corners is helpful. Otherwise, known property corners or permanently located points will serve. Mapping this kind of area requires locating the boundaries by starting at a known corner, using previous survey notes if possible. Surveyors use a mathematical process for closing a traverse to make sure of its accuracy in legal surveys. This kind of map is okay as a base map and as a means of determining the acreage.

Traditionally, foresters map the forest at the same time they estimate the volume of standing timber. Since most boundaries are not distinctly marked, it was necessary to locate corners. Altazor boundaries are shown in Figure 45213-2.

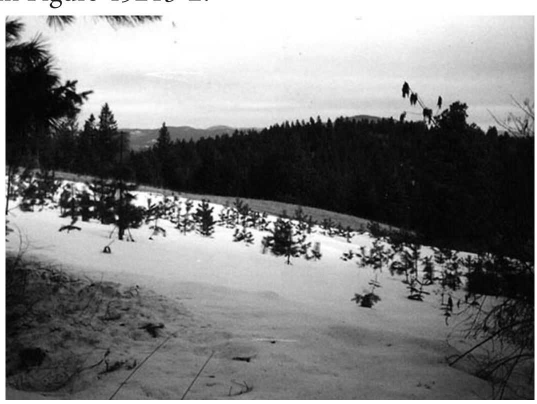

Figure 45214-1. East Nursery

To determine the area enclosed within an irregularly bounded property or within a forest type, foresters commonly use the grid method. A planimeter is more accurate, but it is not always available. Knowing the scale of the map drawn, we drew a grid on transparent paper. Each square in the grid represented a known area, for instance 1 square centimeter equaled 1 hectare. We placed the transparent grid on the map and counted all of the grids completely within the area to be determined and added up the acreage. Then, we summed up all the grids that fall partially within the boundary line and estimated the proportion lying inside.

We determined forest types by the use of a stereoscope, although also by the naked eye—especially the type lines between conifers and hardwoods. Small crowned larch can distinguishable from large crowned cedar, for example. Acreage in aerial photos was also determined by the transparent grid method.

Figure 45214-2. Cedar draw at Altazor

Satellite imagery is a new dimension, which is especially useful in detecting insect and disease depredations, acid rain effects, and areas of potential forest fires. Topographic maps are useful for rough country. They have contour lines imposed over a base surface map (a basic kind of overlay). Most topographic maps of forested areas of the US have been made by the US Geological Survey and can be ordered by sending a legal description of the area, including section, township, and range). Figure 45214-4 shows part of a topographic maps.

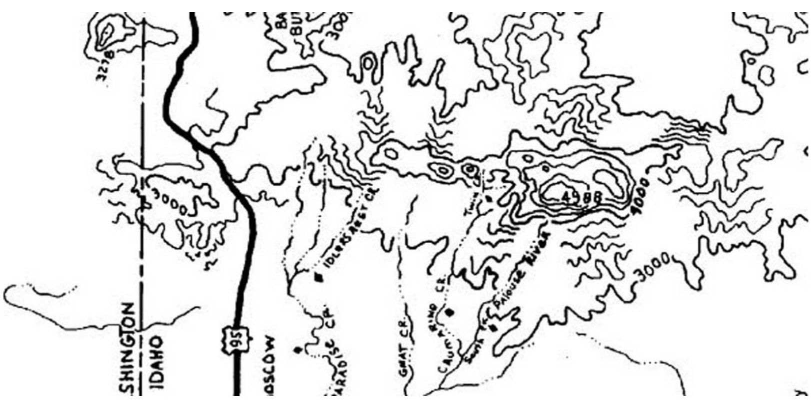

Figure 45214-4. Topographic Map of WHTF region

The purpose of mapping in forestry is to set up measures of forest productivity. Ecologists, however, measure forests with much more intensity, although they also value rapid surveys. The ecological method is different and provides an interesting contrast.

Planning is not meant to be a finished work of art—it has to reflect our understanding and use of the forest. Each activity needs to be fed back into the process of updating the plan. Implementing the plan should result in improvements to it.

4.5.2.2.3. Creating an Inventory

We needed to collect knowledge about the forest, from local people who know something of the recent history, or from tribal elders, who had cultural knowledge, or from other sources: Written reports (such as Lewis-Clark or early surveyors), maps, aerial photographs. This required some research and we made a narrative report of what we found.

The next part of the inventory was a walk-through, which gave us a rough idea of the state of the forest. In the walk-through, we looked for geological characteristics, wildlife, sensitive plants, number of stems, snags, large downs (or downed woody debris or nurse logs), reproduction, and fire potential. The walk-through was informal—we followed trails, although it could have been formal (creating and following a grid, marking distance by chains). We had aerials and maps, but we also made our own maps, with easy to find reference points.

4.5.2.2.4. Analyzing the Landscape

Once we determined the pattern, character and condition of the landscape and particular sites, we indicated them on the map (graphically with patterns). The character described the pattern of forest habitat types (species of plants and animals), as well as patterns of age and reproduction. The condition indicated how human activities had changed, damaged or improved the state of the forest, as well as the landscape pattern. For instance, Figure 45224-1 shows the No Name Creek watershed, which is part of the larger Flannagan Creek watershed, which is part of the Palouse River watershed, which drains into the Columbia Basin. Much of the forest surrounding Altazor had been cleared for fields; virtually all of the rest of it had been cut regularly using a variety of methods.

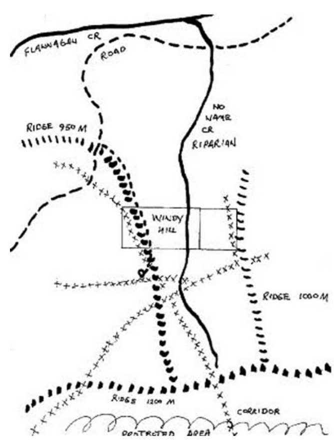

Figure 45224-1. Watershed of No Name creek
Headwall to confluence with Flannagan Creek

4.5.2.2.5. Establishing Zones for Protection and Use

The primary concern of an ecoforestry plan is to protect the framework of the forest for all forest organisms during human use. That means that the habitat of key species has to be preserved. Grandparent trees have to be protected in old-growth areas. Ecologically sensitive areas—steep or broken slopes, shallow soils, xeriscapes (really dry areas)—have to be used lightly, if at all. All riparian ecosystems (rivers, creeks, streams, lakes, ponds, wetlands--all water courses) have to sustain minimal human interference. Animal and plant corridors, especially cross-valley corridors that cross ridges between valleys, need to be maintained for critical movements; remember, many animals, such as bear and deer, require different habitat for eating, mating, and sleeping. The result is an interconnected network of protected ecosystems extending throughout the forest (see Figure 45225-1). For this illustration, I have used a sketch (over a photo) instead of aerial photos with mylar overlays.

Once the protected landscape network was established, the remaining forest areas were zoned for uses to provide for human and ambihuman needs. Forest use zones include culture, recreation-tourism, conservation, fish and wildlife, wilderness, trapping, timber, firewood, and alternative products. None of the uses in these zones should damage the forest. We created two old growth areas (seed trees left consistently by loggers in the 1930s-60s), two natural nurseries, three aesthetic areas, and a 20-acre control stand, where no cutting was ever done.

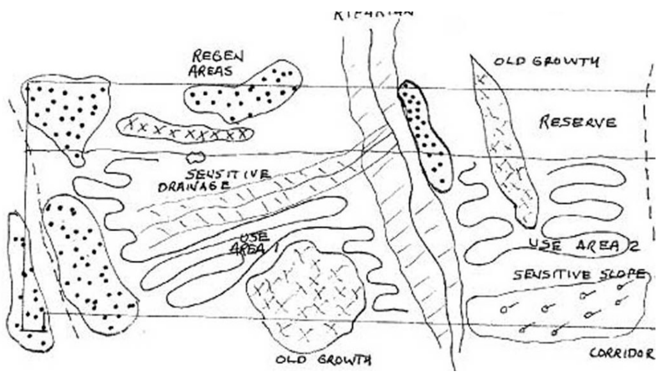

Figure 45225-1. Broad Zones.

4.5.2.2.6. Field Sampling and Cruising

Once the zones were established, each zone was refined, in its margins and content, with field data. Using forest characteristics and the principles of ecoforestry, we were able to set the objectives for each zone.

We established permanent plots and cruised them. Field data was collected in an orderly way, along routes in the forest determined from maps and air photos, and adjusted as necessary in the forest. Field data collected included soil, water, plant, animal, timber, terrain (landforms), and other information that is important to understand and use forests in ways that do not impair their functioning. At this time, we established a series of permanent plots with photograph points. We took first series of ground-level photographs with a camera.

Our data revealed several missing species. For instance, only two white pine were located, one approximately 12 years old and another 6 years old; the younger one died within a year. There was no other natural regeneration. Yew trees were also missing.

4.5.2.2.7. Creating Specific Plans, Including Activities Plan

Field data can either be summarized in one grand ecoforestry plan or in individual plans. We used individual plans, with many of the following being completed: Landscape plan, Watershed inventory (Form 6, Soil report (Form from Richard Hart), Road plan (Figure 45227-1), Zone plans, Harvesting plans, and a Restoration plan. The plans provided an overall picture of the parts of the forest landscape and stands, and how they are functionally interconnected.

Based on this picture, the protected landscape network and activity zones were revised.

Then, detailed plans for on-the-ground activities were prepared for each zone. Using forest characteristics, the principles of ecoforestry, and objectives, we were able to set standards for each zone, e.g., number of intrusions, number of snags left or created, and projected canopy coverage. The standards are established to set limits and provide direction for activities so that the forest is protected at all scales in the short and long terms.

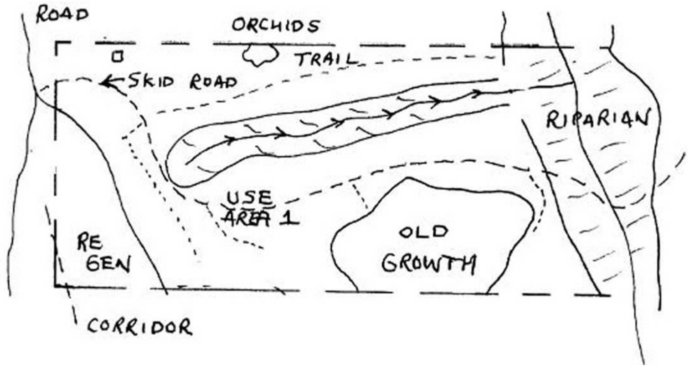

Figure 463227-1. Road Plan

Because the wheel-base of the tractor was 3.5 feet, all of our trails, except for the main road, were about 4.5 feet wide (roughly the same as standard rail gauge). All of the trails were original skid trails from the 1930s-60s, some of which had been replanted; one was an old game trail (still used by white-tailed deer and coyotes). The main road was reworked and re-planted with local native grasses for erosion control in 1989. Some of the old skid roads had been replanted. I still thought we had too many roads. By taking few trees regularly, I do not think as many roads were necessary. Dragging the trees across the duff layer mixes it up with a minimum of impaction. The roads were contoured; the main road crossed the stream only once on a low, flat area. All of the skid roads were constructed by hand, with pick and shovel. Many of them were named after animals or relatives or states of mind; thus, "meditation walk" is more intimate than the "elk highway" (the main road, favored by elk in fall).

4.5.2.2.8. Analyzing Activities to Prepare a Business Plan

Once we knew what we wanted to do, and where, in the forest, as well as how, we needed to find out how much these activities would cost and how much revenue we could expect from the goods and services. This analysis ensured that our activities would be profitable without degrading the forest. If timber cutting or leasing was determined to be unable to generate adequate revenue to cover costs, then this activity was abandoned before we were tempted to "cut corners" and degrade the forest in order to achieve short-term economic success. Our economic goals included covering costs, ensuring that sufficient revenues are generated to cover future costs, such as equipment replacement, improving forest health and aesthetics, and guaranteeing that workers are paid fairly for their services. Many of these activities were not be considered profitable under conventional timber management.

4.5.2.2.9. Putting the Design on the Ground

The knowledge and planning was applied in the forest. Within the limits of principles and standards, we began laying out the human infrastructure (trails, landings, buildings) and performing the activities that were beneficial or profitable. As we worked we added feedback to the plans; for instance if a granite outcropping made a road in one place prohibitively expensive, we rerouted or reconsidered the road. For a cutting approach, we decided on single-tree selection, with a small group selection of white fir that had root rot. We also decided to put aside several restoration areas, including one where we would artificially accelerate successions by cutting and burning (to mimic natural processes). For instance, I climbed and topped one large tree so that it resembled an old-growth tree (this one sent up a new leader in 2 years).

4.5.2.3. Monitoring Activities

In order to understand the effects of your activities, as well as the natural changes in the forest, we started monitoring a number of vital things, from soil depth and compaction, with a penetrometer, to diameters of trees. Monitoring ensured that standards of ecoforestry were followed for the duration of the activity. Monitoring also allowed the standards for the activities to be revised to increase the protection of forest functioning and to increase efficiency. The results of monitoring need to be evaluated and fed back into the process of planning and acting. You may wish to create a narrative summary of your experience for later use.

Planning is only the first part of acquiring human needs from a wild forest. How we interpreted and executed the plan was also important. Our skills and knowledge of the forest determined the success or failure of the principles and standards developed in the plan.

4.5.3. *Designing a Forest*

We created an ecological design for the forest. Design can imitate nature on many levels: From structure and process to landscapes. We can imitate the structure of mature forests by planting on every level of the forest hierarchy, from canopy to below ground. We can use native species. We can imitate the process of forests by allowing birds, bats, and other animals opportunity to distribute seeds and energy to other areas or prey on "pests." We can create microclimates within the landscape that may shift the landscape in new directions. Planting trees, for instance, allows new species to become established under their protection.

Ecosystem health is one of the goals of design. The goal, of course, is not an end point that can be reached once, but is rather a continual striving. The landscape provides its own metaphor for design. The landscape is a unique individual, a community, a dynamic system of interacting patterns—the human pattern is a part of it now and should be preserved as part of the whole pattern, but not necessarily as the only pattern or a completely dominant one. Most products of an ecosystem are produced and consumed and recycled within the ecosystem. Humans need to minimize the external inputs in the form of energy and exotic substances. The community must be restored to health, by balancing human needs with bird or fish needs in a sustainable pattern. Each element relates to others and to the whole.

4.5.3.1. Design as Lessons from Nature

Natural processes, including building up and breaking down, development, disturbance, animal movement, inter-element flows, human interaction, and shifting mosaics, operate in forests. Conservation biology (after Michael Soule) suggests a number of rules for reserve design that are based on natural patterns: Well distributed species are less at risk; large blocks of habitat are safer from species extinctions; blocks close together are better; contiguous blocks are better than fragmented; interconnected blocks are better than isolated; corridors can make larger blocks functionally; and, disturbance similar to natural ones are less threatening.

4.5.3.2. Formalizing the Forest

Since tree farms are called farms and not mines, we assumed that they were expected to be sustainable. However, many association rules and standards were not concerned with health or sustainability. Rather than cover the spectrum of possible characteristics, several ideal ones can be identified and discussed. Some of the information is in the form of personal anecdote, since we worked the forest for 25 years.

4.5.3.2.1. *Permitting Change*. Without a forest there is not a farm. If the forest is degraded, the farm cannot last long. The forest has to be allowed to be healthy; the habitat has to meet the needs of the community of species; and the genetic pool of the species has to be large enough for long continuity (I wanted to say long life, indefinite development, or perpetuity, but these do not sound quite right either). The protection of a forest has to accommodate natural processes. Natural processes, such as snow melt or species creation or extinction, have to continue. Natural disturbances, such as fire or wind storms, have to be continue as well. In the case of fire, it might be possible with prescribed burning to duplicate the effect of wild fire; at Altazor, we burned small slash piles (for low-intensity burns) in the fall and spring—due to our ignorance and inability to manage light ground fires, we did not use them until 1997.

4.5.3.2.2. *Protecting Riparian Areas*. The quality of flowing water, in rivers, streams, intermittent streams, or just surface flow, is vulnerable to human activities, such as logging or recreation. Fish have quite explicit needs for temperature, stream bed character, and cleanliness. Water tends to cross ecosystem boundaries; fish also move between ecosystems, quite dramatically in the case of salmon. Even in north Idaho, the streams used to support trout and possibly salmon. When our neighbor to the south clearcut, the shape of the clearcut followed our boundaries and the riparian area, doing the worst damage there; silt from erosion has made the stream less variegated; water flow now is more seasonal and less constant.

The stream that flows through our property and on into the Palouse River (marked "no name" on aerial maps, hence it is now called 'No-name' creek) crosses through 4 other property boundaries. When our southern and upstream neighbor (a retired professor of forest engineering named Forrest Hall, oddly enough) clearcut the riparian, the character of the stream changed dramatically in the upper reaches. When we first started to manage our tree farm in the 1970s, one of the things that we had scheduled to do was to remove all of the logging debris and downed trees from the stream and its banks to "restore" it to a pristine, neat stream; fortunately, we never got that far. Conventional wisdom changed and downed trees received recognition for their role in creating fish and insect habitat in streams. So, we started dropping trees in the cleaned up areas.

4.5.3.2.3. *Retaining Mixed Species and Ages Structure*. Tree farms, like forests, should retain the structure of the forest. This included snags at every stage. Cutting the oldest or best trees was a bad idea; the Altazor land had been stripped of all western white pine in the 1940s and 50s—only one sapling remained but died several years later, probably from rust. Cutting the subdominants was be a good idea either. The advantage to a forest of having a large gene pool is having a set of flexible responses to a wide variety of environmental conditions, from fires to high winds, diseases, and insects. Removing any one part of the forest completely could make the forest susceptible to some unforeseen or unpredictable factor, e.g., trees seemingly genetically inferior under the current conditions may have the best response to other conditions, such as the greenhouse effect or frequent disturbance from logging. We never really knew which trees nature had selected for removal until after they had died or been removed, and even then maybe not. We cut a few of every age group and species.

Often, other animals and plants will control "pests," mistletoe, for instance. When we change conditions by eliminating nesting areas or animal populations, we increase the likelihood that some disease or pest will spread without being checked. When I was walking our neighbor's 1991 clearcut (these are the neighbors to the south, the ones to the east clearcut in 1977—it's still a wasteland, and the ones to the north had a sanitation cut—it was not infected—in 1992, while the neighbor to the west takes only a little firewood and runs a few cattle), I found two black squirrels dead on the ground next to a fallen tree. I had never seen squirrels this dark and did not even know they lived in the area, even though I found the bodies less than 100 yards from our house. After that I saw one live one. I waited to see what effects are taking place on our (and his) forest as a result of the cut.

4.5.3.2.4. *Using Benign Timber Harvest Methods*. Some kind of individual tree selection, e.g., Natural selection harvesting, was used regularly. We thought that selecting trees from each age group was wiser. Any increase in the size of the cut should be the result of good protective practices, rather than a larger percentage of growth.

Over each year, we have never cut more than one tree per week. If we run short of money (also a weekly occurrence), we never cut more trees. Instead, I consulted or taught or worked as a waiter; my partner, who was almost as old as Merv Wilkinson, borrowed from his social security account. We figured our annual cut was less than 1 percent of the total volume—far less than the productivity rate. Most tree farmers cut at some rate less than the productivity; Michael Pilarski cites Leo Goebel, of the Goebel-Jackson Tree Farm, as saying that he cuts 3-4 percent of the total volume each year.

Equipment should be appropriately sized. We had a 16 horsepower Kubota four-wheel drive tractor that handled everything we cut; we bucked to 8-16 foot and never tried to remove the whole stem (30-70 foot). We had had a local horse-logger pull logs out sometimes. Since we had our own mill from 1978 to 1992, we were able to sell dimension cut and planed lumber; our western neighbor had a wood miser, now, so we sold some raw logs to him. I used a bow saw or ax for anything under 7” diameter-breast-high (DBH). We had various-sized chainsaws for larger trees (a Pioneer, Stihl, and Echo). Although we walked most of the time, we had bicycles, skis, snowshoes, and a toboggan (to get downhill fast).

4.5.3.3. Attractions of Trees and Wild Lands

Tree farms have great potential. Through tree farms, public understanding and forest protection could be increased. Tree farms also offer the possibility of having a good, small business and more supervised recreation. For the owners of a tree farm, there is the possibility of self-sufficiency and the definiteness of unique amenities. For example, last week, I spent a day cutting (limbing and bucking) one fir tree. I also bucked a tree that had fallen across the power line to the pumphouse, started a fire for slash (from a pre-ownership 1961 cut), had a picnic lunch by the fire, walked around inspecting the general health of the forest, climbed a tree, played with the dog, cleaned up the pumphouse, and walked home (1100 feet uphill). One month I gave lectures at Claremont Graduate School (CA) and New College (FL); the smog was bad both places. Later, I was working at a computer by a window looking north over Boston (our 5th-floor walk-up studio) toward North station and the Boston Garden; there was one tree in sight in someone’s rooftop garden, 9 TV antennas, many chimneys, and countless roofs and windows. Later that day I walked to DeLucca’s market for a sandwich, and I was grateful that the streets had small trees lining them. The next day I dressed in a suit, took the Red Line to Cambridge, and talked to a botany professor about the Harvard forest. I preferred the first week’s activities.

People like to buy land with trees on it. Forests imply good business sense, individualism, healthy outdoor activities, including work and adventure. Yes, adventure. Personally, the adventure extends from plants and animals to ideas. The Altazor Forest incorporates the territory of bears, mountain lions, coyotes, and others; for instance, one day Carolyn and I were gardening on the edge of the trees when a bear, 50-gallon barrel-size, ran along the garden, through the orchard and down the hill towards a spring—we were so surprised we just kept planting. We see bears rarely, but the evidence is everywhere in smashed logs, barked trees, and ravaged raspberries. Once I was walking along a trail reading and saw the neighbor's tan dog out of the corner of my eye standing in a clearing (our neighbors had clearcut on the boundary to pay for a vacation to Canada). I reached out to pet him before I noticed the shape was not quite right—he was a male mountain lion just standing watching me. I stopped and looked at him; he looked, I looked; I looked, he flowed off down the hill. I started walking after him, until we were in deeper woods, then changed my mind after I lost sight of him, not wanting to be a nuisance or dinner. I saw a lot of life in the forest. As I was writing this (12/16/96 at 1:11 p.m.) two moose were loitering in the lower field (a pine nursery), having just come across from the western neighbor's cattle trails; as I was focusing on them, a pygmy owl landed on the branch in front of the window and observed me.

The forest teaches many things that we humans value. The forests teaches virtues, such as patience, frugality, and possibly self-reliance. The forest also teaches awareness of its limits and complexity. The forest is not something, like a computer game, that you can master in a day, or even know completely in a decade or lifetime. A good tree farm (or forest or ecoforest) starts from an assessment of the whole forest system, rather than from a goal of high productivity. In a good tree farm, the self-ordering, self-regulating processes of the forest are allowed to continue, and human need is served by careful techniques, such as single-tree selective felling. A good tree farm can serve all needs through limited exploitation.

4.5.3.4. Forest Management

One major problem with some tree farms is that indigenous flora and fauna are thinned or removed in favor of "useful" species that can provide maximum production. This "redesign" of the forest almost always requires external human controls and inputs in the form of biocides, fertilizers, soil scarification, and artificial selection. Simplification of the forest for short-term maximization of goods usually leads to dedifferentiation and destabilization. Although such tree farms may contribute to soil conservation, wild life diversity, and biogeochemical cycles more than a plantation, they do not contribute nearly as much as old-growth.

The idea of a tree farm implies that we have the knowledge and power to manage a part of a forest. We do not. A resource management approach leaves out necessary information, so that is automatically inadequate. Ecosystem management uses a more scientifically-based understanding, based on ecological principles. But, the management assumptions of ecosystem management are fatally flawed: That ecosystem protection can occur under high production levels of timber; that human concerns come first; and, that all human culture is monotonous and large-scale. Ecosystem management, however, is not required to have these assumptions. The assumptions could be ecocentric (or ecoperipheral) and locally controlled.

Multiple use of the forest—each use below replacement rates or impact limits—is a more intelligent approach (intelligent in the large sense). There are several things to consider, however: The health of the forest, the limits set by old-growth, key species, or the watershed, and the problem of trade-offs. If the forest is small (~80 acres) and logging might destroy the structure, perhaps it should just be set aside. If archaeological sites are present or rare species, entries should probably be strictly limited. Public support or opposition is also a critical factor in the success of forest operations and should always be considered. (Just as an aside, game theory has been used in African situations to help farmers determine the best mix of crops for environmental conditions—it might be applicable to multiple-use forestry as well.)

There was probably a limit to the number of things that can be done in multiple use. There were a number of potential uses here at Altazor could include (Table 4534-1, current uses are starred; estimates are in parentheses):

Table 45234-1. Potential Tree Farm Income

Activity	*Dollars/acre/year*
*timber harvest, *poles, *firewood	50
*Christmas or ornamental tree	10
beef-cattle	(400)
*mushrooms (Morel)	5
recreation (hiking, snowmobiling, skiing)	(100)
hunting (or photography)	(25)
*scientific research	0-25
<u>*gathering (fronds, ferns, lichen)</u>	<u>15</u>
Totals	90

As you can tell, we were underusing our resources; because this forest was cut heavily in the early 1960s, we were more concerned with rebuilding the forest. The figure for beef-cattle was for 3 animals per acre (from our neighbor); recreation was a guess, although snowmobiling is really big in North Idaho; hunting income would be from fees. Some tree farms (mostly absentee owners) lease their land to hunting clubs. The amounts for mushrooms and firewood was a low replacement figure because we no longer sold firewood or mushrooms (we consumed all of those two items).

We tried to get a few nontimber products from our farm, mostly pinecones and boughs. In a good year we sold a few flats of black-cap raspberries at a local farmer's market. One year I sold two Christmas trees, including a Macintosh apple tree that had been ruined by gophers—the people who bought that decorated it with small lights inside blue glass water bottles. The following year I contacted Walmart to supply boughs for the Christmas market, but I could not promise a minimum amount (one cargo container load), so I ended up selling small numbers to local floral shops. We expected to do more to develop others goods, but never did.

Many of these activities prohibit other activities, so deciding which to do involved making trade-offs. For example, beef-cattle raising, which our neighbor does in his forest, requires forage, which means less timber stock; furthermore, increased forage means increases in deer, and reduced timber stock means increase in speed of winter runoff, which may decrease timber growth in the long-term. Some foresters have found that intensive timber production reduced the number and value of visitors.

Some activities fit together nicely. Morels require regular fires, which we provided by burning slash and brush. Research depended on grants for income, but fit well with hiking, photography, and light gathering. Activities may be classified as complementary, competitive, or exclusive. Figuring out optimum values can be difficult (mathematically difficult as well as ethically). Most foresters limited such activities to two or three.

Tree farm management involves occasional planting, using careful techniques, such as root spreading, but also the follow-up care, such as mulching, hand weeding, and possibly protection from browsers and direct sun (for shade tolerant species). Good management also includes management of past practices. For instance, we did a series of small burns every winter to get rid of the slash from the last high-grading operation in 1961. This reduced the fuel load in the forest. I spent a lot of time cutting dead limbs off trees; I usually cut them all the way up the tree if I could, and sometimes this involved climbing a ladder (we keep a couple in the woods) or climbing the tree (which is more fun, but time-consuming). Except in the natural nurseries—pastures, meadows, or fields that were farmed, but are small and near seed trees—we rarely thinned trees. We preferred having the good grained wood that grows under conditions of closer tree spacing.

Reforesting was done when necessary. We used to have cows and horses in a pasture near the edge of the forest. We did not replace them after they died of old-age. Trees and shrubs were kept down by grazing, but recently had been invading the old pasture. The most heavily used part of the pasture was too shrubby still, but other parts have been replanted, and natural regeneration has surpassed the planted areas in growth and diversity. The trees that were planted were planted in late winter; the seedlings were transplanted from skid roads and trails nearby. For a tree farm on land that has been totally destroyed, planting and artificial preparation, such as fertilizing, must be more intensive until some cover is established. We did not use fertilizers or pesticides. Pest control was minimized. We did nothing for pest control other than cut down branches with dwarf mistletoe infestations.

After an initial survey in 1976-77, with permanent quadrats and photo points, assessment became more informal. Since we walked the woods every month, our community audits were less formal. We had the two old growth areas (seed trees left consistently by loggers in the 1930s-60s), two natural nurseries, three aesthetic areas, and a 20-acre control stand, where no cutting is ever done. Other areas were marked. In a small forest, management was participatory and hands-on. The work is also labor intensive. For instance, when taking poles out after thinning we just carried one or two at a time rather than dragging them behind the tractor.

Ecological design is not finished with a forest design. The forest may need to be managed as a result of the design. Noninterference matrix management (NMM) is proposed as a technique for design. A forest exists as part of matrix that many interacting elements. Any activity in the matrix can have some effect on these elements. The whole matrix needs to be managed with the forest in mind. A noninterference approach to forest management (the essence of a Taoist way) is to let forest take its own course. Therefore, once the temporary constructs were in place, whether planting or cutting or any other manipulation, the forest would be allowed to develop without further interference. In nature, noninterference means letting be. NMM is not indifference, which is diffuse. It is caring. Noninterference will not lead to chaos, poverty, and stagnation. The technocratic vision strives for "life under control," but the forest is self-managing, productive, efficient, and orderly. We need to practice the rule of noninterference so that all beings can enhance themselves. Noninterference can be derived from nonviolence (or taoistic nondoing). This attitude would entail using what is necessary, exploiting parts of some forest ecosystems, changing a place to fit human aspirations, and killing plants and animals for sustenance. But, it would also mean limiting human use to local impacts, and letting other beings live without interference. It is not necessary to dominate or terraform the forest completely to save it. NMM weaves people back into the fabric that supports them and in a sense makes them subject to the constraints of ecosystem processes. NMM would manage the forest system with minimum subsidies, manage activities that could upset equilibrium, manage sustainable conditions, align human activities with natural processes, work with system instead of attacking it, and restore context.

Design may be costly. For example, grassland restoration costs about $1500 per acre per year, based on the first two years. Forest restoration costs more. Design may take a long time—longer than human lifetimes. The forest may be too complex to design. Remember the thought experiment about how to design a forest using artificial pieces, such as giant sponges or shade cards. The experiment made many people uneasy, possibly because it was absurd or too complex. How do we design a forest, a complex, self-making, self-sustaining wild forest? Management has to recognize the limits of design. Such limits might include the fact that forests are wild, we have no real control. The scale of forests is too large to manage everything; the longevity of forests is too long, we will never complete the design in human lifetimes. The costs may be prohibitive—indeed, we have depended on the free goods of forests for economic advantages. Other human limitations apply to our ability to see and understand the forest.

4.5.3.5. Harvesting

Every harvesting style essentially moves timber from the forest to a mill. The cutting, preparation and delivery of trees is usually performed by independent contractors as a service to landowners and corporations, although some corporations may have their own logging departments. We decided not to clearcut or use other methods of endcuts, such as seedtree cuts or shelterwood cuts. We decided not to use several kinds of partial cuts, such as high-grading, release operations, sanitation cuts, or salvage cuts. We decided to use single-tree selection most of the time, considering the goals and scale of our operation. Individual Tree Selection is a system in which foresters select the trees to be cut for thinning, culling, or logging; these trees may be poles, young, or mature, depending on the emphasis of the forester. All-age or uneven-age management, as defined by the US Forest Service, is equivalent to individual tree selection. Orville Camp, Merv Wilkinson, Gordon Robinson, and others practice single-tree selection. Edward Fritz, Charles Stoddard, and others sing its praises. According to Edward Fritz, the US Forest Service argues that individual tree selection yields benefits to the forest, but it is a lost art, without enough skilled foresters to practice it.

There are numerous reasons, in general, why individual tree selection is a good practice. The form and the diversity of the forest are preserved; individual components, such as fungi, are preserved; and leaf litter is conserved. There is less damage to soil (fewer roads and trails or none, less exposure to elements). The diversity of microsites maintained, and the gene pool is kept intact. Age diversity is maintained. Trees grow upward with fewer limbs, which results in clearer lumber. Outbreaks of insects and disease are minimized. Individual tree selection promotes growth in the forest, since removing a single tree accelerates the growth of neighboring trees—industrial forestry has tried to extend this logic to clearcutting, but the destruction of all the trees has too many negative impacts.

Once a tree was down and bucked into logs, the logs had to be moved to a mill, or if they were milled on site, then to a lumber yard or point of sales, or if the lumber was being sold on site, then taken out by the buyer or delivered. Moving logs to a landing is referred to as primary transportation; from the landing to the mill as secondary transportation. Most movement required a skid path, skid road or haul road.

Any time a road is built, the structure of the ground is altered (and possibly made unstable) and the drainage patterns are disrupted. There are harvesting systems that minimize roads, such as helicopter or balloon logging, but they are expensive. Horse logging does not need as many skid roads or trails, since the duff can be raked after each pass. Even some of the large-rubber-tired feller-forwarders do not need branch roads and cause less compaction. Because Altazor is a permanent forest, where trees are harvested below the reproduction rate using a selection system, roads are minimized. But, we needed to have a few skid roads and a haul road. At the Altazor Tree farm, we used to have only three skid roads and one haul road; when I was working in Cambridge in 1989, my partner, Mad Jack, had a haul road built out of the profits from our 1988 horse-logging harvest—his main concern, having been in several large fires, was fire protection, while mine was watershed integrity. Since then, I rehabilitated several skid trails, planted the haul road in wild grasses, and lined the banks with wild rose.

Since the haul road cut across all three skid roads, no new roads have been built; the haul road crosses No-name creek at 90 degrees at least over a culvert. Our skid roads were built by hand and are only 3-4 feet wide—just about the tractor width; they are also planted. By contrast, when our neighbors to the south, at Twin Pine tree farm, had a salvage cut, a haul road was built on the east bank of the creek, causing tremendous erosion (we are still trying to decide whether to sue for water damage); their skid roads go straight up and down the hills, causing more erosion.

Roads may have weaknesses or acquire them. There may be rock slides or slough from the upper bank; the lower bank may erode. These need attention and repair. The surface will last longer if it is seeded; we used native fescues and clover. Canadian thistle is uninvited but the horses eat the flowers. We used a 0-foot clearing on our road and on all trails. We have kept most of the skid trails from the 1930s-60s. Once and a while we will remove the regeneration and replant it in old fields or brushy areas. Skid roads are sometimes cleared and graded, although we inherited most of those, also, and do little maintenance beyond removing regeneration and adding water turnouts. We made sure both were revegetated. None of the skid roads or trails crossed the stream. We made two short skidroads by hand, using brush and slash as water retardants until the vegetation grew in. Most of the skid roads I have seen or read about have been for far greater traffic than ours, especially if they handled power-skidders skidding tree-lengths. Roads also serve other purposes than hauling logs. These purposes include access to the stand, hiking or walking paths, browse for deer, access for fire protection, and light.

4.5.3.6. Restoration Design & Plan

We identified a number of characteristics that foster good design. A few are listed below. These characteristics are intimately related to the principles of ecoforestry: Frugality, avoiding excess, or the style of use of things; adaptation, fitting in the forest, within established cycles and functions; plurality, allowing many values; respect, recognizing the “beingness,” value and rights of the forest itself; playfulness; and others, including anticipation, responsibility and participation. Designers should participate in a complete design process, guiding involvement and commitment to the art of living together as a community.

4.5.3.6.1. *Recognizing Principles*. Principles must be flexible to mirror the flexibility of open systems; flexibility is provided by diversity in fact. Sample principles of forest design include: Irregular shapes are pleasing, and the eye follows them. Design should follow sensory force and enhance the spirit of place. We need to value diversity in the forest and work with the forest. Succession can be assisted, slowed, or speeded up, but not skipped or ignored. A forest is designed by its limits, time, scale, complexity; the scale of the forest should respect that of the landscape. Only details and exceptions form the forest; only generalities are important—so you have to live with contradictions. We should make the smallest number of changes; maintain the size and completeness of the forest; maintain the ratio of interior to edge areas; preserve the riparian zones. We need to adapt the process of change to the site (you fit the forest, not other way). We should seek best use for products; everything in the forest is a resource for something; many can be directed to human use; extend the life of things through cycling, then return to forest; things can be recycled indefinitely, as in an old growth cycle. Above all, we must preserve the components, structure, and function of a forest, as well as understand the patterns and connections.

4.5.3.6.2. *Applying Principles to Standards & Practices*. All design elements are related psychologically by designers, as focus or frame, as contrast or uniformity, as dominant or recessive, or in a number of other pairs. Good forest design means not violating any of the aforementioned principles and ideas. Design can improve the results of bad practices. Bad harvesting practices often result in geometric wastelands. Good design can correct reliance on straight lines, parallel lines, right angles, and perfect symmetry. In cutting or planting to improve natural appearance a number of things have to be considered, including the age of the forest, windthrow, width of corridors, and minimum size of the habitat.

There are many key species, or resources, or patterns in a forest. Since it is so difficult to discover all of these, design must be cautious and minimal. Is the centipede more important than an owl? Is the mycorrhizal fungus more critical than the tree? We tried to think of the trees as the bones of the body of the forest. We allowed human participation and encouraged responsibility in visitors and workers.

Our restoration activities included saving legacy trees in small (possibly too small to be meaningful at the forest level) preserves. We created several nurseries to replant agricultural fields that had been cleared and rented out to farmers by the previous owners. Over 25 years, these areas produced many good trees and even a few holiday trees that were sold. I tried an accelerated successional area to try to speed up old-growth by creating old growth characteristics in mature trees by cutting and burning, but abandoned the program as ineffective; the only practice that might have benefited the area was a small amount of thinning.

4.5.3.7. Design Summary

People often judge the health or wholeness of forests by how they look. Traditional design has emphasized visual results above all else. Ecological design, however, achieves the same results by paying attention to the structure and function of the forest first. Design has been concerned for centuries with making domesticated landscapes out of wild ones. Now, design must address the opposite problem: How to preserve or provide the conditions for wild forests.

Design must address the common good, that is, the good of the entire ambihuman community; it can do so by: promoting the well-being of all individuals in larger community, deciding what is preferable, attempt to regulate and anticipate all effects, encourage convivial activity, recognize links and dependencies, mediate the relation between technology and community, and alleviate some of the problems of modern industrial society. Designs provide a framework for natural and artificial process to work in. The patterns in design are echoes of patterns in nature. Good designs learn to embrace error and failure, so necessary in open systems.

Altazor is not a restoration, because of the uncertainty about the kinds and associations of native vegetation. Furthermore, we are now a large part, although not yet an integral part, of the system; therefore it could not be restored to a premodern or prehuman state (and even if it could, which state?), even if we wanted. This design is not the biotechnological design of a new ecosystem, either; we cannot accurately control and predict ecological events in most ecosystems. However, we can steer some of the events in a known direction—known because we have historical records of the system, although not complete. We can also reduce those human activities that we know alter the conditions of the forest, such as overcutting and pesticide use.

Ecological forest design is the design of communities. We should design places as organic wholes to promote the well-being of individuals and the common good. The immediate goals of design are to reverse degradation and reclaim places for communities, but also to work to increase public awareness of the interdependence of communities, to create environmental quality, and to transform public values by generating new metaphors for living.

4.5.4. *Summary: Protection & Ridiculous Laws*

Due to legal entanglements resulting from an automobile accident involving Carolyn Hagen in Boston, the court ordered the home (with 5 acres) and her titled share of the tree farm (20 acres) sold to cover medical expenses. The irony is that the partner who loved the forest the most became a vegetable on a feeding tube in a rest home and her expenses were paid for by the sale of the forest. The other partner, Mad Jack Hagen, then decided to harvest his 50 acres for a new truck and vacation with a 'sanitation' cut.

The mechanic who bought the house razed it and brought in a new double-wide trailer. He set up a dog run in the orchard and removed the bluebird trail. He cut the largest trees on the east slope behind the house for reasons of 'safety.' Then he harvested the larger trees downslope to pay for a new water system and pay down the mortgage, which the Court had already reduced by 50% because he had argued that the property was over-priced without a water system (although a new system had been installed the year before the ordered sale).

The farmer who bought the north 20-acre tract of forest was able to benefit from 30 years of care and restoration by harvesting the largest and most valuable trees. New roads were made by caterpillar tractor for the access of logging trucks. She and her family were able to buy a retirement place for her in town.

I suppose that the moral to be taken from the complete destruction of Altazor is that no matter how good a job of planning and restoration, unless the forest is protected legally, by some kind of trust, which we never finished doing, good work can be undone for the ripe profit of others. Obviously, in hindsight, we should have set up a land trust and made legal protections, regardless of ownership, in terms of minimal cutting and removal. However, even these might not have worked for long. It was an ecosystem tragedy even more than a human one.

Figure 4534-0. Half-finished bank-run sale harvest 2000

4.6. *Local Animal Patterns*

Animals are mobile organisms, including zooplankton and insects, which survive by preying on plants or other animals. Each organism is inseparably related to a place; breaking the bond with place may mean death for the organism. Organisms and places shape each other. Even if individuals can be described in terms of vortices, as the poet Pound did before the physicist Prigogine, they do exist materially, and they participate in the field in which they exist. The organism must adapt to the environment, which implies having a memory and being capable of learning; the organisms must also reproduce, that is, duplicate its pattern in a separate being. Organisms are goal seeking, and often stability is sought above change or complexity. The individual is a subject centered in a milieu. Because of this implied point of reference, J. Rodman concludes that ecology is teleological. Often, organisms strive for well being beyond just survival. Their goal is to come into the fullness of being; A. N. Whitehead considered that all organisms have three urges: To live, to live well, and to live better. Living better is being more attuned, stimulated, receptive, flexible, spontaneous, and integrated into a milieu.

4.6.1. *Wild Animals: Individuals, Species & Ecosystems*

Animal populations vary according to cycles or unknown causes; they move and concentrate or disperse. Because animals fluctuate in such a cyclic manner on the tundra, for instance, management by the maximum sustained yield concept is even more difficult and questionable. Furthermore, the ranges of caribou and birds cover more than one ecosystem; wilderness designation for areas outside any one focus must be coordinated. Animals move between ecosystems, carrying their biomass and experience. Wolves, elk and other species use different systems for feeding, mating and sleeping. Other species, such as birds, can connect ecosystems separated by thousands of kilometers.

Microbes are vital to the environment because they participate in the Earth's element cycles like the carbon and nitrogen cycles. Microorganisms are involved in the production of oxygen, biomass control and 'cleaning' the Earth of remnants of dead organisms.

4.6.1.1. Interactions of Individual, Species & Ecosystems

As they try to adapt to or modify their surroundings, the individuals in a community engage in interactive behaviors, which can be considered positive (+), negative (-), or neutral (0) in effect for each individual or species in relation to another. If they can form partnerships or create a niche, then the organisms can stay and participate in the community interactions. These interactions are neutralism (0,0), 'interference' (0,-), 'charity' (0,+), amensalism (-,0), competition (-,-), 'altruism' (-,+), commensalism (+,0), parasitism (+,-), predation (+,-), protocooperation (+,+), and mutualism (+,+).

The interactions in single quotemarks (interference, charity and altruism) have rarely been identified or have been considered as unimportant or nonexistent interactions, but they may have equal effects on the community as a whole. Altruism, charity or interference can shape a group as much as neutralism or parasitism. Altruism is the sacrifice of an individual for another individual, often related genetically, or for the community as a whole. Charity is giving a benefit to another individual at no cost to the giver. And, interference is harming another individual at no benefit to the doer, and perhaps even a significant cost at a later time, if the doer depends on some service from the other individual.

Most interactions are not simple, but are complex and paradoxical because of the integration of levels. For example, parasitism that is detrimental on an individual level may have benefits on the species level, by influencing reproduction rates or resistance to diseases. Some of these interactions are poorly defined in the literature. Predation, for example, is regarded as the adverse effect of one population on another, while being dependent on it. Yet, predation can benefit both species; it may be more mutualistic than parasitic in character. The predator/prey are not excluding opposites, but generate a whole unity on the community level, where there is stabilization and survival for both species, according to M. W. Fox. Predation increases the survivability of two species. In Caswell's open nonequilibrium model, the incorporation of predation results in an indefinite coexistence of species—extending the extinction of either indefinitely. Predation opens up cells for colonization by inferior competitors (gaps caused by physical disturbance can also have the same effect). Predation increases the diversity of species in a community.

Table 4611-1. Forms of Individual /Species Interactions

Interaction	*Individual 1*	*Individual 2*	*Species 1*	*Species 2*
Neutralism	0	0	0	0
(interference)	0	-	0 -	-
(charity)	0	+	0 +	+
Amensalism	-	0	0	0
Competition	-	-	+	+
(altruism)	-	+	+	+
Commensalism	+	0	0	0
Parasitism	+	-	+	+
Predation	+	-	+	+
Protocooperation	+	+	0 +	0 +
Mutualism	+	+	+	+

Steven Stanley argues that predation, or cropping, may have controlled the evolution of metazoans. In communities of primary producers, a few species can monopolize a place. A predator dominates its favorite species, usually the most populous, thus limiting it so that other species can develop to claim a niche. Stanley explains the Cambrian explosion of life through the evolution of cropping herbivores, which "opened space" for a greater diversity of producers, which in turn permitted more specialized croppers, for which specialized predators evolved. Each new level of the trophic pyramid broadened the one below; the pyramid became wider and higher.

One difference between individual and species is the time length. Things that are positive in the short-term may be disadvantageous and hazardous in the long term. The global level would be even more positive due to the good impact on recycling and global cycles.

Competition was once considered the basic interaction between individuals and between species, from C. Darwin to S. Lehmann and others. But, cooperation is seen now to be as effective a strategy as competition and as necessary. Survival of the fitter is correct only to a certain point, then it becomes survival of the more cooperative. Both old studies (Reinheimer and Kropotkin) and new research (Lorenz, Fox, and Schaller) stress the primary use of cooperation both within and between species instead of unrelieved struggle. As Arne Naess says, "live and let live" is a more powerful principles than "either/or." Cooperation creates communities of many species in which competition is necessary but limited. Neil Evernden notes that organisms often go to extreme lengths to avoid direct competition; species form a spectrum of attempts to share the life base without risking their health. This diversity enhances the potential for survival.

Table 4611-2. Forms of Individual /Species/Ecosystem Interactions

Interaction	*Indiv. 1*	*Indiv. 2*	*Species 1**	*Species 2*	*Ecosystem*
Neutralism	0	0	0	0	0
(interference)	0	-	0 -	-	-
(charity)	0	+	0 +	+	+
Amensalism	-	0	0	0	0
Competition	-	-	+	+	+
(altruism)	-	+	+	+	+
Commensalism	+	0	0	0	+
Parasitism	+	-	+	+	+
Predation	+	-	+	+	+
Protocooperation	+	+	0 +	0 +	+
Mutualism	+	+	+	+	++
Disturbance geological	0 - +	0 - +	0 - +	0 - +	- +
ecological	0 - +	0 - +	0 - +	0 - +	- +
Interference geological	-	-	-	-	-
ecological/ human	0 - + *	0 - +	- + *	-	-

Many species in communities live closely together; this constant, intimate relationship between dissimilar species was identified as “symbiosis” by Heinrich De Bary (1879). Biological symbiosis results in a greater store of genetic information—in a new species. Lichen, for example, is composed of fungus and algae; each is part of the milieu of the other in a necessary and beneficial relationship. In this paper, symbiosis is also used in a philosophical, etymological sense, to denote living together, which involves all kinds of interactions from competition and conflict to cooperation and mutualism. No one interaction can dominate others without unfortunate consequences. If all plants were mutualistic and none were competitive, it is unlikely that trees and flowers could have evolved.

4.6.1.2. Evolution & Domestication

The process by which species reorganize their structures to adapt to their environment, as well as modify the environment for their benefit, is called evolution, an integrated, partly open process that selects whole individuals in whole environments. Evolution can be said to flow upward and outward, as well as inward and downward, from the simple to the complex, but also back again. For moths that mimic bark patterns, there are others in the same area that are conspicuous; for herbivores with complicated stomachs, such as deer, there are those with simple stomachs, such as elephants or horses. It cannot be shown that a particular evolution took place by necessity, only that an adaptation had value and the species survived. The consideration of observations can lead to the conclusion that evolution is converging to a single end. Darwin himself did not want anyone to consider evolution a purposive movement towards a goal. Rather he regarded evolution as a bush, growing where it can. Evolution can be considered as a building up of complexity, or an unfolding of patterns, in Maurice Merleau-Ponty's term, a "pattern mixed-upness" of styles of living, as beings radiate through time and space. Evolution does not seem to be a hierarchical ladder or an up escalator, but a history of forms adapting to changing environments.

The adaptation of beings to a changing milieu cannot be perfect. Over-specialization reduces flexibility and the ability to change, but underspecialization reduces efficiency. Beings that survive tend to have a satisfactory level of specialization. Beings that are not optimally (or satisfactorily) adapted are eliminated through competition and stress. Evolution can increase the levels of complexity through the operation of natural events.

Species are defined by their position in the environment and thus are in internal relations within the environment, but it is also true that they define the environment through positive and negative feedback. While some species adapt to a niche, others create new niches. The species is much more than a passive group—it is intentional and flexible, sometimes stress-seeking and maladaptive. Species in their milieu are in dynamic relationships. While relationships are as real as the organisms, the relationships are not necessarily or logically prior. The whole part, or holon, creates the whole as the whole creates the part. The organism creates the ecosystem as the ecosystem creates the organism. The multiplicity of beings and relationships create and are created by the field.

Humanity created new niches for wild animals when people started to domesticate animals. However, candidate animals were distributed around the planet very unevenly. For instance, with mammals over 45 kilograms (100 pounds), Eurasia had pigs, five species of cattle (Aurochs, water buffalo, yak, guar, banteng), horse, and mouflon sheep. Africa had 3 wild pigs, buffalo, and zebras. And, the Americas had bighorn sheep, bison, and boars. In Eurasia, almost all the candidate animals were domesticated. In Africa and the Americas, only one in each region was domesticated.

4.6.1.3. Disappearance & Images

The disappearance of wildlife and wild places to live is a problem. Many people do not miss wolves, but they are very important to keeping the deer populations adjusted and healthy. Pets and domestic animals also need to be considered as competitors for wildlife. But, they also need care, even when it means sterilizing them to keep them from breeding freely. The solutions to this are to save some habitat, that is, do not convert it to tree farms, farms, or roads. Zone the valley, using an ecological plan. Then, limit the takes of all wild species, not just wolves but also deer.

Wolves in Bulgaria, for instance, are excellent hunters and prey on large hoofed animals, such as roe deer and red deer. Since wolves weigh far less than their prey, they must hunt in packs. Although a single wolf could kill a large deer, hunting in a pack is safer and more reliable. Except under rare conditions (such as heavy snow), wolves do not determine deer populations, whose numbers are limited by food supply. Instead wolves cull weak and diseased individuals that lag behind their herds. Wolves help strengthen herds by killing such animals. Wolves are also efficient scavengers of domestic animals that are sick or have died. Old or unhealthy animals can be a burden on a herd, for example, by eating browse that a healthy animal might need or by infecting young deer. By eliminating such animals, wolves perform an important natural function in wild ecosystems.

Their persecution could reduce the complete functioning of ecosystems in immeasurable ways. Wolves are keystone species and an indicator of the quality of wildlife habitat. Their actions are crucial for maintaining the long-term viability of ecosystems. Other predatory species are also supported by wolf kills. These species include ravens, foxes, wolverines, vultures, bear, and eagles. Wolves contribute to an ecological 'balance' and prevent overpopulation in deer and other grazers. Wolves are evidence of the diversity that we value so much, from genetic diversity to the full spectrum of an ecosystem.

All of nature is not human nature, however. There are many other sentient species. All animals, 'two-legged and four-legged,' are equals in the view of Black Elk. Science is only beginning to support this idea in terms of ecosystem functioning. Adolf Portmann shows that every form of life appears as a gestalt, developing in a specific place. All living forms create an image of their environment. Genetics provides the proper image choices for some—frogs, for instance, focus most closely on objects that have the same size and trajectory as flies. Others must learn what is valuable.

Humanity is exploiting nature recklessly, without attention to the minimal health of ecosystems. Yet various societies are working to preserve animals, species, and habitats. Their efforts are described, according to three levels: Individuals, species, and habitats. Ecology supports the uniqueness of individuals in their life-worlds and the interrelatedness of species in communities. Psychological and geographical studies support the importance of healthy places for human beings. The concept of earth as home is proposed as a metaphor for the development of appropriate attitudes and participation in appropriate ways of living.

4.6.2. *Interactions in Nature: Disturbance Exploitation & Interference*

This section examines the parallels between the interactions of processes, of animals and of humans in ecological systems. It concentrates on disturbance and exploitation behavior and contrasts them with the interference behavior that characterizes the nonecological activities of the dominant human, industrial culture. Examples of each will be taken from wild ecosystems, forestry, animal cultures, archaic human cultures, and industrial culture. The word interactions is used, instead of words like 'events' or 'catastrophes,' to describe the feedback and cyclic nature of actions.

Humanity is exploiting nature recklessly, without attention to the minimal health of ecosystems. Many ecologists, such as Eugene Odum, have observed that complex communities have existed for thousands of years in relatively stable environments, even though these environments are characterized by regular disturbance and constant exploitation. These environments are now vulnerable to human interference, which is a different thing from disturbance or exploitation. Disturbance, by definition, is an event that can be caused by climate, biological entities, or other actors. Exploitation is the normal use of a resource or of a species by another species, including the human species (this ecological definition differs from a sociological definition, which means 'selfish or unethical use,' although it may suffer from negative connotations due to the latter); in fact, ecological exploitation has a rejuvenating effect on populations. Exploitation is contrasted with interference, an activity that can degrade, destabilize, or destroy entire ecosystems. Interference is not a form of disturbance, exploitation, or competition; it is destruction without gain to any species; sometimes it is caused by planetary events, but in the case of human interference, it is the destruction of the structures and processes of evolution for large-scale, one-species, short-term gain.

The interactions of living beings in ecological contexts may have positive and negative effects on themselves and other species, as well as constructive and destructive effects on ecosystems and the operation of biogeochemical cycles. Human interactions are also considered. The pandominance of ecosystems by humanity is related to the biological and cultural characteristics of the species. Ignorance and indifference are identified as major reasons for continued interference.

4.6.2.1. Interactions

Living organisms in a given area interact with the physical environment so that an energy flow leads to the defined trophic structures and material cycles that comprise an ecosystem, according to Eugene Odum. An ecosystem can be analyzed into parts, including organisms, energy circuits, food chains, diverse patterns, nutrient cycles, development and evolution, and control. No organism can exist by itself or without participating in an ecosystem.

Organisms interact in a number of ways. Interactions can be positive, negative or neutral in effect. In 'neutralism,' for instance, neither population is affected; in 'competition' each group adversely affects the other for resource use; in 'parasitism' one benefits and the other is adversely affected; and, in 'mutualism' both benefit in a necessary relationship (see Section 4.6.1.1). These kinds of interactions are basically forms of exploitation. Disturbance or interference are also possible.

4.6.2.1.1. Exploitation

Animals and plants, algae, bacteria, fungi, live together in ecosystems. Living together involves many kinds of interactions, from competition and conflict to cooperation and mutualism. Interactions may be reciprocal or complementary. They may dominate or control. Interactions are multidimensional. A wolf, for instance, may howl to communicate, or to restore proximity with a mate, or for simple pleasure. Many animals, such as wolves and caribou, develop together over time, adapting to each other's strategies. Paul Ehrlich and Peter Raven refer to this mutual adaptation as coevolution. Coevolving systems never completely adapt.

Every species uses some part of other species or of the environment. This use is termed exploitation. Insects, diseases, and animals, more than being simply agents of mortality, are native components of complex food webs in ecosystems, and they contribute to the selection of species. In a Ponderosa pine forest in the Pacific Northwest, insects exploit trees; they pollinate some trees and overwhelm others, but rarely more than 1 percent of a forest. Diseases exploit trees; they remove stressed trees—also probably a low percentage on the order of 1 percent. Their effect on the long-term health of a forest, however, is positive.

Birds and mammals eat foliage and seeds; they also disseminate seeds. Mammals, the best regulated of more recent species according to Frank Golley, change their habitats to suit themselves by chewing, digging, and burrowing. Rodents can dislodge earth at a tremendous rate. In many cases, these activities improve the conditions for the growth of vegetation. Mammalian grazing promotes vegetative regrowth and the movement of seeds. Bison and prairie dogs were responsible for much of the character of the American plains. Rodent caches may account for a good percentage of pine seedlings; possibly 15 percent of a Ponderosa pine forest rises from such seed caches. Beavers and other rodents create their own microsystems. Wide-ranging caribou and wolves transfer energy between systems.

Predation increases the survivability of a prey species. Predation also increases the diversity of species, according to Steven Stanley, by limiting the most populous prey species. Rarely do predators kill all of the prey. Rarely do animals interfere with the operation of the biogeochemical cycles in the environment. The exploitation of the system by plants, insects, and animals contributes to the health and continuity of the ecosystem. Exploitation is not chaotic; there are limits and rules.

4.6.2.1.1.1. *Rules*. Animals obey rules of behavior. Many animal communities have codes of behavior that regulate interactions. In birds and less complex mammals, these rules may be very rigid and predictable. With increasing brain complexity, however, learning takes a larger role. For example, young white-tailed deer in Idaho have to learn to cross highways.

They appear to use rules of thumb (not the best phrase), finding a proper balance between safety and reasonable progress, between no traffic in sight and bumper to bumper congestion.

Animals like wolves have behavioral inhibitions against killing too many prey or killing their own kind, against coupling with a mated or disinterested female, or against attacking nonprey species. Animals that break such inhibitions are usually sometimes attacked or ostracized. In general, food is shared by all members of a wolf pack. Adults will regurgitate part of their food for adults who stay behind with juveniles. The members of a wolf pack cooperate bringing down an elk, but then compete for the choicest parts of the prey. Rules are not always strict; wolf mates raising pups may consciously deceive one another to get a break from the responsibilities, according to Michael W. Fox.

The social structure of a wolf pack is most important. Breeding, playing, hunting, feeding and territoriality are tied to social structure. Wolf pups are taught how to behave and how to hunt. Much of the behavior of wolves is directed to keeping the animal's status in the pack or to raising it. Quarrels take place often and the entire pack seems to take an active part. Actual battles, however, are rare. Ritualized squabbles result in few physical injuries. Wolves do kill each other, however. Wolves that behave strangely, such as epileptic pups or adults crippled in the chase, are sometimes killed by the pack. Disputes over the alpha position may end in death. Foreign wolves may be killed if they do not flee. Prey may be killed in excess during times of denning. Rules of encounter are complex and the outcome depends on numerous circumstances, such as the abundance of prey, the size and health of the pack, and stress; that is, the rules often depend on limits.

4.6.2.1.1.2. *Limits*. Mammalian behavior is controlled and population regulated through the use of space in general. Most mammalian populations, wolves for instance, regulate their density well below the limits of the food supply, often by as much as 50-70 percent. Territoriality limits populations, but populations can also be limited by specificity of prey or plant source, size of prey or plant populations, predators, natural events, or individual tastes.

Wolves in the Arctic disperse with the migration of the caribou. According to David Klein, they prefer Caribou to other often more easily obtained species, such as mice. This preference reduces their hunting efficiency, however.

The goals of an organism are limited by the life-images of its species. Each animal is a participant in a field of existence. Using its senses, each participant creates an image of nature, or world (umwelt, life-world, is the term used by von Uexkull), from the sensations that are meaningful to it. Each animal fits itself to its unique world as completely as it can—simple animals to simple worlds, complex ones to well-articulated worlds. Each fits its place as well as it can. Konrad Lorenz, Michael W. Fox, and others have elaborated this kind of fitness in more detail. Each organism is inseparably related to a place; breaking the bond may result in death. Organisms and places shape each other. This is true of archaic human cultures as well.

4.6.2.1.1.3. *Traditional Ways of Human Archaic Societies*. The Chipewyan people in Northern Canada occupy the same territory as wolves and compete for the caribou, although their niches are not identical. Both social systems are adjusted to the hunting of barren ground caribou. Chipewyan hunters depend on animals other than caribou, which migrate out their Indian grounds. The cultural decision to hunt caribou as the primary item of subsistence, however, has produced many similarities between the two species in their utilization of land and in the formation and distribution of social groups. The cultural decision to hunt caribou results also in a population density lower than what would result through other decisions regarding the utilization of resources.

For hunting, Chipewyan use dog teams, snow shoes, and boats to increase their mobility and rifles and bows to supplement the traditional spears. The strategy of the Chipewyan, according to Henry Sharp, is to kill caribou at any opportunity. They increase their opportunities by walking aimlessly, watching, and driving the caribou, although the Chipewyan expend less energy by watching and ambushing. Wolves follow the more active strategy because of their increased and superior mobility. Both species adopt a pattern of dispersing and concentrating with the caribou. The basic choices regarding subsistence patterns, social organization, demography, terrain usage, and yearly cycles, are made on the basis of the internal logic and structural characteristics of the two cultures (wolves do have culture, in the general anthropological sense, according to Sharp and Fox).

Although the two species do not compete directly, both Chipewyan and wolves are predators that put pressure on caribou populations. Sharp suggests that the commitment of both to caribou hunting is ecologically inefficient, since both species could spend more energy on secondary sources of food. For the Chipewyan, a deliberate "underutilization" of moose, rabbit, grouse, birds, and fish, is the result of their cultural values, including their willingness to live below the carrying capacity of the local environment—a characteristic of most hunting/gathering societies—the complex practice of drying caribou meat, and the reciprocity of their kinship system, i.e., caribou is a better basis for future relationships. The cultural decision to hunt caribou as the primary item of subsistence has produced a unique pattern in the utilization of land and in the formation and distribution of social groups. Wolves also underutilize their resources.

Regardless of cultural order or cooperative interactions, part of the process of life is uncoordinated, unfitting, disorderly, unbalanced, and destructive. Therefore, suffering often occurs. Suffering is an unavoidable part of disturbance or exploitation. We cannot intervene in every case, nor can we eliminate the possibility of suffering. We cannot maximize the self-realization of every being, and we cannot make evolution into a perfectly functioning machine; the functionless features of evolution are part of the process, but, we can protect the process. The mode of operation of nature consists of a rhythm of dissolution and reformation. The extravagance and beauty of the natural world features many more species in an ecosystem than would be necessary if exploitation alone were its organizing principle.

4.6.2.1.2. Disturbance

Disturbances in nature are regular but unpredictable events. Disturbances are caused by geological events, climatic events, physical processes, and biological agents. Hurricanes, for example cause disturbances, as do volcanic eruptions, windstorms, tidal waves, disease outbreaks, and acid rain. Disturbance is one thing that causes change in an ecosystem. On a small scale, a single tree falling over is a disturbance. Although an individual dies, species continue. Mortality is a normal part of the life cycle of the forest. The disturbance may be necessary for the ecosystem to continue to mature; for example, according to David Perry, without windthrown spruce that expose mineral soil seedbeds, the northern forest ecosystem would shift to bogs.

Disturbances, if sufficiently regular, become a 'known' feature of the ecosystem. In Florida, some species such as Cypress, need the complete inundation provided by hurricanes to remain healthy. Yet, even catastrophic disturbances like hurricanes rarely damage more than 5 percent of a forest; for instance, the 1938 hurricane in the eastern US blew down less than 4 percent of the trees. As the frequency of a disturbance increases, the forest becomes adapted to the disturbance; even pine plantations in the southeastern United States that are managed with controlled burns are less damaged by lightning-caused wildfires. Many disturbances in forests, such as insect explosions or fires, kill low percentages of trees.

After long periods without a major disturbance, however, a catastrophic disturbance becomes more likely. Where wind and fire are absent, for example, the probability of insect and disease outbreaks increases. By trying to prevent one kind of mortality, ecosystem managers often establish conditions for another kind.

Fire is regarded as catastrophic. In some ecosystems, for instance tall grass prairies in Illinois, fire is required to suppress competition from trees. In some forests, such as lodgepole pine in Washington state, fire is required for the cones to open and the trees to regenerate. Forest fires rarely damage more than 10 percent of the whole forest. Even the Yellowstone fire of 1988, still regarded by some as a tremendous disaster for "Smoky the Bear" policies of prevention (resulting in dead material forming fire ladders), caused limited damage as it leapfrogged along, leaving healthy untouched stands that became the source for the regeneration that is now being observed.

A typical percentage of death is the normal condition of an ecosystem, necessary for its renewal. The rate of death per year in an old forest is remarkably consistent at about 1-2 percent, even with wind storms, fires, disease outbreaks, and animal damage. In some cases, a larger percentage of the forest is affected. For instance, high elevation balsam fir forests are subject to bands of dieback that progress up the slopes parallel to the contours of slopes. These "fir waves" seem to be triggered by cold winds striking exposed forest margins. A new stand regenerates where the trees have been killed.

Disturbance may change the direction of maturity in an ecosystem, but it also is stimulating for those species adapted to it. Disturbance may continue succession or it may deflect it, according to Bormann and Likens. Because of the range of scales and intensities with disturbance, it is a complex concept.

Disturbances that are not part of the history of an ecosystem may cause irreversible changes to the system, because the system has not evolved a defense or response mechanism to such a rogue disturbance. A meteor strike would be such a disturbance, especially if the landform was altered by a crater. Human disturbances, in the form of acid rain or clearcutting, are both novel and threatening. If they are small enough or rare enough, however, the ecosystem may rebound. Very large scale disturbances, such as volcanic eruptions or meteor impacts, can destroy entire ecosystems or disrupt global biogeochemical cycles. However, such very large-scale disturbances are rare, and the ecosystems often have thousands or millions of years to become reestablished, although changed.

4.6.2.1.3. Interference

Although rare large-scale or novel disturbances can interfere with ecosystem processes, the term 'interference' is reserved for constant large-scale or novel effects. The destruction of ecosystem processes in nature by the action of one or more species is rare; any species that did so would become extirpated or extinct, unless it was not dependent on a single ecosystem, as is the case with wolves. Many commentators have accused mammals, wolves for instance, of overkilling their prey. It is fairly well established now, by David Mech and others, that wolves will take prey in excess of their immediate needs. This behavior has been interpreted as useful in maintaining not only the wolf but also secondary predatory and scavenging populations, for example, foxes and ravens. Indian informants are aware of this aspect of the wolf's excess kill, but they attribute to the wolf sufficient foresight to kill an excess of caribou near the den site in order to have an adequate food supply when the caribou are absent. Regardless of the wolves' intent, excess kills of caribou by wolves seem to be linked to the pup-rearing part of the pack that follows behind, as well as providing some food for the reverse seasonal migration—wolves can eat the remains of kills that are up to a year old.

Like wolves, human beings, as part of the process, interact with the individuals of other species or with entire species. Like other mammals, humans change their habitats to suit themselves. Humans have modified animal and plant associations in a different way from other mammals, simplifying patterns of energy and chemical exchange and solidifying themselves at the end of many food chains as a dominant species.

Human populations have increased exponentially, with billions in giant urban ecosystems. Agriculture has produced monumental yields, but only at the cost of tremendous erosion and great subsidies of fertilizers and pesticides. Dams have been built all along rivers, and riverine forests have been cut, altering rivers and fishing grounds. Changes have been made without regard to the long-term impact on the ecosystem or on its human population.

By its influence of all ecosystems, humanity has become a pandominant species. As such, humanity reclaims, overgrazes, clears, depletes, and wastes at a scale that interferes with the stability, processes, and existence of many systems. This pandominance has major effects on ecosystems: Transient perturbations in energy relations (from oil spills and burning); chronic changes/shifts of systems (from dams, irrigation, and chemical wastes); species manipulation (from the import and export of exotics); and interference competition with wild species. One of the ecological consequences of human activity is the degradation of wild habitats for human developments and the introduction of novel elements into the biosphere—elements that have not been added slowly over time as the result of natural processes.

Human beings have contributed to the extinction of species and to the destruction of ecosystems. Human hunters are hypothesized to have wiped out the most of the large mammalian species of the Pleistocene through overhunting—not for future food, but rather from the style of hunting—by driving herds over a cliff (animals already vulnerable due to changes in climate and food supply). There are other instances. In the 1880s, soldiers and cowboys slaughtered buffalo as a political strategy to reduce the resources of native peoples. Farmers and loggers destroyed the dense forests of Ohio and other states. Settlers and industrialists in the Amazon are destroying vast tracts of rainforest, as part of a political strategy to move peasants out of cities. Industrial forestry in the Northwest is content to take a high percentage (well over 90 percent) of a forest for wood and pulp, destroying the basis for the continuity of the forest, as well as all beings that depend on the old-growth, fungi, and physical properties of the forest to live.

Human exploitation at the tremendous physical scale that occurs in industrial states is different from exploitation by other species, because it results in the destruction of the entire system, the very basis for renewal of a system that human beings (as well as other species) need for life. Human actions are damaging global biogeochemical cycles, such as the carbon or nitrogen cycle. For instance, deforestation, burning, wetland loss, and industrial processes are releasing massive quantities of carbon dioxide into the atmosphere, which disrupts the carbon cycle. Although the destruction of large species, from whales to frogs, has a dramatic effect on ecosystems, the destruction of microbes, which generate oxygen and recycle nutrients, has a critical impact on the entire food web. These actions are global, like a large volcanic eruption, but, unlike a volcanic eruption, they are constant and hourly. These human activities are best referred to as interference.

Humanity is calculated by Norman Myers and others to be using over 40% of the ecosystem productivity for the entire earth (56% by 2004, according to Stuart Pimm and others). Humanity influences virtually every ecosystem to some extent, destroying some, interfering directly with many, and exposing the rest to exotic chemicals and materials. Species normally use a percentage of system productivity without disrupting the processes of production. The human species interferes with the processes.

4.6.2.2. How Should We Live? A Discussion of Rules Limits & Actions

The problems of ignorance and inappropriate images are multicultural, ecological, and cosmological, and must be solved on those levels—the entire activity of culture is guided by metaphors. Metaphors emphasize likenesses between living things and languages (or human constructs). A metaphor furnishes a label and emphasizes similarities. It not only defines and extends new meanings, but redescribes domains seen already through one metaphoric frame. A culture that fits a local ecology is adapted and more likely to survive. Fitness is a way of reducing negative effects to make cultures more flexible and longer lived. An understanding of ecology, with an emphasis on limits, can lengthen the life of a culture, but ecology is not enough. Good metaphors are necessary, as are good rules of behavior.

4.6.2.2.1. *New Human Rules*. Human beings have no complete guidelines, legal or philosophical, to interacting with other species in an ecological context. An ecological ethics is a set of rules for living together with other beings. It is based on ecological knowledge, grounded "in the breadth of being," in Hans Jonas' words, founded on principles discovered in existence. An ethics based on ecological knowledge places human behavior in vital social and biological communities in nature. The frame of reference of ethics is enlarged, as Albert Schweitzer predicted, leading to appropriate behaviors in a larger context, through reverence for life. Skolimowski and Callicott recommend a reverence for life ethic. We must develop specific rules to live with other species, more formal than isolated cultures like the Campa and more comprehensive than modern cultures like the French or German.

4.6.2.2.2. *Observing Ecological Limits.* Life involves a vast number of interacting structures. Living consists of complex behaviors whose limits are defined empirically. Animals and plants stay within limits of an ecosystem; for instance, Klein concludes that caribou populations are limited by food supply. Wolves are sometimes limited by stress. Trees are limited by water supply. Traditional human cultures have often stayed within the limits of an ecosystem. Detailed understanding of the plants in a locale allow gathering of food and medicine.

4.6.2.2.3. *Practicing Noninterference*. Exploitation, in the ecological sense, is necessary and beneficial to biological populations. A machine metaphor approach, with its assumptions of interchangeability and quantity, apparently has difficulty distinguishing between exploitation and interference. An ecological metaphor, that is more receptive and reverential, may be more appropriate to understanding organisms and nature in general. Such an approach would stress noninterfering observation rather than controlling manipulation.

A rule of noninterference states that human beings ought to avoid behavior that disrupts essential ecological processes or destroys biotic communities. The rule stated here is concerned with limited and sustainable exploitation of ecosystems already shaped to some extent by human activities. Many other ecosystems, perhaps covering 50 percent of the land area of the planet, would be reserved by law for predominately natural ecosystems or adapted first nations. Noninterference is not indifference, which is diffuse. It is caring. Noninterference will not lead to chaos, poverty, or stagnation. It can permit the rational exploitation.

We need to practice the rule of noninterference so that all beings can enhance their lives and habitats. Noninterference can be derived from nonviolence (or taoistic nondoing, a metaphoric expression for the nonbeing of nature) or even from English Common Law, which is well-established in Western law; it includes a precept: "Use what belongs to you in such a way as not to interfere with the interests of others" (*Sic utere tuo ut alienum non laedas*). This rule could be defined by positive laws and by negative restraints on behavior. This attitude would entail using what is necessary, exploiting some ecosystems completely, changing a place to fit human aspirations, and killing plants and animals for sustenance. But, it would also mean limiting humanity and its technological effects, limiting human use to local impacts, and letting other beings live without interference.

4.6.2.3. Interactional Design

Interference has been a rare phenomenon on earthly ecosystems; it has happened in the past as the result of global catastrophes, such as meteor impacts. Now, interference, as opposed to more limited and predictable disturbances or exploitations, is threatening the stability of all ecosystems. It is dangerous to interfere with the processes of ecosystems because it disrupts the communities on which other species, and ultimately human communities, depend. Furthermore, in the deepest sense, it violates the idea of living together with other species on the planet. The proper relationship of humanity with nature includes competition and exploitation and mutualism, but not interference.

We kill millions of animals in laboratories to insure our safety, we kill billions of plants and animals for food and clothing and products, while indulging in the sentimental preservation of some individuals of other species. How do we incorporate this variety of interactions into design? Should we ban interference activities entirely? What do we design for? Wild animals in place, good domestics? Many original ecosystems supported good numbers of mammals, from mice and coyotes to deer, antelope, and elk. To some extent they have been replaced by domestic species: Dairy and beef cattle, swine, sheep, and poultry. Livestock often outnumbers the human population. Over 60 percent of the cropland production is devoted to feeding them, and over 30 percent of raw materials to housing and transporting them (for example, it takes 5 to 20 calories of fuel to produce 1 calorie of meat). Should design consider the numbers of feed animals. An optimum might be determined by dietary preferences or by the amount of land available for raising healthy free-range domestic animals?

Although many animals, such as cattle and sheep are raised on ranges, they often spend months in feedlots being fattened with grain for human consumption. About 95 percent of this food goes for respiration or ends up as manure. The 95 percent loss is acceptable when an animal is raised on rough ground or when native populations are used for food.

Harvesting some wild animals may be a better alternative than agriculture; this would be cheaper than improving the pasture degraded from overuse. Wild species might be more appropriate on marginal soils. The husbandry system whose forms underlie the foundations of modern thought, excludes wild nature as chaotic and other. We commit biocide on the wrong (or not 'our') animals. The living world faces a massive failure of interspecies dynamics, with great destruction of life and devastating psychological effects.

Pets, as domestic animals and a few wild but caged birds, reptiles, and mammals, need to be considered for fitness into nature. Because of pets, it could be argued, we are less concerned with wild animals and allowing them to slip into extinction. Then, too, we maintain our pets out of context; they are fed food from cans, kept indoors or in cages, and taught to defecate neatly. Zoos, aquaria and aviaries also keep animals alive out of context, out of the conditions that shaped them. Denied the possibility of biological meaning, many of the animals may go mad. We will never understand why they are the way they are if we only study them in our homes or their prisons.

Aldo Leopold's chief concern was the need to reestablish the personal coexisting relation with nature, rather than large-scale impersonal management of resources by a professional elite. What the preservation designer wants is to preserve natural cycles, not a frozen state of habitat like scenes from a Disney movie. As civilization staggers, we can find an ecology and psychology that can be trusted to find balance and compensation, as part of life-support system.

4.7. *Wolves in the Balkans*

The wolf is one of the largest members of the dog family. In the past, wolves have been domesticated to form a domestic alliance with humans. In spite of this, wolves are feared and persecuted, and now are endangered or extirpated throughout much of their range around the world.

Wolves are excellent hunters and prey on large hoofed animals, such as caribou, deer, and elk. Wolves in Bulgaria are timber wolves (*Canis lupus lupus*), which in general live in wooded subarctic regions. Wolves in their original range roamed over all of Bulgaria. There may have been as many as 6000 wolves in Bulgaria then, based on habitat requirements and low human populations. As the human population expanded, they took over wolf habitats, competing with, then hunting and poisoning wolves. The wolf population diminished or disappeared from many areas, such as the Stara Planina Mountains in central Bulgaria. In the 20th Century, the activities of the government and hunting societies virtually eliminated wolves throughout most of the country. Small wolf populations may have remained in the Pirin and Rhodope areas in the south of Bulgaria. Healthier wolf populations remained in northern Greece, Macedonia, Serbia, and likely Albania.

The wolf population was considered to be as few as 100 individual wolves by the early 1970s (this number was also given in the 1999 *World Book Encyclopedia*). Most lived in the Eastern Rhodope mountains. Then the numbers increased slowly, according to G. Spiridonov, a biologist with the Wilderness Fund. By the early 1980s it was estimated that 20 had established themselves on Sredna Gora mountain; in the rest of Bulgaria the number had increased to about 200 individuals. Poisoning was banned, and economic difficulties, along with urban migration, allowed some habitats to open again. Game was plentiful, although after a while, game started decreasing for many reasons, including poaching. Wolves started finding easier prey, such as sheep and cattle, which often were not protected by shepherds or dogs. Over the next ten years the population increased to over 1000 individuals countrywide, with perhaps 20 in the Central Balkan National Park, and the largest concentration still in the Eastern Rhodope mountains in the south (600-700 individuals). There may be 200 now in the Park (Spiridonov, personal communication, 2000). However, N. Spassov et al. (in Biological Diversity of the Central Balkan National Park) state that the “wolf numbers in the park are unknown.”

Wolves increased in many areas after the breakdown of the former regime because the governmental control systems with bounties were no longer in place. Now, due to a dramatic decrease of ungulate populations, which is most likely the result of uncontrolled poaching, wolf populations are becoming endangered. Poachers may have almost completely wiped out ungulate populations in some areas. This may be true also in Romania and Slovakia, as well as in Bulgaria. As a result of decreasing food resources, wolves turn to livestock as easy prey, although since the political transition to democracy, livestock numbers have also been decreasing. This has the effect of increasing hunting pressure on the wolves.

Wolves are still persecuted by hunters throughout the year with the express intention of decreasing their numbers. The Forestry Committee, the national authority responsible for wolf management, estimates that the number of wolves in the country is about 1800 (based on informal questionnaire “window-side” surveys of forestry units). This has resulted in the permission to kill wolves outside the Park and to take wolf pups from their dens. Although the use of poison has been officially forbidden by the Forestry Committee since April 1993, as of summer 1996, there is evidence of illegal use of poison (griffon vultures were found dead as a result of feeding on poisoned baits).

Anthropogenic impacts have resulted in dramatic changes in wolf numbers, as noted, but also in wolf habitat and wolf behavior. For example, wolves are now active almost exclusively at night, rather than during the dawn or evening, when they are more vulnerable to human interference.

4.7.0.1. Ecology of Wolves

The niche of the wolf is as the northern predator of large mammals. Since wolves weigh far less than their large-mammal prey, they must hunt in packs. Although a single wolf could kill a large ungulate, hunting in a pack is safer and more reliable. Except under rare conditions, such as very heavy snow packs, wolves are not a limiting factor for ungulates, whose numbers are limited by food supply. Instead wolves cull the population of young, weak, diseased, or elderly individuals that often lag behind their herds. Wolves help strengthen herds by killing such animals. Wolves are also efficient scavengers of domestic animals that are sick or have died. Old or unhealthy animals can be a burden on a herd, for example, by eating browse that a healthy animal might need or by infecting young deer. By eliminating such animals, wolves perform an important natural function in wild ecosystems.

Wolves are keystone species and an indicator of the quality of wildlife habitat. Their actions are crucial for maintaining the long-term viability of ecosystems. Other predatory species are also supported by wolf kills. These species include ravens, foxes, wolverines, vultures, bear, and eagles. At the head of a trophic cascade, wolves also limit these other predators. Wolves contribute to an ecological 'balance' and prevent overpopulation in deer and other grazers. Wolves are evidence of the diversity that we value so much, from genetic diversity to the full spectrum of an ecosystem. Their persecution could reduce the complete functioning of ecosystems in immeasurable ways.

4.7.0.2. Project Areas

Evidence suggests that the wolf populations in the Pirin and Rhodope areas in the South of Bulgaria are relatively healthy and stable, as seem to be those near the borders of Greece, Macedonia, and Serbia. Therefore, research in Bulgaria is currently concentrated in two areas: Central Balkan National Park (CBNP) and Kraishde—a third area, Strangja, was studied but does not have enough data for discussion. The CBNP is in the center of the nation, surrounded by many small villages, towns and a few large cities. In addition to offering easy access, park rangers regularly traverse the park. The Kraishde region in western Bulgaria stretches to the Serbian border. Habitat is changing rapidly due to urban migration and changes in herding and land use, offering new territory for wolf recolonization. The Strangja Reserve was a military reserve for over forty years, used for practice and exercises, and thus also offers dramatic habitat changes.

Other areas in Bulgaria were visited and examined for presence of wolves, but were not part of formal studies as of this report. Romanian wolves have been studied extensively by Christoph Promberger and the results reported by him. Wolves in Greece have also been studied under a separate program, and are not described here.

4.7.1. *Wolf Studies & Research in the Stara Planina of Central Bulgaria*

By Anton Stanchev, Pavel Kolev, and Courvin Woulfe

Although scientific studies of large mammals in Bulgaria started in the late 1800s, the first systematic information was published in 1925 (V. Kovachev, 1925, *The Mammal Fauna of Bulgaria*). Until the 1950s most studies focused on micromammalia. In the 1950s and 60s, several books addressed the "damage" caused by "harmful" predatory species, such as the wolf (P. Zimina, 1962, The Mammals of Bulgaria). Research intensified in the 1970s and 80s; comprehensive studies of threatened species were established. G. Spiridonov and N. Spassov wrote chapters on large mammals, especially wolf and bear, in the *Bulgarian Red Data Book* (Spassov and Spiridonov 1985).

When the National Park Central Balkan was established in 1991, it was declared to preserve areas of high natural significance, containing many rare and endangered animals and plants in a remarkable diversity of habitats of international significance. The Park stretches along the spine of the east-west mountain range in central Bulgaria. The Park is the third largest protected area in the country (with 71,670 hectares); it includes 9 strict nature reserves (IUCN category I), as well as forest and agricultural lands. The Park is managed by the Ministry of Environment and Waters; a Park Directorate, composed of advisors and a professional staff of over 70, controls activities within the Park.

The Park has been the object of studies by several scientific units, including the Bulgarian Academy of Sciences, the Institutes of Ecology, the Institute of Zoology, and the Institute of Forests. Specialized studies on many species in the park have been conducted by the Institute of Ecology, Wilderness Fund (Sofia), Departments of the Sofia University, and the Polish Academy of Sciences. Except for the one survey of wolves, no other studies have been done on wolves.

Spiridonov made inquiries in the State Forestry Departments in 1989 and 1990; these surveys indicated that the population had begun to increase. Periodical surveys have been conducted to determine the size and distribution of the territory used by the packs in the Park; surveys have been sent to forestry units to get data on wolf numbers (Spiridonov et al.). The Park has been surveyed for signs of wolf activity usually during late winter. Roads and trails within the survey area have been traversed and inspected for recent wolf activity. Tracks, scat, territory markings, and kill sites have been documented in an effort to determine the number of wolves using the area.

The Central Balkan National Park Management Plan (August 2000, Description Volume, P. 8) states that "the Central Balkan is not Bulgaria's best studied area." Furthermore, in the prescriptive volume, the Management Plan continues (Prescriptive Volume p. 426): "The study of the ecology of predators is in its infancy in Bulgaria (wolf)." And notes that there are only "Vague ideas about condition of smaller species such as weasel, polecat, wild cat, pine marten." In fact, there are large gaps in the study of wolves in Bulgaria. G. Spiridonov and N. Spassov (*Bulgaria's Biological Diversity*: Conservation Status and Needs Assessment, p. 468) state that the "most poorly studied aspect of the large mammals is their ecology." This is particularly true for carnivores.

Biologists monitor wolves and make population estimates using a combination of techniques. The primary methods used by the Park so far are surveys for sign (tracks, scat, and snow urinations), interviews with hunters and foresters, and incidental observations, according to the Park Management Plan and Biodiversity Study, and to Bulgaria's Biological Diversity documents.

In 1997 a questionnaire was sent to the forestry enterprises and to the Union of Hunters and Fishermen. The data gave much information about wolf sightings and some about body weight figures (where wolves had been killed). But, as Spassov et al. note (2000), the "opinion for a sharp increase do not seem to be related to an actual population study."

A field study was conducted from November 1997 to February 1998 in the Rositsa area and partially in the Karlovo and Aprilci areas. The data suggested the presence of "5 wolves" in the middle and western areas of the Stara Planina (Spassov et al. 2000). Spassov et al. concluded that "No up-to-date figures of this carnivore in Bulgaria exist, but there are probably more than 1000 animals at least."

More research was needed. Wolf research is used to determine habitat preferences, prey selection, movement corridors, mortality causes, and the location of critical areas such as den sites and trails. Animal abundance is one appropriate measure for gauging the success of wildlife management, monitoring the status of threatened and endangered species, and determining the outcome of many experiments. Thus, estimates of abundance are among the most important information needs of wildlife managers. Unfortunately, wolves, like many carnivores, are cryptic, secretive, and occur at low density. Accurate estimates of abundance are seldom obtainable for such species, so indices of relative abundance often substitute. This information can have an important bearing on the management of protected areas, and may influence selection of locations and levels of human use of trails, facility location, and seasonal closures in critical areas, such as den and rendezvous sites.

Figure 471-1. Bulgarian rangers examine an Elk bed, *Stara Planina* 2001

Because of the size and expanding distribution of the wolf population in the Park, not to mention the number of other unknowns, the Park needs to increase these studies into a formal population study and monitoring program, and supplement these techniques with newer techniques, such as radio telemetry and mathematical modeling. The Management Plan (August 2000, P. 26) discusses possibilities for scientific research and concludes that there is an enormous "range of still-untouched issues and scientific levels." Although education activities have been started, there is still no infrastructure or sufficient partnerships in the field. Interestingly, the Management Plan (P. 27), for fundamental research, suggests developing a research facility using existing buildings in the Park.

4.7.1.1. Community Need

For a long period of time, Bulgaria has been influenced by the traditional idea that large predators, mainly the wolf, are the enemies of game and livestock. In the last several years, the opinion became somewhat more moderate, and wildlife managers accepted the role of the wolf in ecosystem dynamics, but hunters and gamekeepers in the field do not want to accept the existence of a large population of wolves. The traditional myths and folklore, not to mention the evidence of wolf predation—wolves also act as efficient scavengers of large mammals that die from starvation or injury—are hard to overcome. Sick, injured, young, or aged animals that lag behind their herds make easy targets for wolves.

Public attitudes towards wolves, especially in rural areas, are still very negative. Many people fear wolves, because of their reputation in myth and folklore, and also because they believe wolves attack human beings—the howl can be frightening. But, wolves avoid people as much as possible. Many people hate wolves because they kill domestic animals, such as sheep and cows, but wolves prefer to eat deer (statistics in the United States show that coyotes and wolves kill only 2.7 percent of total livestock losses, 117,400 cattle out of 4.3 million, according to the 1995 National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture). Wolves are blamed for many livestock losses, which may result from poor health, accidents, or feral dogs. In fact, according to the Central Balkan National Park Management Plan (August 2000, p. 434), poaching causes more losses of game animals than wolves. Many hunters dislike wolves because they kill game animals, such as elk and deer, but wolves usually only take sick or young individuals and not healthy trophy animals.

Many attitudes and problems can be overcome by research and education. Research needs to be performed not only to understand the status and ecology of wolves in the ecosystems, but also to understand the extent of the threats to the species. Social and political measures cannot be taken until there is a sufficient knowledge base for the decisions. Neither wolf policy nor wolf management can be addressed until wolf ecology, numbers, and damages are known definitely. Studying wolves will do much to preserve sufficient habitat for wolves and benefit wildlife conservation.

Education can demonstrate that wildlife is important to people and communities for four main reasons: (1) aesthetic value (beauty), (2) economic value (especially tourist income), (3) scientific value (knowledge), and (4) survival value (the health and diversity of ecosystems). Wolves control game animals. This gives them an economic value, because they increase the value of game animals. Wolves have other economic values as well; in some countries, people spend hundreds of thousands of dollars to go and see wolves. Wolves also have an aesthetic value; they are beautiful animals, which is why people like to see them. They are wild and different; this gives them a scientific value. We can study them, to understand the operation of nature and the workings of biodiversity. Regarding biodiversity, even St. Thomas Aquinas thought that although one Angel is better than a stone, it does not follow that two Angels are better than one Angel and one stone. As for stones, so for wolves. Finally, wolves have a survival value, simply because they have existed as part of wild places for millions of years. If people cannot learn the need for wildlife conservation, the threatened and endangered species will become extinct. Then, many others will die out. If this happens, human beings will lose much of great value that cannot be replaced.

Although education and research about wolf ecology is essential, wolf policies may not be successful unless the human population is healthy and stable, and is related to the carrying capacity of the land, which would include also the populations of wild animals. Then, wolves and people might be able to live in harmony again.

The Park itself is expected to meet many needs of the regional community. The Management Plan (August 2000, p. 30) states that "there are no conflicts of interest between the legal forms of use by visitors and the nature conservation activities." But, this is said without knowing the carrying capacity of the park for animals or for humans. Research into how the Park operates ecologically must be done before we can say that we know that the needs of local people can be met.

By themselves, the national parks are not large enough to sustain a healthy wolf population; Spassov et al. (Status of the Large Mammals in the Central Balkan National Park, Ministry of Environment and Waters, Sofia, 2000, P. 425) recognize that the park is “not a fully independent and self-sufficient ecosystem as far as large mammals are concerned.” So, to have healthy populations, the people of rural Bulgaria must expect to live with wolves outside the park.

Studying wolves will do much to preserve sufficient habitat for wolves and indeed all large predators. A large-size preserve, or well-buffered series of national parks, sufficient for wolves should be sufficient for all other smaller predators, including fox, wild cats, and martens, and for all plant species as well. Understanding the role of wolves in wild ecosystems will help to promote wildlife conservation. The combination of large forested areas, human tolerance (or decreasing human populations), and the inefficiency of the former political system gave the wolf a chance to survive in Bulgaria (and in other Eastern European countries).

Research needs to be performed not only to understand the status and ecology of wolves in the ecosystems, but also to understand the extent of the threats to the species. Social and political measures cannot be taken until there is a sufficient knowledge base for the decisions. Neither wolf policy nor wolf management can be addressed until wolf ecology, numbers, damages, are known definitely.

If people ignore the need for wildlife conservation, the threatened and endangered species will soon become extinct. Many other linked or dependent species will also face extinction. If this happens, human beings will lose much of great value that cannot be replaced.

Threatened species are generally abundant in some areas, but they face serious dangers nevertheless. These dangers may result from unfavorable changes in the environment, as well as from extensive hunting, fishing, or trapping, or even to collecting by hobbyists. The timber wolf, a threatened species, is plentiful in some places, but its overall numbers worldwide are being steadily reduced by hunting, trapping, and poisoning.

The success of wildlife conservation depends on a knowledge of the ecology of a species. That is, it requires an understanding of the way in which a species lives, and how it relates to everything, living and nonliving, in its environment.

Figure 4711-1. Distant view of mating area of alpha wolves 2002

4.7.1.2. Future Sustainability of Park Wolf Populations

The sustainability of the population depends not only on direct Park policies and regulations, but also upon numerous other factors outside the Park. Furthermore, since the park size alone is insufficient, and wolves are likely to wander beyond its boundaries, where they may be in danger, a larger countrywide plan is necessary to guarantee the sustainability of the wolf in Bulgaria.

According to the Management Plan (Description Volume, p. 3), "the park area is insufficient for 40-50 protected bird species and 30-40 mammals." If their territories exceed the park area, then they must be protected in buffer zones. The park also is narrow and has a poor interior/exterior area ratio for interior species. Loss of land is main threat to diversity (Description Volume P. 2). Human disturbance is main threat to stability. Furthermore, according to the Management Plan (P. 50), there is only indirect evidence of sustainability of the ecosystems in the park. Wild boars have increased in alpine meadows, for instance, while chamois have decreased dramatically. Research is needed to determine what levels of wildlife and human activities are sustainable.

The current Park plan is based on earlier studies based on questionnaire surveys and notations of signs done on a regular basis. The Biodiversity Plan for Bulgaria notes that population studies are needed. The current estimates of wolf population numbers have allowed the status of the wolf to be changed from "endangered" to "protected." Wolves can still be shot and killed outside of the park. More research is needed to determine the status of this species. This proposal is intended to fill the gaps in knowledge so that wolf programs and policies can be implemented, and sustainability of populations can be addressed.

Although education and research about wolf ecology is essential, wolf policies may not be successful unless the human population is healthy and stable, and is related to the carrying capacity of the land. That carrying capacity would include also the populations of wild animals, including the wolf.

4.7.1.3. Community Initiative & Cross-cultural Exchange

Several groups, in addition to Park personnel, have been concerned with studying wolves and educating people about wolves. Green Balkans has expressed interest in wolf research programs and in educational programs. The Balkani Wildlife Society has also expressed interest in working with wolf projects this year.

There are also international groups, such as the World Wildlife Fund and Humane Society, which are interested in protecting wolves in national parks. Through another NGO or the Park itself, it might be possible to set up a program so that students and scholars from other cities and countries can participate in wolf studies in the Park.

Many people, including scientists and volunteers, have expressed interest in helping to study wolves in the Park. The Park itself is very interested in exchange activities and has promised to consider ways of incorporating it in the mission and activities of the Park.

People in countries without wolf populations might consider taking vacations in areas that had healthy wolf populations. For some kinds of research projects, such as watching in the field and at night blinds, it might be possible to attract students and tourists who would pay for the opportunity to work with wolves (as is currently done is several other countries).

4.7.1.4. Goals and Objectives

The primary goal of this project is to take a snapshot of wolf presence in the two easternmost regions of the Park. A secondary goal is to train the Park personnel in wolf survey techniques. For this project, selecting an appropriate survey design is dependent on establishing clear objectives. In general terms, there are three objectives that pertain to this species inventory project: (1) to obtain baseline data on the abundance and distribution of species in question, wolves, (2) to monitor changes in abundance, composition, and distribution of wolves, and (3) to measure the direction and extent of these changes.

There are three broad levels of intensity at which inventories can be conducted: presence/not detected (possible), relative abundance, and absolute abundance. The selection of a level of intensity will depend on survey objectives. For this project the first level will be addressed.

4.7.1.5. Methods & Designs

For a project of short duration, only a "presence/not detected" survey will be used. The project will begin as soon as feasible. Two scientists, working with two PC volunteers, two regional directors and approximately 10 park rangers, will work along identified transects for a three-day period, in at least 4 groups. After the survey, data will be entered into the Park database from standardized forms.

4.7.1.5.1. *Presence/not detected Using Design Components*. Presence/not detected surveys are designed to determine a species' occurrence in an area. Presence/not detected is the simplest measurement of a population. Generally there are two goals of a presence/not-detected inventory: (1) To make a species list for a study and (2) To determine species/habitat associations. The former can be used to determine species richness, while the latter helps to clarify distribution and habitat association of a species. These surveys require design components.

Design Components are geo-referenced units that are used as the basis for sampling, and may include geometric units, such as transects, quadrats or points, as well as ecological units, such as caves or colonies. A "sampling unit" is a special class of Design Component, which also includes the various nested pieces of geometry that are used in designing a survey, but are not necessarily relevant to statistical calculations. For example, a large mammal survey may utilize a grid as well as scent stations along that grid. Both of these are Design Components, although only the former is used in abundance calculations.

4.7.1.5.2. *Stations as Design Components*. Sampling stations (or points) involve the collection of data at one point in space. Stations may be randomly located, but often they are placed systematically at points separated by standardized distances. Stations are usually spaced so that no individual is counted twice. Interstation distance is generally dependent upon a species home range requirements with larger distances for larger animals. This method, repeated at several stations, can provide a list of species present in an area.

4.7.1.5.3. *Transects as Design Components*. A transect is a linear sample unit, which usually does not have width. Transects can be conducted on either foot, motor vehicle, or aircraft. They can follow predetermined straight lines, contours, watershed drainages, or paths. Species may be sampled continuously along the transect or at fixed points along it. Several different types of transects are used in wildlife censusing. Transects are expected to be utilized in several ways within the Park. An encounter transect is a survey area in the form of a long continuous line along which observed species are counted continuously or at fixed points, regardless of the distance from the line. Generally these transects are used to provide species community composition and general distribution information. Encounter transects are generally used only for presence/not detected surveys because the lack of a measure of area surveyed makes it impossible to estimate population size.

4.7.1.5.4. *Habitat Features as Design Components*. In some cases, a habitat feature may be used as a Design Component. An explicit feature of habitat may be the most logical unit for the basis of sampling in certain cases. In such cases, surveyors are chiefly interested in surveying a known habitat feature, such as paths, wildlife trees, bat hibernaculae, or bird nests, in an effort to determine occupation or to count or estimate the number of individuals that use such a feature. Habitat types or large landscape features are not generally used as Design Components, as these are more appropriate as Study Areas or strata.

4.7.1.5.5. *Observations*. An observation is an encounter with the focal taxa or with its sign. An observation is made when a surveyor visits a Design Component on a specific date at a specific time. Each observation may be geo-referenced in itself or simply by association with each specific Design Component. Observations are recorded on specific Animal Observation forms and include information on species, sex, age class, activity, and measurements.

Often, field workers such as Park Rangers make ad hoc observations of wildlife species as a consequence of spending long hours outdoors. These incidental observations can have considerable value to provincial conservation programs, particularly when the observations involve red- or blue-listed species, or critical habitat features. When making an observation of a red or blue-listed species, they accurately record their location. A fairly simple form allows them to record observations of species and habitat features which were not collected as part of a systematic survey. All field personnel carry several copies of this form with them at all times in the event that they encounter noteworthy species.

4.7.1.6. Limitations of a Presence/not detected Survey

The general objective of presence/not-detected surveys is to determine whether a species is present to document species geographic ranges or species diversity in an area. To determine species absence or local extinction in an area is more difficult. Some species, such as the wolf, are very difficult to detect because they occur at very low densities, possess a cryptic nature, and show a great degree of spatial and temporal variability in geographical distribution. Therefore, the documentation of absence or local extinction can occur only after survey efforts are replicated both spatially and temporally for a longer time period. Given these constraints, the results of presence/not-detected surveys should always be phrased as a success or failure at detection, rather than a judgment of absence or extinction.

Nonreplicated presence/not detected surveys cannot yield data having statistical value; however, it may be possible to "upgrade" surveys to employ methods used for relative abundance. This way the data can be used as preliminary data (for power analysis or sample size determination) for planning of relative abundance surveys. In many cases it may be more effective to use relative abundance methods to document changes in the geographical ranges of species. It is useful to discuss some general guidelines for optimal sample sizes to use in presence surveys. In all cases the sample size for determination of presence will depend on assumptions that can be made regarding species density and distribution. These assumptions may vary markedly between Study Areas and habitat types. Therefore, the calculation of sample size cannot be generalized to all other areas or all other studies. In addition, a preliminary survey using replicated relative or absolute abundance methods is needed to make appropriate sample size calculations.

4.7.1.7. Project Management & Monitoring for Central Balkan Park

Continuous evaluation is an integral part of this project. Using principles from Adaptive Management and Matrix Management, the project will be refined and improved continuously for its duration. Both the product and the process will be addressed during this continuous formal evaluation. The PCV will monitor the progress of the project and evaluate its success, based on the criteria listed previously, and using appropriate scientific procedures and standards. The PCV makes daily notes of work on the project, as well as enters the data from surveys. US sponsors will receive a summary report at the end of the project, in narrative form, unless they require special reporting conventions.

4.7.1.8. Project Summary for Central Balkan Park

The purpose of this project is to update the field surveys in the northern and eastern regions of the park. It is recognized in the Park Management Plan (August 2000, p. 464) that many “species need individual management plans urgently and with priority: chamois, bear, red deer, wolf.” A management plan for wolves requires monitoring of dynamics, roles, and even social issues such as poaching.

In addition to the park fauna expert, district rangers and Peace Corps ecologists, two zoologists from Sofia will be hired to coordinate parts of the survey (they participated in the previous survey in 1998). The timing was after the wolf mating season, when females were active with denning activities, but before whelping. Three teams were formed to survey different regions simultaneously; all teams concentrated on the reserves on the north and southeastern edges of the park.

In this season, the researchers were able to track wolves to determine the movements and activities of all members of the pack. By following the tracks of wolves and their prey and looking for other clues in the snow, researchers can piece together events of movement and hunting. In order to avoid disturbing wolves, researchers generally rely on “backtracking” (following the wolf tracks backwards from the direction the wolves were traveling).

Figure 4718-1. Rangers tracking a wolf family (4) across a road.

The park provided most of the labor including the park rangers, Peace Corps Volunteers, Chief of the Fauna, computer expert, and general support. The park also provided all of the equipment, including computers, binoculars, mobile telephones, maps, tape measures, field guides, and notebooks and pens. The park paid for most of the travel related to the survey, as well as telephone support, and use of the park vehicles.

This survey was crucial to determine wolf numbers and activity as quickly as possible. It was part of a complete strategy for population studies and monitoring that was necessary to establish a scientifically based policy for predators in the Central Balkan National Park (the NPCB Management Plan, August 2000, p. 458, recommends monitoring wolf populations, as well as using additional field techniques with the participation by the park team, then assess actual damages by wolves to domestic animals).

4.7.1.8.1. *Results and Discussion*. A previous field study was conducted from November 1997 to February 1998, partially in the Karlovo and Aprilci areas (which were now duplicated in December and February), and in the Rositsa area. The data then suggested the presence of “5 wolves” in the middle and western areas of the Stara Planina (Spassov et al. 2000).

In the northeastern side of the park, we had found evidence of four wolves, obviously a pack with two young adults. This matches the number of December 1997. We were tempted to say that the population is stable, but did not have enough information. In the southeastern part of the park, we found ambiguous evidence of only one female individual, so it seemed that the numbers there also matched.

4.7.1.8.2. *Success and Obstacles*. The major successes of the project were: that it duplicated in terms of area and season, an older survey; that it involved people from four different organizations (Museum, Wilderness Fund, Central Balkan Park, and the Peace Corps); and that it was accomplished on a minimum budget. The objectives did not change between the planning and execution of the project. Although over 6 rangers were trained, only 4 outsiders were invited and only 2 of them participated.

The weather either provided too much snow or not enough for good tracking, but we were pleased that we had results. A major problem was public opinion. Public attitudes towards wolves, especially in rural areas, were still very negative. Many people feared wolves, because of their reputation in myth and folklore, and also because they believed wolves attacked human beings. Wolves were blamed for many livestock losses, which may have resulted from poor health, accidents, or feral dogs. In fact, according to the Central Balkan National Park Management Plan (August 2000, p. 434), poaching caused more losses of game animals than wolves.

Working with Forestry and Agriculture was a major problem. Alan took the new design of wolf areas and paths to Anton to ask that it be sent to the Forestry Units, but he said that it would be ignored if the Park sent it. So, Alan arranged for a meeting with Dr. Boshinov at the Ministry of Environment and Water; he essentially said the same thing, and suggested a name at Forestry. Forestry refused to make an appointment. However, we spoke with some of the foresters to get some information on an informal basis. We also tried to get the printouts of the taxation of wolves from Forestry.

4.7.1.8.3. *Conclusions.* The indicators of wolf presence are the signs that can be seen and recorded; these include scat, tracks, fur, vomit, and kills. Although this project was indeterminate, e.g., it could never be finally finished, the next phase of the project was for the park to implement biannual surveys, one in the winter, when snow-tracking can be used to advantage, and one in the summer, when offspring can be counted. Further surveys were scheduled for 2002 and 2003.

This project was very valuable for not only collecting data but for demonstrating that formal presence detected surveys are possible on tight budgets and yet valuable for collecting information needed for species management plans, especially for Red Book vulnerable species such as wolves. Combined with the incidental observations of the rangers and scientists throughout the Park, these observations permitted us to state that there was wolf presence in the Park.

Nikolai Spassov et al. (in "Status of the Large Mammals in the Central Balkan Park," *Biological Diversity of the Central Balkan National Park*. Ministry of Environment and Waters, 2000) state that the "wolf numbers in the park are unknown." This was still true. Only regular annual surveys, some with more advanced techniques, would determine absolute, or even confident relative wolf numbers. Because of the size and changing distribution of the wolf population in the Park, not to mention the unknowns, the Park needed to increase these studies into a formal population study and monitoring program, and supplement these techniques with newer techniques, such as radio telemetry and mathematical modeling. Furthermore, the fate and sustainability of the wolf population depended not only on direct Park policies and regulations, but upon numerous other factors outside the Park. Furthermore, since the park size alone is insufficient, and wolves are likely to wander beyond its boundaries, where they may be in danger, a larger country-wide plan is necessary to guarantee the sustainability of the wolf in Bulgaria. Because the wolf is a Red-listed species, Bulgaria will have to stop hunting wolves for bounty in order to be in compliance with accession to the European Union. The banning of hunting, more than any other policy, would allow wolf populations to become stable.

4.7.2. *Project Area 2. Kraishte Region in Western Bulgaria*

By Elena Tsingarska, Alexander Dutsov, & Courvin Woulfe

The purpose of this project was to establish the absolute number of wolves in the Kraishte area of Bulgaria; the project was also part of a larger effort by The Balkani Wildlife Society (BWS). BWS had been actively working in the field of wolf study and conservation since 1993, starting with programs in western and southern Bulgaria. With money from several sources, including Bernard Theiss, USAID, and the G.P. Marsh Institute, Balkani started a project on radio-telemetry of wolves in the Kraishde region. Balkani also exchanged data with carnivore projects in Macedonia, Yugoslavia, Greece, and Romania. In fact, the Carpathian Large Carnivore Project, under Dr. Christoph Promberger in Romania, help provided help for trapping and radio-collaring.

To address problems with predation, the Balkani Wildlife Society started a program to give guard dogs (Karakachan breed) to shepherds in western and southern Bulgaria. But, educating people, especially children, will do more to create a climate of understanding and acceptance for wolves. Balkani has also started an educational program in some of the schools, to tell children about wolves and ecology. Whenever we asked children if they wanted to live near wolves, they said yes (and these children are sophisticated about domestic and wild animals). We agreed that we would not want to live in a wolf-less Bulgaria, much less a wolf-less world.

Figure 472-1 Karakachan guard dogs Arul & Shara resting in their barn

4.7.2.1. The Region Itself

The Kraishte area (in middle-west Bulgaria) is lightly populated and in fact the population in most villages is declining. Although the regional capitol Pernik is industrialized, the villages to the west have made their living raising sheep and other domestic animals. As the numbers of people have dwindled, the area for grazing has been reduced by tree-planting by the neighboring forestry enterprises. The human activities are not as intensive as in the past, and carnivores, such as wolves, are returning to the area—more rapidly and in greater numbers than in the north, east or south of the country.

The number of livestock has sharply decreased in a comparison with the past. Before the socialist time each village had had a thousand or even several thousand sheep. Nowadays there were about 200-400 sheep per village. Each family had only few sheep or other livestock, so each sheep taken by wolves was a big loss for the owner. This was one reason to concentrate the activities of providing shepherds with livestock guarding dogs. The local people's knowledge about the species' natural role was at a low level. The general attitude towards wolves was negative, as in other parts of Bulgaria. Public awareness and education activities had been conducted here. The BWS had been doing analysis of the local population in this region since 1997.

4.7.2.2. Project Background & Description

Dutsov and Tsingarska worked with Groups in southern Bulgaria to determine wolf numbers there. They worked also with the Greek Government and other groups on to exchange information on wolf numbers there, as well as in northern Greece. After the equipment was received, two teams of four were formed; they were trained by Dutsov, who had received training from Dr. Christoph Promberger in Romania; furthermore, the trapping expert from the Romania group helped train on trapping techniques. Team members included: Elena Tsingarska-Sedefcheva, Project Co-coordinator, Alexander Dutsov, Project Co-coordinator, Kostadin Valchev, Daniel Alexiev, Sider Sedefchev, Atila Sedefchev, Katerina Rakovsk, Marcella Crider, Amy Ihrke, and Courvin Woulfe.

Western Bulgaria is lightly populated and the human activity has been decreasing. The large pastures from the past have been afforested with pine plantations, which gives good shelter of wolves. The area is not popular among tourists, so it could provide good possibilities for field work for wolf analysis.

The people in western Bulgaria, who are relatively poor, are more vulnerable to wolf predation of their flocks. Research needs to be performed not only to understand the status and ecology of wolves in the ecosystems, but also to understand the extent of the threats to that species. Social and political measures cannot be taken until there is a sufficient knowledge base for the decisions. Neither wolf policy nor wolf management can be addressed until wolf ecology, numbers, and damages are known definitely. The wolf population itself in this region may be vulnerable; although it seems to be increasing, there is little information about the amount of increase or stability of the packs.

This project was run from a small office in Leva Reka in the Kraishte area. This office was given to the BWS for this project and remodeled. The teams met and worked out of this office. Team members will be housed in the near-by village of Sadovik. The primary office of the Balkani Wildlife Society is in Sofia, although it has a small satellite office in Pernik. Over several years the BWS has organized surveys using its staff and volunteers. The employees in the local forestry authorities have been providing us with valuable information. Mayors, officials and teachers in the small villages have also been approached.

The overall aim is to obtain data about wolf ecology and biology in the area of Western Bulgaria, which information to be used for preparation of a national wolf conservation strategy (which has been called for in numerous publications, such as the Biodiversity Study for Bulgaria, and which is urgently needed). For any plan to be effective, it has to increase the people's knowledge about wolves, which can decrease wolf-human conflict.

The most important objectives are:

1. To capture 5 wolves in April (after acquiring and testing capture techniques and new equipment)
2. To observe the wolves for 60 days and record data on their numbers, health, movements, and diet. To obtain baseline data on the abundance and distribution of wolves in the area, and enter it into the database
3. To monitor changes in health, abundance, composition, and distribution of wolves, and to measure the direction and extent of these changes. To continue monitoring of wolf activity and interactions between packs and individuals, using simple presence-detected methods (signs).
4. To acquire important knowledge of the predators, especially wolves, by using special-

ized sophisticated equipment. To determine the absolute number of wolves, as well as details of wolf ecology and biology, which will serve as the basis for our conservation strategy. Absolute numbers of wolves in the area should be determined before creating any kind of management plan (without knowledge of numbers, birth and death rates, and emigration and immigration rates, any plan may not be appropriate or effective)

5. To decrease the number of animal losses by wolf predation by 30 percent within the 60-day period
6. To help the residents understand what they can do or change to avoid losing livestock. To improve the understanding of local people about wolves and predators in general, through meetings with all the local mayors and shepherds. To increase the support from local shepherds and village representatives for these efforts.
7. To educate and to train the Society members in capturing or monitoring techniques, so that they can extend the program with less help from the Romanian group. To build two more (professional and voluntary) teams of people who have the capability for monitoring wildlife, especially wolves. To increase the efficiency of wolf monitoring efforts, by building volunteer and professional capacity and including them in sister projects.
8. To document the methods used (for capture, as well as for getting data, and explaining the data to residents), and to identify which ones were effective To create a model for optimum wolf-human interactions in natural and agricultural settings (this would be easy to replicate for other Bulgarian projects).
9. To make this knowledge available to other scientific and governmental groups, through a Project database and through special reports and publications. To produce articles detailing the project, so that it can be used in other parts of Bulgaria.

Figure 474222-1. Alex with 2 volunteers tracking 2001

4.7.2.3. Methods

Many of the methods used by Balkani were the same as for the Central Balkan National Park—Presence detected, Sampling stations, Transects, Habitat Features, and Observations (including night blinds)—and are not repeated here, other than in results.

4.7.2.3.1. *Observation and Tracking was a major method.* An observation is an encounter with the focal taxa or with its sign. An observation is made when a surveyor visits a Design Component (transect or location) on a specific date at a specific time. Each observation will be geo-referenced by association with each specific Design Component. Observations are recorded on specific animal observation forms and may include information on species, sex, age class, activity, and measurements.

Non-replicated presence/not detected surveys, as done previously in the Park, cannot yield data having statistical value; however, it is be possible to "upgrade" surveys to employ methods used for relative abundance. This way the data can be used as preliminary data (for power analysis or sample size determination) for planning relative abundance surveys. It may be more effective to use relative abundance methods to document changes in the geographical ranges of species. In all cases the sample size for determination of presence depends on assumptions that can be made regarding species density and distribution. These assumptions may vary markedly between Study Areas and habitat types. Therefore, the calculation of sample size can not be generalized to all other areas or all other studies. In addition, a preliminary survey using replicated relative or absolute abundance methods is needed to make appropriate sample size calculations.

Track Surveys are one of the least invasive and expensive techniques for surveying wild carnivores. This method is particularly effective during winter. The observers conduct multiple tracking surveys sponsored and overseen by wildlife biologists; in the absence of funding, these surveys could be conducted by volunteers. Observers execute these practices as part of their regular rounds through the area; they enter their observations in notebooks and collect signs.

4.7.2.3.2. *Scat Collection and Analysis*. Scat Surveys, due to current advances in genetic analysis that allow genetically differentiating wild canids at the species level, were used to further differentiate wolf DNA from hybrids or feral dogs. Like track surveys, field costs for scat surveys are minimal. However, precipitation in beech forests on the north side of the Park may have decreased scat availability in some areas. These samples were collected, examined for gross aspects in-house, and then sent to a laboratory, where DNA is extracted so that individual animals can be identified, their heredity understood, and even some of their movements mapped. This type of non-invasive data collection allows researchers to also analyze hormones, disease factors, and sexual condition.

4.7.2.3.3. *Scent stations*. Scent station surveys are a possible method of monitoring temporal and geographic trends in wolf populations. There are important aspects of the design, analysis and interpretation of scent-station surveys. Scent-station surveys are widely viewed as an accurate and inexpensive means of simultaneously gaining reliable information about the distribution and relative abundance of several species of carnivores. Whether a particular scent-station survey will meet these high expectations depends largely on how the following issues are resolved: Sampling, Response variables, and Statistical models.

Scent-station surveys could vary in design, depending on a number of factors. Stations do not need to be grouped. The dispersion of stations could determine how stations are treated in analyses: in some cases, stations may reasonably be treated as independent samples; in others, they should be considered correlated samples or subsamples.

For this project, a scent station consists of a one meter diameter circle of smoothed earth with a scented lure placed at the center. Stations could be grouped in lines to simplify data collection. Ten scent stations will be placed along an unpaved road at 500 m intervals, which will comprise a line. There will be three lines. Minimum spacing between lines will be 5 km. Sampling will be non-random, Each line will be operated for one night each year. Presence or absence of tracks would be recorded, by species, at each station after activation. Data will be entered on the computer database at the computer expert. Statistic models will be developed and analyzed.

4.7.2.3.4. *Trend Surveys.* Trend surveys are based on: ground (or aerial) tracking for wolf signs; counting visits to scent stations; counting packs by simulating howling to get a response; interviewing hunters, trappers, and resource professionals; and studying and mapping trends in livestock depredations. Interviews and livestock trends are being handled separately. Preliminary ground tracking (presence/not detected) is being handled as a separate project. The computer expert, aided by the volunteers, will compile trend surveys from collected data. Statistical models will be developed and analyzed.

4.7.2.3.5. *Wolf Vocalization Analysis.* Bioacoustic research is needed to study the vocal characteristics of individuals in the pack to determine how a wolf's individual vocalizations can be identified. We want to use digital recordings and computer spectrograph analysis to determine voice prints of all vocalizations. We want also support graduate work on wolf bioacoustics to further this research and ask questions regarding hierarchy, age, and sex through voice print analysis.

Observers and volunteers formed 3 teams, comprised of 1-3 individuals. Each team studied a different section each night for 3 nights. The survey groups canvassed their routes on foot (or by jeep, depending on the roads and trails). Survey groups identified their routes during the day, traveling and marking howling stations at approximately two-kilometer intervals with flagging tape.

Surveys were carried out after dark utilizing protocol developed in the Western United States. After dark, usually in the evening but occasionally in the very early morning, surveyors retraced their routes in order to perform a howling trial at each marked station. Current protocol for wolf research allows for one individual from each of the teams to howl in an area in order to record any responses (although the howl can also be a recording). Howling was done during evening hours when sound travels farther and wolves in the area are more active.

Emphasis was not placed on exactly imitating the sound of wolf. Volume and duration of the howl for each trial was considered more important in order to capture the attention of any canids that may be in the area. If a howl is fifteen seconds or less in duration, chances of success decreased markedly. The howls were done in three segments, totaling 25-30 seconds long. The segments alternated between a flat 'siren' howl, and a 'breaking' howl that changed abruptly in pitch. Importance was placed on finding a high vantage point and howling down a mountainside or across a lake as opposed to howling up a hillside or directly adjacent to a stream or river. Close proximity to a stream or river would create conditions that were too loud for successful howling trials. Excessive wind or rain could also produce unfavorable conditions (Harrington and Mech 1982, Tucker et al. 1990).

The same subject within a team performed the howls at each station for the entire route to avoid the impression of more than one dispersing wolf. At each station after the first howl, the howler waited two full minutes, then gave another set of calls. If a response was recorded after the first session, the location and time of the response was recorded and a compass bearing taken. If still no response was heard after waiting five minutes after the second set of calls, the surveyors moved on to the next howling station. Flagging was removed from the station if no responses were heard.

If a response was heard that the surveyors were reasonably confident was that of a wolf or wolves, the location was carefully plotted on the map. Flagging was tied to mark the howling location and marked with a magic marker. After recording the bearing and plotting the findings, surveyors moved to a location that gave a substantially different bearing for a second response. While 20 minutes between responses was common, some wolves may take as much as an hour if a second response is not heard (Tucker et al. 1990). If a second response was heard the bearing was again plotted. The point where the two bearings cross indicated the location of the responding animal (for a discussion of howling survey methodology, see Fuller and Sampson, 1988, Tucker et. al. 1990, and Gaines et al. 1995).

4.7.2.3.6. *Trail Monitoring*. Remote Sensing Photography (RSP) is an expensive and labor intensive technique for monitoring (see Tucker et al. 1990); it has been used to successfully documented sightings in the Northwestern United States. Wolf trails can be monitored with infrared equipment and cameras. The Trailmaster is a trail monitoring system that has accuracy and dependability; it has been successfully used to monitor wolves in North America, tigers in India, and forest elephants in West Africa.

Here is how it works: An event is recorded each time an animal breaks the invisible infrared light beam. The beam itself is invisible for animals. The dates and time to the minute of each event are recorded and stored in the Trailmaster each time the beam is broken. Up to 1,000 events can be stored and easily recalled using a single button in the front of the receiver and then transferred to a desktop computer. Trailmaster can be connected to a weather-proof, fully automatic, 35 mm auto-focus camera. Another possibility is to connect the Trailmaster to a video camera inside a weatherproof housing. The Trailmaster then becomes a tool to detect the specific animal being patterned.

We plan to buy and set up one Trailmaster on a trail where wolf tracks have been seen regularly. The device would be visited every three days and the data transferred to the computer in Sofia. This would contribute data towards knowledge of an absolute abundance of wolves in this section. The device could be moved to other sections or kept in place for an entire year.

4.7.2.3.7. *Mortality Studie*s. Information is collected on wolf mortality and predation. Although in some parks, Canada for instance, the greatest wolf mortality is from highway accidents, in Bulgaria wolf mortality is predominately from hunting, with some disease. Hunting mortality could be reduced through education.

The group set up a procedure to examine dead wolves. This required educating people to inform us of dead wolves, collecting the wolves, and examining them. Carcasses would furnish varieties of information, especially for parasites. At the same time, remains of prey species, especially red deer and roe deer, should be studied for presence of disease. Getting bodies did not prove effective, as bodies or ears were turned in for rewards from the forestry units, who refused to allow examination before destruction.

4.7.2.3.8. *Laboratory Analysis*. Researchers attempted to collect tissue and blood samples from Park wolves. Some samples will be taken from animals found dead or taken by trappers. If a live wolf is captured, samples will be taken by a veterinarian. Carcasses will also furnish parasite samples, and droppings will be collected for genetic analysis and to help track the movements of wolf packs around the park.

Other research techniques that could be employed in this sectional wolf study include analysis of scat (fecal material) to determine food habits, assessment of physical condition of prey animals, and necropsy (post-mortem examination) of dead study wolves. This would provide information on health as well as on inbreeding.

Further research is needed to determine what additional studies need to be done on the genetic markers of the Park population of wolves.

An important objective of the study is to make a fundamental contribution to understanding the genetic basis for the vitality of the immune system in wolves. The project may make use of a bank of genetic material, known to be unique to wolves, and kept in the United States. Other genetic samples taken from wolf skulls collected 5-30 years ago may be used as a benchmark.

New volunteer laboratories have been established east and south of the area. One or more of these new laboratories will be used for the laboratory work for the project.

4.7.2.3.9. *Geographic Information Systems/Modeling*. The Park has a Geographic Information System, which could be used to collect, access and utilize accurate information relevant to the management of wolves in the Park. This would be the start of a long term monitoring project in the Park, in the heart of historic wolf habitat where cattle grazing and hunting are primary uses of this public land. Wolf movements, grazing allotments and wildlife activity in the mountains could be mapped using vegetation as the basis of the ecosystem. This could indicate, over time, what factors influence the movements and interactions of animals dependent on this area.

Mathematical modeling is a good way to try different scenarios in the Park with no effect on the structure of the Park. It would be possible to adapt a predator-prey model for the Park based on work done by biologists for Yellowstone Park in America. This model could simulate the impact of wolf interactions in the habitat, as identified by research. The model could be used also to estimate the effect of a wolf population on deer and mouse populations, as well as on domestic animals, in the Park. The model could then be used to compare and contrast wolf predation levels with hunting levels and with variable prey.

4.7.2.3.10. *Radio Telemetry.* This project seeks to determine absolute wolf abundance in the Park, using capture and collaring, and tracking by radio or satellite. The project was begin as soon as was feasible. The PCVs worked with Anton Stanchev and Pavel Kolev to set up transects through the Park. The approximately 10 Park rangers will conduct the survey over a one-year period. The PCVs will participate in a percentage of these daily walks. After the survey, data will be entered into the Park database from standardized forms.

To determine absolute abundance of wolf populations in an area, two methods are recommended: aerial snow-tracking or radio-telemetry. Aerial snow-tracking for wolf tracks is mostly used in relatively open habitat (such as the Northern Boreal Mountains or Taiga Plains ecoprovinces in Canada). Radio-telemetry works better to obtain absolute abundance data in dense, rugged forested areas where visibility is poor and aerial survey techniques are not practical; these factors apply to the Park. Of course, where possible, a combination of both methods would provide the most accurate absolute abundance estimate. Aerial surveys have the advantage of covering greater distances than just scat or tracking surveys. However, cloud cover and operating costs for aircraft are prohibitive. The Park could explore the possibility of sharing observation time with other aerial work in Romania or Slovakia.

4.7.2.3.11. *Monitoring*. We intended to collect data by using VHF telemetry method, snow-tracking, collection of species activity signs. By means of these methods we are going to collect data about wolf activity in the region. Private meetings with local people and questionnaires conducted with them will help to complete and to compare the information.

We intended to collect the following information: 24 hours and seasonal activity of the wolves, using of home-ranges, interactions between packs and individuals, and wolf numbers. The data was to be used to prepare an appropriate wolf conservation strategy. The data will be collected by field work. Data about the number of killed wolves will help in the defining the number of the subpopulation and the reproduction rate. Inquiries to local forestry authorities. Data about animal losses in villages will be used to assess the wolf impact on the local agriculture economy and the reasons for successful attacks. It will be used also to decide where the preventive measures are most needed. Inquiries were made among local farmers.

The Society intends to collect regular statistics on: Number of the wolves collared and monitored; amount and quality of the data collected; the level of damages on domestic animals caused by wolves; and, the level of acceptance of our activity by the local people.

4.7.2.3.12. *Capture Techniques.* Leg-hold trapping (using offset steel traps with rubber padded jaws) is an efficient technique. Furthermore, this type of trapping is usually limited to warm periods, from March through October in Bulgaria, because leg-hold traps could impede circulation of a captured limb, resulting in freezing the caught foot. There are some problems with this approach—wolves often struggle to get out of leg-hold traps; damage to legs can include skin lacerations and broken metacarpals, and in severe cases, broken long bones; and wolves left in traps for long periods can break their teeth on the trap itself. Due to the season of the project, as well as cost and technical considerations, we have decided to use traps. Traps were set along forest roads and trails where tracks or other wolf sign have been located. To minimize the capture of nontarget species, such as eagles, fox or weasels, we did not use baits. Old scats (or scent posts with scat or urine as attractants) were used.

Figure 472312-1. Alex setting a fish-scented modified leg-hold trap

Traps were checked every 24 hours to minimize the risk of injury to captured animals (and checked every 12 hours in hot weather to prevent hyperthermia). This was crucial; and, this was why the team lived close to the area. Captured wolves would have been anesthetized with intramuscular injections of drugs (administered with a jab stick), and fitted with radio-transmitter collars with individual frequencies which can be monitored from the ground. Animals would have been classified by age and sex; if possible they were to be eartagged and weighed. Other measurements such as body length and canine teeth were to be taken. Any captured wolves with foot injuries from the trap were to be injected with antibiotics.

Traps were placed along trails, but away from human activity such as sheep trails, hiking trails or campsites if possible. The trap areas were marked, but not the individual traps (due to possibility of theft). This had been discussed with people in near-by villages.

Leg-hold traps were attached by trap chains (about 2-2.5 m in length) to drags or grapple hooks rather than staked in place. This would have allowed the wolf to escape a short distance from the trap site, reducing its initial fear and tendency to fight the trap, and thereby reducing injury. Retaining chains were centered below the trap pan to reduce torque on the foot when the animal struggles. The trap was set where there was adequate standing timber and brush for the drag to tangle near the trap site.

Captured animals were to be hand injected with a jab stick. Trapped or snared wolves would have been immobilized with a mixture of Ketamine Hydrochloride and Xylazine, depending on an estimate body weight of the captured animal first (animals are usually down in 2-4 minutes and then stay immobilized for about 30 minutes).

After immobilization, attach ear tags were to be attached to the captured animal and standard body measurements (sex, est. age, weight, canine length) recorded on data forms. Finally, a radio-transmitter collar was to be put on the wolf and checked for transmitting.

We tried to collar at least one wolf from each pack. If only one wolf was collared from a pack, its home range could have been assumed to represent the pack's home range, unless scat transects or observations indicated otherwise. Movements and territory sizes of radio-collared wolves were to be calculated from radio-telemetry data collected during wolf inventory.

As the study area was identified, we intended to create a framework to guide trapping efforts or a useful context for relocations, based on expected densities (low, medium or high) or on wolf home range boundaries (approximations based on previous surveys). There was no strict sampling design for animal capture. With ground-based techniques, traps were placed near scats, territory boundaries, or along trails, but away from human activity such as sheep trails, hiking trails or campsites. If results of tracking radio-collared wolves were to be extrapolated to other wolves in the project area, then traps should have been equally accessible to all animals in the project area so that captures represented a random sample of wolves.

4.7.2.4. Results & Discussion

Relocations of animals every 2-4 days were considered adequate, and could have been less frequent locations during winter months. The desired minimum total number of relocations depended on pack territory size with more frequent relocations required for larger territories. A minimum of 30 relocations would have been considered minimum to determine wolf (and pack) territory size in this area.

When traps are used to capture wolves, as in this pilot project, qualified biologists that are experienced in trapping are necessary. Biologists (or veterinarians) must also be experienced in animal handling, affixing radio transmitters and ear tags, and taking standard body measurements. For ground telemetry relocations, a biologist with previous radio-telemetry experience is required. We had been offered assistance by the Carnivore Program in Romania. Staff of the Wilderness Fund in Sofia had expressed interest in observing (two biologists and one veterinarian).

The result of all this effort was to capture 3 pigs. However, 437 samples of wolf scat were photographed and 70 samples were collected and analyzed. Photographs of 493 wolf tracks were made (and compared with one Karakachan dog track); 7 other tracks were not positively identified. Laboratory analyses of scat indicated no abnormal infections in any animal signs collected.

To evaluate this project, monthly statistics were collected on: Number of wolf signs, number of captures (0), number of collars (2), and time tracking; for local residents, number of contacts; number of inquiries, number of requests for brochures, number of web site visits (for requests for information), time invested by the members, and overall satisfaction of the members of the community. Short-term measures came in the form of feedback from the larger community. Since the team resided in the community for the duration of the project, and met regularly meet with leaders and shepherds, feedback was forthright and immediate.

4.7.2.5. Conclusion: A Promising Beginning

The purpose of this project was to set up a pilot project to see if it was feasible to determine the absolute abundance of wolves in the area, using radio-telemetry equipment. Radio telemetry provided the best chance for BWS biologists to have an absolute number count of wolves. The number of wolves that are traveling with a collared animal are counted, and the pack's territory can be accurately mapped. Because of the expense, it is not feasible to radio-collar a wolf in every pack, so population trend surveys are also conducted at the same time. Large volumes of data could have been collected with no further field telemetry effort; this demonstrated the potential for this type of collar to answer questions about movements of medium-sized mammals. The target for the next survey next year was to collar 4 wolves.

BWS provided most of the labor, general support and materials. They also provided much of the equipment, including computers, binoculars, mobile telephones, maps, tape measures, field guides, and notebooks and pens. They paid for some of the travel related to the survey, as well as telephone support, and use of donated vehicles.

This survey was crucial to determine wolf numbers and activity as soon as possible. It is part of a complete strategy for population studies and monitoring that is necessary to establish a scientifically based policy for predators in the area. The Ministry of Environment and water recognizes that many species need individual management plans urgently and with priority, including wolves. A management plan for wolves requires monitoring of dynamics of wolves and even social issues such as poaching.

The project is expected to be extended for several years by BWS. It could also be used as a model for other projects in Bulgaria. The project is run by BWS for the benefit of local wildlife and villagers; the villagers are a critical part of the project; thus far, they have been eager to help BWS with wolf sightings and depredations. How they use the guard dogs may determine their attitude towards wolves and their acceptance of this project. Once the initial costs, have been met, the community will be able to continue social monitoring.

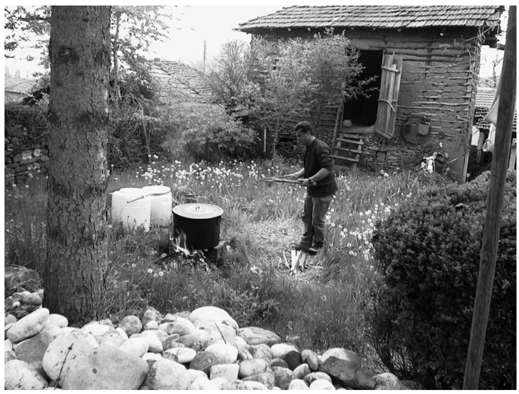

Figure 4722-2. Kosta boiling the traps at the farm in Sadovik

4.7.3. *Wolf Population Models for Bulgaria*

The basic mathematical model shows that the wolf population is declining in 2002. How fast depends on numerous factors. Mammal populations respond in different ways to changes in environmental conditions, such as food shortages or hunting pressures; they may increase or decrease the birth rate for instance, or the death rate may increase. Some mammals, such coyotes (*Canis latrans*) in the US respond to hunting pressure by increasing the litter size; in the Rocky Mountains wolves (*Canis lupus irremotus*) respond to hunting pressure by reducing litter size. The observations by forestry units in Bulgaria indicate that there are only about 1-2 pups seen with adults. Mammals may also avoid or reduce environmental stress by moving to a new area (immigration) with more favorable conditions or by leaving the area of stress (emigration). Under favorable circumstances births and immigration exceed or balance deaths and emigration. Mammal populations are dynamic; they respond to challenges.

The numbers of individuals of certain ages and gender determines the structure of a population. In a growing population there are a larger number of young animals. The structure can be skewed by disease or predation. Very young or old or weak members may die when exposed to stress. Hunting pressure takes out healthy males.

Different factors can effect the birth rate, such as the number born. For large mammals, having fewer births makes a species more vulnerable to extirpation. The rate is also affected by the number of times a female goes through a breeding cycle each ear, and by the length of gestation. If the population declines below a certain number, individuals may not be able to find mates easily, which lowers the birth rate below normal (of course, crowding also lowers the birth rate, but this is not likely for wolves in Bulgaria for quite some time).

The death rate is influenced by a typical survivorship curve, which is determined usually by how long they take care of their young. Since wolves are large mammals that care for their young for 1-3 years, they normally fall into a Type 1 curve. The chance of death increases with age. Hunting, disease, or persecution can alter the survivorship curve. Thus, wolves in Bulgaria have a higher mortality rate when young. Interspecific competition for resources, with humans or fox, can also increase the death rate for wolves. Disease, parasites, which increase from stress, can increase the death rate. Loss of habitat or catastrophic events, such as fires or droughts, can increase the death rates.

The growth rate of the wolf population can be calculated in an equation linking birth and death rate, and emigration and immigration: $r = (b - d) + (i - e)$. The death rate (d), however, has been broken out into three parts: Deaths from hunting, which is a countable number every year, deaths of pups in the first year (relatively high), and deaths of individuals from illness and disease. Immigration and emigration have been potent factors in the Bulgarian wolf population. Wolves have been entering from Greece, Serbia, and Yugoslavia.

The model iteration 1 has been calculated using a series of differing assumptions. For instance in the first iteration of the model, the birth rate is average: 5 pups per pack (with 6 individuals but only 1 alpha female giving birth). The death rate is taken from Mech. The immigration and emigration are basically guesses at this point. The growth rate is a negative 35 percent and wolves will be extirpated from Bulgaria by 2006.

The iteration 2 model has a significantly higher birth rate, 8 pups per pack (of 5 individuals). This model, even with hunting deaths increasing, show an increase of population. By 2006, the population is predicted to grow from 1200 to 1704 individuals (at about a 7 percent annual increase). But this number of births is much higher than reported and is high by any standard.

The model with the lowest birthrate, iteration 3, which seems to conform closest to the observed rate in Bulgaria, predicts that wolves will die out just after 2004. However, if hunting is eliminated, as in iteration model 4, wolves will increase at a 1 percent growth rate per year. These models will be compared with the actual (or estimated) wolf populations for the next 10 years.

4.7.4. *Summary & Recommendations for Bulgaria*

Although some studies and monitoring of wolves has been done in Bulgaria, it has not been enough to estimate or monitor current populations of wolves. Biodiversity studies done for the National Parks and other areas recommend that more work needs to be done to pursue a rational wildlife policy and to create species management plans. A series of research strategies have been proposed for the years 2003-2004. Funding has been requested. Wolves can coexist with human populations in Bulgaria. But, the country's population needs to be educated about the ecological significance and value of wolves. There are many habitats set aside for wild nature, but a rational policy needs to be established to allow the habitat to be protected.

There needs to be a major study on the ecology of major predators, especially wolves and bears. The study of the ecology of predators has been said to be in its infancy in Bulgaria. There are only vague ideas about condition of smaller species such as weasel, polecat, wild cat, pine marten, according to the Central Balkan National Park Plan. The study could be divided into components: Wolf Study, Bear Study, All Predators, Prey Species, and Habitat Restoration.

4.8. *Defining & Describing Local Wildness*

What should we call the regions that we do not use or want? Those that are not domesticated? Wildness? Wilderness? Wilderness has been the name used by many cultures for uniformly empty, chaotic, useless, valueless, or untamed areas. Although what remains currently is still largely untamed, wilderness is not uniform, empty, chaotic, useless, or valueless. Recently, wilderness has been recognized as holding resources and as being important for recreation. Wilderness has also been realized to be the source of agricultural and cultural richness. Indeed, these reasons are presented as justification for saving wilderness from exploitation or interference. But there are more basic reasons to save wilderness: It is the source of diversity, it exists apart from human concern and industry, and it is the only sanctuary for wildlife apart from humanity. Wilderness is filled; it has its own values and uses.

No one of the ancient or modern descriptions and definitions is adequate to define wilderness. It is not a negative thing or the opposite of humanness; it is wilderness itself. An understanding of ecological knowledge shows the importance of wilderness itself and what it entails—other beings for themselves, dynamic system stability, and finally the health of systems upon which humanity is dependent. A set of definitions and distinctions are recommended to justify and plan the preservation of many kinds of wilderness.

4.8.1. *Wilderness As Empty, Disordered, Useless, Waste*

The Romans did not really have a word for nonhuman nature. Words or phrases they applied to wilderness meant emptiness, waste, loneliness, and deserted place. The definition of nonhuman nature changed slightly over centuries. The modern word wilderness means "of wild beasts." Wilderness was understood as an uncultivated, empty region, or a confusing multitude. In the 17th century, untilled heaths and fens were regarded as a reproach to civilization. John Houghton in 1681 called Hampstead Heath a 'barren wilderness.' Cultivation was a symbol of civilization, whereas "wild and vacant" lands were thought of as a deformed chaos. Similarly, mountains were thought worthless. Wilderness meant uncontrollable, and was also applied to the beasts of inhospitable regions. Something wild was untamed or untilled. Samuel Johnson (1755) defined wilderness as "a desert, a tract of solitude," or a wild place inhabited by deer. Gradually, people have come to regard wilderness as filled and ordered (4.8.1.2.-4.8.1.3.), with values and potential uses (4.8.1.3.-4.8.1.6.), and as a beautiful playground (4.8.1.1.—in *Redesigning the Planet: Foundations*), but even these do not form a complete definition.

4.8.1.7. Wilderness Definition

Wilderness remains essentially undefined; it has been defined as emptiness; and it has been defined recently as a place "where man is a visitor who does not remain" (Fromme 1974). But, these definitions are vague. The popular wilderness definition, where man is only a visitor, is utilitarian; humans visit for recreation and relaxation. There are flaws in this utilitarian approach to wilderness; wilderness is considered a resource, and it is related to human experience exclusively. Wilderness does not have to be destroyed or used or even visited to be beneficial. It is valuable as wilderness, because it is there. Humans are already using a very large percentage of it indirectly.

The most important definition of wilderness treats it as a "vital organ" for the life of the earth, the generator of hydrological, geochemical, and atmospheric cycles. It is where nonhuman species live for their own purposes. None of these 'definitions' is sufficient to identify wilderness exactly, just frame it with words. Definitions have become more complex as more about the functions and values of wilderness becomes known. There are differences between ecological definitions of wilderness (as a 'mature ecosystem that changes with time') and cultural definitions, which vary with cultures, from wasteland to sacred spaces. Wilderness is more than a geographical concept; its boundaries can never be just geographical. It is an abstraction. It is hard to define wilderness exactly or objectively. Any region that can be described verbally is also a state of mind. And because it is a state of mind, it is ambiguous. Consider the biblical attitude toward wilderness, first as a howling wasteland, then (in Revelations) a sublimity greater than the world of "man," that enabled contemplative prophets to see the Divine more clearly. What originally held the disorder of humans now holds the order of nature. Wilderness is a changing process. And, the English language becomes imprecise and mystical dealing with process thought. Benjamin Whorf pointed out the problem with verbs. A forest is not just there ("is"); it is being and becoming, treeing and animaling. Many attempts to define wilderness limit it to human experience. Obviously, that cannot be done. Wilderness is still greater than, or empty of, most human experience.

Definitions have to consider the nonhuman nature of wilderness, as well as the pervasive human influence on all ecological systems. Definitions also have to consider traditional human reference to wild areas, as well as to areas that are restored or created to become wild. Despite the inadequacy of strict definitions, it is possible to describe different kinds.

4.8.1.7.1. Kinds of Wilderness

Wilderness can be delineated by human use and nonhuman use, as well as by global function. Eight distinct kinds of wilderness are identified: Sacred landscapes, Foundation Areas, Reservation Areas, Preservation Sites, Restoration Areas, Neopoetic Communities, Conservation Parks, and Wild Forests (or Fields).

4.8.1.7.1.1. *Sacred landscapes* are those areas set aside out of respect, for habitats for others, where humans do not belong, and for species that cannot coexist with humanity. Examples of sacred landscapes are mountains, fisher/marten habitat, and large areas of tundra. In many archaic cultures, significant parts of the landscape are regarded as sacred (and, although not used, the wilderness is considered a part or center of their territory). This may be a mountain at the center of the world, a burial ground, or the portion of a river that belongs to the fish gods. Sacred spaces are highly valued locations, with limited access and usage. Such spaces have great symbolic value to societies where they are associated with significant events (or divine manifestations). The assignation of sacredness may result from functional necessity, to prevent flooding, limit population, or to balance the economy. In sacred landscapes no direct human impact should be permitted; mapping would be possible from satellite or airplane observation.

4.8.1.7.1.2. *Foundation Areas* are zones that contain active wild communities where the integrity of nonhuman life is not challenged by human interference. Foundation Areas house the depth of wilderness. The depth of wilderness is what allows recolonization after disruption or human influence. Foundation areas could include common lands, that is, one of each kind of ecosystem, regardless of aesthetic value. Some visitation could be allowed, but without permanent residence or machinery. Human impact would be limited to noninterventive science (perhaps based on Goethe's method of contemplative nonintervention). Examples of foundation areas would include large areas of the Amazon.

4.8.1.7.1.3. *Reservation Areas* are zones for the support of nonindustrial native cultures expressing traditional ways, that is, natural systems in which humans play a limited role—limited by a percentage of net ecosystem productivity, for example, the Miskito in Central

America. Many traditional or archaic human cultures play a large part in the design and maintenance of these areas, not only by using fire, but by their traditional hunting practices. Limited human use often increases the diversity of a system, although the diversity tends to flow from human preferences for some plants and animals. Removing humans from this kind of wilderness would alter it and perhaps diminish it, so human use is retained.

4.8.1.7.1.4. *Preservation Sites* are places where the system is maintained by human activities, such as burning or planting. Specific kinds of preservation areas could include: Boundary areas, ecotones or lands bordering agricultures, small patches influenced by human activities, or corridors. Human impact could be limited to traditional, experimental science. An example could be the central long-grass prairie in the United States. In these areas, human activity is consciously limited to maintaining the desired state of the system, where the system has lost keystone species or where the area is too small or oddly shaped for the large-scale processes of an ecosystem to work independently.

4.8.1.7.1.5. *Restoration Areas* are zones which are set in a former native pattern by human activities, but which may not need further intervention. This may include the experimental restoration of ecosystems disturbed by human activities or natural events, for example, Lake Shagawa or larger restored areas of Tall-grass Prairie. Once the system has been reestablished, it would be allowed to develop on its own. This zone requires large enough areas for the natural processes to continue.

4.8.1.7.1.6. *Neopoetic Communities* are areas that have been created through the introduction of exotic species over time, but have become naturalized. Most of these recent areas have been started by human activities, but saved as self-regenerating systems and not built up or interfered with, for example the California grasslands, which have been changed with Mediterranean plants, e.g., wild oats, wild mustard, wild radishes, and wild fennel, or the Stara Planina of Bulgaria, which have been modified by grazing over thousands of years, so that grasses replaced the shrubs and trees.

In a sense, every ecosystem and community is neopoetic. North America once boasted a wide suite of large mammalian species, including camels, horses, jaguars, and mammoths—a combination of circumstances, that may have included climate change and human hunting, resulted in their extinction. It seems these niches were never quite filled completely by the immigrant species from Eurasian continent. Species compete or partner for space in ecological systems. They are always making and remaking the assemblages, causing new combinations or new extinctions. Creating a wilderness in North America by reintroducing similar megafauna from South America and Africa would be an interesting experiment in creating this kind of community.

4.8.1.7.1.7. *Conservation Parks* are areas set aside for multiple use of resources without interfering with the operation of the ecosystems. Research may be conducted to answer questions as to whether the park is big enough and shaped correctly to constitute a proper habitat for its inhabitants. Human recreation would be permitted in temporary camps and with some light machinery, for example, the Boundary Waters Canoe area in the United States. These areas would have been adapted to human presence and exploitation of many species.

4.8.1.7.1.8. *Wild Lands* (Forests and Fields), as well as other wild systems managed for the harvest of wild species, such as antelope or fish, are a final category. Although forests can be lightly harvested for wood and other products, they are predominately wild, and would be left wild, rather than being clearcut and replanted with a single species. This is an unusual category of wilderness, since we do not always consider forests and some kinds of agriculture as wild. In fact, wild species in wild systems have been shown to be more efficient in their use of resources and more resistant to other wild species that we humans consider pests. In fact, as regards forests, wild areas are preferred to agricultural areas such as tree farms, for many reasons, from automatic regeneration to the quality of wood. In this category, we recognize that areas of wilderness can be used without being destroyed or domesticated.

By just wilderness, the first three areas are included indiscriminately. They all have similar values, as mirrors of existence, examples of natural, complex processes, expressions of love for nature, and wild, nonhuman places. In a complete zonagraphy, these categories would be a critical part of all separate (within limits) areas.

All wild systems have had human influences for thousands of years. Even now, human influence extends into every system through pesticide drift and artificial gases. Yet, over 30 percent of the earth now has no permanent human settlements. In general, none of these wilderness areas will be inhabited (at least by industrial cultures), none of them will have permanent built roads, and management would be limited to temporary intervention.

Each of these categories would occupy different percentages of the planetary surface, depending on calculations of minima and maxima, and depending on cultural values and decisions. I recommend placing 50 percent of the land area in the first five divisions (eighty percent of ocean and water surfaces); then 16 percent in each of the last three (five for water); leaving 2 percent for completely artificial landscapes—industrial or city (three for water). These figures are consistent with several earlier proposals. Eugene Odum, suggests 30 percent forest cover world-wide, with 60 percent in tropical areas. C. A. Doxiadis offers 67 percent of the surface area of the planet left in wilderness. Paul Shepard argues that 75 percent of the land area should be left wild in a techno-cynegetic society. Regardless of exact percentages, reserves of every kind of region need be saved. They must be large enough for natural cycles.

4.8.1.8. Separating Wilderness

Many popular arguments against wilderness share the following six statements of "fact:" (1) Wilderness locks out people, so they are separated; (2) wilderness is a human construct; (3) wilderness is a false dichotomy between man and nature; (4) native people improve on nature with deep knowledge; (5) humans have always modified all of nature; and (6) people need to be put first, since nature is our garden and millions will starve if we lock wilderness away. I do not want to argue against them, but I want to expand the framework so that they disappear into a common ground.

Paul Shepard concludes that the consequences of ecological conflict in technological, humanistic civilization are either exile or sanctuary; and sanctuary is the only solution available to the humanitarian ideology. The idea of sanctuary recognizes the multiplicity of factors necessary for viable populations. But, although there are sanctuaries for frogs and ferrets, it would be impossible to establish one for every creature. Shepard discounts the humanitarian objective as considering only 'worthy' species. Yet, if all species were considered, the whole planet would end up as a sanctuary. Therefore, he considers sanctuary an unfeasible 19th century political solution, based on a time when space was unlimited. Shepard states that exile (extirpation or extinction) and sanctuary are allopatric choices (meaning 'life not occurring together'). Allopatry (from the base word for fatherland) is seen as being consistent with the tradition of personal property, domination of nature, and model of the nation state.

What Shepard has overlooked is that humanity was never really sympatric with most other species. It never lived together (the meaning of sympatry) with major carnivores and noxious insects, if it was avoidable. Therefore, allopatry is consistent with the nonexploitation and nondomination of nature as well. Sanctuary as personal property or as nonhuman property is a moot point if habitats are saved from destruction. Personal property, of the wealthy elite or of religious orders, has often allowed species, especially plant species, to be saved (the dawn redwood or yellow pine for instance). Domestication and enslavement are sympatric forms. A conservation program, despite Shepard's argument, cannot be based solely on sympatry. Not all species occur together in the same place. Sympatry describes only those that do. At the habitat level, allopatry is the most intelligent use of available resources by animal communities. Large herbivores, such as elephants and rhinoceros, may choose poorer quality food to avoid competition with smaller animals and to exploit an untapped food source. Many interactions between different species contribute to the mutual benefit of the members of the community, as well as to the community itself. Humanity must be allopatric with most wild species and allow them to develop independently in their own places.

Separate areas are necessary, although thinkers such as Gary Snyder question whether complete compartmentalization is healthy. Snyder suggests that some land is saved like a virgin priestess, while other land is overworked like a wife, and some is brutally reshaped like a girl declared promiscuous. This argument is certainly good for human lands, but wilderness lands should being compartmentalized for the use of other species, which do not share our treatment patterns of females.

Saving wilderness means saving large areas of land. It means placing wilderness, which is support for cultivated and industrial areas as well as natural communities, off limits to development and perhaps to any use. Every ecological community should be allotted a place for self-development, a foundation area. Wilderness is not land that is locked up, as several U.S. Senators have claimed; it is quite interactive. We are already living with it. Foundation areas are not museum pieces, as Birch seems to think—only humanity is directly absent.

Wilderness costs are sometimes considered too tremendous to bear, in terms of lost opportunities, resource use, and administrative overhead, according to Lehmann and others, but that cost is reckoned without considering the free services of wilderness. Their conclusion is based on the assumption that everything that can be used should be used. Wilderness areas, left by themselves, would require a minimum of management costs. Often, when it is suggested that wilderness areas be left without human management, critics conclude that humanity is not being considered as part of the environment. This is an unfortunate conclusion and untrue. Humanity does not have to convert every system to be a part of it.

4.8.2. *Wooing the Wild*

Currently, stewardship of wilderness seems to be a form of exploitation. We simplify ecosystems of which we are still greatly ignorant, killing billions of creatures. The rate of extinction of species exceeds our rate of learning about them. Shepard rejects the model of exploitation: "The historical model we have for being lieutenant of the planet is the shepherd and husbandman, who always destroy the wildness of the animals they seek to protect." The professional form of this exploitation is 'wildlife management,' where the manipulations are more extensive and include fencing, marking, trapping, breeding, and game farming. Humans can never be stewards as long as they dread every intrusion of wild nature into their gardens, neighborhoods and fields, as long as they try to control everything. Stewardship is based on knowledge that we only think we have. Nature is already self-governing; we do not need to be stewards. Nature will heal herself, either through self-healing of the human species or its self-destruction, which would allow alternate forms of life to flower. There are several possible human relationships to the earth or to wild beings: among them, pandominant species, lord-and-master, good steward, or fully conscious and self-limiting beings. Historically, we have preferred lord-and-master.

There is an arrogant belief, from Plato to J.S. Mill to Rene Dubos, that all human action improves the spontaneous course of nature. Dubos, for example, is disturbed when farms revert to natural vegetation. He dreads forest regrowth in New York as barren and uninteresting. He claims that the statement "nature knows best" is wrong. But ecosystems that seem inefficient and wasteful are many times redundant, and therefore stable and flexible. Natural processes that seem destructive are cyclic and preservative. The humanized landscapes that Rene Dubos praises are the result of a long-term adaptation with limited means. The interplay was slow, so that many species, although not all, could adapt.

The natural state is adaptive, generating a coherent system. But that system is not the only possible one—and it may not be the best one. Many things in nature seem ineffective: population crashes among lemmings; or the partial recycling of carbon (as coal and gas). Dubos claims that guano accumulation on Pacific islands is a recycling failure, but what if it is a way to remove nitrogen from the cycle—a cycle that otherwise may be disturbed? Foresters regard forest fires started by lightning as a waste. But, lightning is essential to life by breaking down amino acids into ammonia, methane, hydrogen, and water; burned forests (from lightning-strike-caused fires) are necessary to maintain diversity and keep single species from taking over.

We have been persuaded than humans are able to transform any habitat on earth and benefit from the transformation. Africans practiced this reclamation, as did Assyrians, Greeks, and American Indians. Occasionally it worked, and long lasting systems were established. But often, the reclamation only contributed to deserts. The United States, Nepal, Brazil, and other countries lose enough soil annually to form a new country in the ocean. Civilization is both adventurous and stupid—it destroys habitats that are the tissue of its existence.

Civilization is inefficient. It wastes land and moves on. Wild species have been destroyed and replaced with various cultural domesticated favorites. Then, those domesticates wasted soil and disrupted animal, plant, mineral, and soil cycles. The increase of favored species displaced others that may be more adapted.

Human motives to transform appear rational and prudent, but really are often prompted by ignorance, greed, and destruction. The means and scale of the destruction has increased dramatically. Managing other species usually means manipulating wild or domestic species to exploit them for profit.

A high human civilization has to limit its consumption of natural resources, its place in wilderness, to consider wilderness and future generations. Wilderness is a limiting factor in the health of human civilization. It is probably not a precise function, but we may be close to the minimum for the earth. As Gregory Bateson pointed out, it is not safe to be limited by lethal variables.

Good management is not the presumption of sufficient knowledge, but the recognition of ignorance. The concept of stability is still too ambiguous to help land-use managers assess degrees of damage. We must know the constraints of health. Rather than emphasize equilibrium, we should emphasize heterogeneity and learn to live with disturbance, as C. S. Holling suggests.

Understanding ecological relationships permits the toleration of fluctuation, irregularity, uncertainty, diversity, spontaneity, flexibility, looseness, and limits. The correction for ignorance of ecology is knowledge. Knowledge by itself, however, merely permits a more efficient utility. Knowledge cannot be the sole basis of decision making. It is always incomplete and therefore cannot describe all aspects of the earth that bear on human life or environmental quality. Something more is required.

Rene Dubos takes the heroic love-adventure of humankind to be the wooing of the Earth. The wooing of the earth is both sweet and sour—sweet because humans can create enchantment within nature, and sour because they can spoil desirable places—possibly to the point of ruining nature's recovery mechanisms. The wooing of earth implies more than converting wilderness into humanized environments. It also means preserving natural environments in which to experience mysteries transcending daily life and from which to recapture an awareness of the natural forces that have shaped humanity.

Dubos celebrates the human ability to woo the earth by creating new environments that are "ecologically sound, aesthetically satisfying, economically rewarding, and favorable to the continued growth of civilization." While that is noble and just, and realistic, there are two erroneous assumptions contained therein. First, civilization does not have to grow to develop; it is development that is important, not growth, which is plainly unfeasible. Second, 'to woo' means to solicit love or to make love. Dubos assumes we will remake nature in our image. And love, as everyone should know, entails respect or reverence. It does not remake the loved one in one's image; it respects and allows freedom and difference. That is the larger meaning. We should 'improve' on nature where we live, but we do not need to try to improve on all of nature. We do not need to domesticate all beings for human use. Joseph Wood Krutch recognized that ecology without reverence or love is only shrewder exploitation.

That does not mean that we cannot change places by living there. We can create places only by living there; by slowly adjusting. Human modifications of the earth can be lastingly successful only if their effects are adapted to the invariants of human and physical nature. Ecological management can be effective only if it takes into consideration the visceral and spiritual values that link us to the earth. Although some of nature can be regarded as a garden to be cultivated, large areas should be preserved as untouched reserves or necessary systems for global balance. Other areas could be studied or urbanized as population centers. Our tendency to redesign nature into a human form, rather than tolerate and cherish, is dangerous; it leads to 'curing' abnormal people and 'solving' weed problems. We do not respect the wild, complex side of human nature or wildness in nature. Perhaps in this sense, design needs to be a form of limiting human impacts as well as restoring natural balances that have been disrupted by human impacts, and not a blueprint for controlling every natural process for human benefit.

It is not possible to address the dimensions of wilderness without considering the beings that make it up, without considering it as a unique pattern of lives, without considering animal behavior and human ethics, without considering human evolution and the history of the earth. A true definition of wilderness is not found in human needs and desires. Wilderness is not for people. It is for itself. It makes and defines itself. For humans, it is a land classification. But a unique one, for it is one which is nonhuman and unmanaged, unknown and unused. Wilderness is not incoherent until human beings give it form. It already has form. Wilderness is made by the life-images of the species and beings that inhabit and inform it. Wilderness is not empty. It is full with living beings whose goal is fulfillment.

The primary justification for wilderness is as a sanctuary for other beings that constitute the richness of the earth. Many of these cannot live with humanity; they are allopatric and anthropofugic (meaning that they actively flee human presence). If, as many believe, wilderness is necessary for human development, its protection can be justified on that basis also. But, its value to humans consists of its separateness, its diversity, aesthetic nature, its economic benefits in recycling wastes, and for recreation, inspiration and teaching.

Many voices defend wilderness itself. But more urge its use. We humans are ambivalent, we want to save areas created by the destruction of wilderness. We want areas that bear no record of us, yet we want to leave our mark everywhere. We want nonhuman places, but we want to live everywhere. We want to use everything, but save it. There are many alternatives, from indifference or conservation, to a more radical alternative: Creating new social organizations using high-technology to solve problems and incentives to save natural places.

Humans need a human way of being, and human worlds. But, these worlds are derived from the wild universe. We need a wild universe to live fully. When we understand our roles and relationships in nature, then we will not be managers or stewards, but participants and sharers in experience. An ecological basis gives human activity dignity. But that in no way negates the life-images of nonhuman beings. All beings are centers of experience.

We must emphasizes the value of all nonhuman beings and try to use as few individuals as possible from as many species as possible—moderate yields, within the limits of the food chain. Many species should probably not be used at all, whales and wolves, for instance; the do not respond well to hunting stress. Plants and animals are as much of our heritage as art, history and tools. Ignorance of one is just as sad as ignorance of another. The survival of society depends on an expanded ecological awareness of the global system in its complexity and connectedness. The spirit of humanity depends on an ecological consciousness that places humanity in a proper relation to the wild places of the earth, taking what it needs, but letting the rest be.

Perhaps new technologies and new philosophies may permit larger human populations or the expansion to other planets or solar systems, but we must be cautious with what wilderness exists here. Conservation and creation must be tempered with preservation. We are too ignorant to tamper with everything. If we cannot live sensibly on earth, the emptiness of space and wilderness of stars will never be home.

4.8.2.1. What is Wilderness Again?

Wildernesses are ecosystems that are self-creating and self-maintaining. An ecosystem itself can be defined several ways. First, an ecosystem can be a thing, a vegetation type, a plant association, a natural community, or a habitat defined by structure, age, geography, condition, or other ecologically relevant factors. Thus, old-growth forests, bogs, sagebrush steppe, wetlands, oak-pine savanna, free-flowing rivers, a downed tree, or a pitcher plant are considered ecosystems. This concept of ecosystem is hierarchical because broad vegetation types include many plant associations, and habitats are part of broad vegetation types, which are subsumed by biomes, the largest type of ecosystem. The concept of ecosystem has been criticized for being too general and scalar. However, the generality of this definition allows assessment of structural, functional, or compositional aspects of ecosystems at any spatial scale or level of the classification.

As a special kind of ecosystem, wilderness is a human classification of an area (including air, water, land, and species) that recognizes that the content is determined by natural physical and evolutionary processes. Of course there are many classifications of wilderness and other definitions. This article does not address the definitions of wilderness that refer to human inspiration, recreation, purity, separateness, fiction, or myth. We have placed so much baggage on the word that it may not be useful. Wilderness is not a pure ecosystem. There never has been, for the past ten thousand years or more, a pure, humanless nature. Nor should wilderness be considered a simple playground for human needs for entertainment or therapy. Here, wilderness is simply a designation of natural systems that are not dominated or significantly modified by human processes.

Wilderness is a metaphor, after all, an invention of city people to describe the kind of nature existing outside their walls. This definition anticipates that nature was being converted to human nature rapidly. The metaphor has a psychological dimension. For instance, the forests of Greece were wild. But, the contemporary degraded landscape is also considered wild. No definition can be completely objective, due to this psychological dimension. Wilderness is a state of mind combined within a state of nature.

Wilderness is designated by boundaries, usually formal ones where governments have set aside wild lands. But, the boundary does not have to be formal, as long as there are rules. It could be recognition of places left alone because they are cold or remote. The boundary can be a limitation on interference or conversion, and perhaps a limit on the number of people or on their use of technology. In this discussion, all of these refinements are included under the umbrella term wilderness.

4.8.2.2. Do We Humans Need Wilderness?

Human needs have been placed by the psychologist Abraham Maslow into five groups: Physical (food, shelter, clothing), Safety (law, order, security, freedom), Psychological (belongingness, love), Esteem (strength, self-sufficiency, competence, attention, prestige), and Self-actualization (achievement, creativity). I reason that wilderness provides the basis for each group.

We humans need wilderness physically. It is the matrix that is producing and supporting us. Even if we understood all of the intricacies of the process, and thought we could duplicate it in artificial environments, on spaceships for instance, we would still need wilderness—as a source of basic ecosystem services (that keep every system functioning) and as a source for ecosystem and human health.

Wilderness, as an ambihuman ecosystem, provides safety through its intrinsic order. In fact, wilderness has provided security for people because of its resources and because by definition it has not been under cultural control. More so, because traditionally it has been a source of freedom from the many kinds of human political tyranny.

We depend completely on the natural environment psychologically. Psychologists, such as D.O. Hebb, have conducted experiments that show the effects of a limited environment. Cut off from external stimuli, the mind becomes strange. The external world is needed to keep us alive and sane. This world is composed of remote occurrences, on polar icecaps and distant stars, as well as immediate personal events. Wilderness provides a constantly self-recreating environment. The human body links this exterior to mental interior. The person is inextricably woven with the world; the body is a mode of presence to others.

Living within many kinds of wilderness, as do many foraging and horticultural cultures, allows the development of strength and self-sufficiency. And, this results in feelings of competence; although, this may be true also where wilderness is used for recreation by industrial cultures. In Archaic cultures, wilderness, as sacred space, is reserved as sacred; it confers more prestige on the sacred chiefs, e.g., Tonga or Samoa (where prestige is the power to influence others, due to success or status). Wilderness can provide sources of prestige that are outside of inheritance or social rank.

We need wilderness mentally and spiritually. Wilderness, basically as sets of places where nonhuman beings could continue, is necessary to the human psyche, where "otherness" continues to exist. It is a source for inspiration from the nonhuman. It permits creative expression and spiritual development, outside of the human cultural limits. Wilderness is the source for all human creativity. It is the experimental ground where forms are recombined.

4.8.2.2.1. How much Wilderness do we need?

Wilderness is an ambiguous and indefinite thing. It is a need like the sun is a need. But, we do not need to live in it or even visit it. It supports and cycles our human ecosystems. We need it because it is not us, not human and not human-made or maintained; it is the source of all nonhuman being. It is one of those things that we need as much as possible of. We can not know exactly what the minimum is, either for the region or planet, or for human physical or psychological requirements. Even if we could determine a minimum, we should consider a more conservative number, or an optimum.

For ecosystem services, that is, for clean air, water, food, shelter, we could calculate a minimum (or optimum) local wilderness area, based on a number of criteria. To ensure the continuity of many habitats and species, we need to restore many systems that have been degraded; and save every one that is left. The hot continental region has been transformed for agriculture and little natural vegetation remains. Nevertheless, many of these areas could be restored as common areas, and support a suite of species that is adapted to the system.

Perhaps, there is enough wilderness for inspiration, but to inspire a billion people may take more than is left in a region. Humans are inspired by different things, so a token wilderness will not likely serve as inspiration for every one who is part of the current or projected population. There may be enough wilderness at this time, especially if we employ better technologies and more discipline in their use. For growing populations, we will require more wilderness. Without knowing how much wilderness we need, it may be possible to calculate an amount that might serve our needs, after considering a few more questions.

4.8.2.2.2. Does the local system need wilderness? Do species?

The local system, as a self-creating and self-maintaining system, needs a minimum volume of wilderness to continue the cycles necessary for renewal. Because the local area is a sum of local smaller ecosystems, a mosaic of different systems, those areas need to be considered individually.

Diverse habitats form a mosaic on the landscape, e.g., patches. A patch is also a landscape element. Each patch contains internal habitat diversity. Disturbance in a patch is a major determinant of species number and size. For sustaining a species there has to be a Minimum Dynamic Area. Patches have different patterns. Squirrels for instance, may be found in small patches but be absent from or scarce in large ones, which may contain predators such as owls. The same situation may be true with land snails, which may be preyed on by wild pigs. There may be a patch size restriction.

The Minimum Dynamic Area is the smallest area for a reserve to have a complete natural disturbance regime in which discrete habitat patches may be colonized from other patches in the reserve. Larger patches are required to sustain a species indefinitely. Formann defines the Minimum Dynamic Area as the patch size required so that the natural disturbance will not eliminate a species.

Although area is one criterion of a landscape, ecosystems are not completely defined by spatial criteria. One reason that it is difficult to have area define an ecosystem is because of the watersheds and airsheds that are larger than one system. In many ecosystems, plants through transpiration cause precipitation in the larger airshed. The spatial boundaries of an ecosystem are more dynamic due to air and water. Of course, parts of the ecosystem are based in soil processes and the plants themselves.

The scale of other pathways contribute to the size of an ecosystem. So, when calculating a minimum or optimum size for ecosystems that need to be labeled wilderness, we have to be sure to increase the area to make sure that the largest extent of water and airflows are also self-sustaining on that scale. The pathways have to be complete within an area, a natural surface with a large number of limits (water catchments, nutrient deposition, nutrient limits, temperature limits); this includes biochemical pathways. The minimum critical size of ecosystems remains one of the central topics in conservation and is dealt with in greater depth by Lovejoy and Oren.

Because the regions are the sum of plant, animal, and material interactions, it may be necessary to calculate some wilderness in terms of keystone species. All animals use environmental signals to time their life events. Day length or availability of food can trigger reproduction. These signals provide predictable information about conditions that are forming in their environment. Sometimes, however, unpredictable events, such as storms, can disrupt behavior. Animals therefore learn to cope with many kinds of unpredictable events. Human actions, such as pollution, introduction of exotics, or large-scale disturbance are also unpredictable events to animals. Population declines of animals can be accelerated by: Genetic change, such as a loss of variation; demographic fluctuations, due to changing birth or death rates; and environmental fluctuations and disturbances, such as fire or poisons. Wilderness is a way to reduce the number of unpredictable events so that animals can flourish.

D. Terborgh (1974-1975, in Lovejoy) demonstrated that very large areas on the order of 1,000 square kilometers are necessary for long-term survival of species (without those large areas, bird species loss has been reduced to 1 percent of the original avifaunal complement per century). Although this particular approach has been questioned, other considerations such as problems of population densities and the likelihood of extinction from random population fluctuations support the general conclusion that large reserves are necessary to keep ecosystems intact.

Thomas Lovejoy and Richard Bierregaard, ornithologists, started a Minimum Critical Size of Ecosystems Project in Brazil. Using a Brazilian law requiring rainforest tract owners to leave 50 percent of the land in tree-cover. Working with landowners to leave patches in size from 1 to 1000 hectares, they started to survey diversity. The purpose of this project is to answer the question: How much land is required to sustain 99 percent of all original species for 100 years?

The diversity of small islands decreased more rapidly. The extinction of species was also accelerated by day winds that were able to penetrate into interior forest, killing trees 100 meters or more deep. Edge species increased. Interior species, including ants and shade-loving butterflies declined. Large mammals, such as pumas and jaguars and peccaries, migrated away from smaller plots. Without peccaries to create wallows in forest pools, some species of frogs failed to breed and disappeared. Beetles needing dung or carrion became scarcer. Second and third order changes would continue down to mites and parasites.

Wildly fluctuating populations are also more vulnerable to other events. Below a certain threshold, a small population is in danger of extinction. Edward Wilson notes that a tenfold rise in population size may increase chances of longevity thousands of times. A modest increase in habitat size may put a species beyond the threshold. Animals may be vulnerable if they are specialists, or if they are large. Large-size predators means smaller populations, which means vulnerability to extinction.

While the general conclusion that large reserves are necessary is undoubtedly valid, the topic has not been dealt with in anything like the depth it needs, from the viewpoint of either conservation or theoretical biology. The main purpose of their study is to determine the role of ecosystem size for primary productivity, autotrophic biomass and system respiration and their temporal stability in experimental mesocosms and natural ponds and lakes. In any landscape, productivity can vary over short distances, due to differences in topography, air temperature, water availability, and history. Therefore, regional averages are used.

We should create a Minimum Critical Volume for local wilderness, below which cycles would wobble or collapse. We are not sure about size or stability of planetary cycles or ecosystems. Worse, the delay time between instability and collapse is likely more than one human lifetime, so unless we start monitoring all ecosystems, we will have a hard time understanding which systems are dying and which are changing to new points of stability.

4.8.2.2.3. How do we know how much wilderness an ecosystem needs?
Or how much species or guilds of species need?

It is thought that if we save a large percentage of an area in wilderness that will be enough to automatically save both ecosystems and species. However, it will not save part of each kind of ecosystem. It is thought that we can save minimum viable areas of each kind of ecosystem, and that would save most of even the larger species. But, that will not save at least one population of each species. For that, we need to inventory all the species on the planet. Then we could calculate areas with adequate populations, or Minimum Viable Populations (MVPs).

That is hard to say, because there are so many human variables, not to mention evolutionary variables. A region may continue with fewer, simpler ecosystems. What we are really concerned about, I think, is richness. How rich a system do we want? Do we want cathedral-like tropical forest canopies that host millions of different species, each making a home there? Or will we settle for desert ecosystems, blasted by centuries of war and destruction? Of course, these ecosystems have their own stark beauty, even after the adapted species have been destroyed. The vast number of species existing now have existed for over a million years. These species have proved resilient to all kinds of natural changes and disturbances, except for human ones, which can interfere with renewal.

4.8.2.2.3.1. *How much wilderness should there be in an ecosystem?* I am not sure how much area an ecosystem needs to be self-renewing. Of course, that depends on the ecosystem. And, the larger and more complex the ecosystem, the greater the likelihood it has dependencies and exchanges with other ecosystems. We know about exchanges, especially bird watchers, who follow the objects of their fascination for thousands of miles. Birds carry information, genes, viruses, and seeds to distant ecosystems.

4.8.2.2.3.2. *How much wilderness does a species need?* For species, we can calculate minimal areas to maintain minimal viable populations. But, even then, there are many variables to consider, depending on the species. For example, some species, such as wolves, use non-breeding individuals to help with education of the young.

Each species needs to keep a minimum number to be genetically healthy. Biologists have been attempting to determine minimum viable population size (MVP), which is the smallest number of individuals to maintain a population indefinitely. How big should a population be to avoid extinction? Population viability analysis is a comprehensive analysis of environmental and demographic factors that affect the survival of a population.

Michael Soule has suggested 500 breeding individuals as the minimum. The 500 breeding individuals is the effective size; the real size may be quite larger, especially where the generations are shifted to elderly or where not all members mate. Long-lived species are also vulnerable, for example, the Pacific Ridley sea turtle or African elephant. So, we could safely use 2500 as the optimum number.

How big is the minimum size of area that will sustain a MVP? What is the minimum viable area? For a forest patch size in forest marsh grassland, a minimum area can be calculated for typical species:

- One to four hectares (ha)—amphibians, frogs, a very few common edge birds, such as Downy Woodpecker or Great Crested Flycatcher

- 10 ha—still dominated by edge species, but may have very small areas of interior which supports numbers of forest interior/edge species, such as Hairy Woodpecker or White-breasted Nuthatch
- 50-75 ha—still predominantly edge, but will support small populations of most birds except those with very large home ranges. Least Bittern may be present in marshes of this size - more bird species (Northern Harrier, Short-eared Owl)
- 100-400 ha—all forest-dependent bird species diving ducks (Redhead, Canvasback, Ruddy Duck)
- 1 000 ha—suitable for almost all forest birds. Some forest-dependent mammals present, but the size may still be inadequate for Sharp-tailed Grouse and Greater Prairie-Chicken
- 10 000 ha—an almost fully functional ecosystem, but may be inadequate for a few mammals such as Gray Wolf and Bobcat (100,000 ha has been suggested as a minimum)
- 100000 ha—a fully functional ecosystem. It may be a minimum size for a functional ecosystem but some species may still be below or near their minimum viable population level.

It might be best to use a strategy that combines all three approaches: a percentage of the planet, in addition to special ecosystems and then special species. Without knowing how much wilderness the planet, ecosystems or species need, it may be possible to calculate an amount that might serve those needs.

4.8.2.3. If we do not know how much is needed, how much should we save?

Obviously, we should be cautious and save as much as we can of every habitat. If the area is large enough, then probably the top predators will survive and keep the system diverse and healthy. The current reserves are inadequate; wild species decline on limited reserves. Designing reserves requires a biogeometry, knowledge of the shapes of ranges. Left to themselves, in an adequate preserve, species may be dropped or generated. Human progress deprives many species of existence, simplifying ecosystems of which we are still greatly ignorant. Industry destroys billions of creatures more than unscrupulous hunters or multiplying homesteaders. The rate of extinction of species exceeds our rate of learning about them. Humanity as a species must develop an awareness that it is infinitely enriched by the organic world, and is poorer each time a species is eliminated or natural community degraded.

There are many ways to approach minimum (or optimum) wilderness areas. Some ways are simple, and others are complex, perhaps too complex. Some simple ways are probably unacceptable to the human populations. Several approaches can described as follows:

1. The Remainder method (What's left?)
2. The 50 percent rule (Best guess?)
3. The Acreage method (After Eugene Odum)
4. Minimum System Method (Processes, after Lynn Margulis)
5. Key Species: Top predator home range (With genetics/ecoregions)
6. The Mixed Method (Appropriate for various areas)

These approaches are expanded in the following paragraphs.

4.8.2.3.1. The Remainder Method

This method works by calculating how much wilderness is left and not critical for human needs. This would result in about 30-36 percent of the planet, according to satellite information. Early satellite information revealed that 32 percent of the total land area was not being used in a way that compromised the self-renewal of ecosystems. For local ecosystems,aerial photo surveys, with ground truthing, can determine the area that remains wild. However, this does not tell us if it is enough to guarantee the functioning of the ecosystems, for minimum function. Nor is there any way to tell if it is enough to support its human populations at any level of luxury. Some ecosystems have 0% wilderness, while others, especially in remote areas, are 100% wilderness.

4.8.2.3.2. The 50 percent rule

This rule calculates potential wilderness and then sets aside half of that, to be restored or allowed to proceed through succession. It applies to land and water areas. For any one water ecosystem, half would be preserved from extreme fishing, dumping or other use, especially those areas close to shore and upwelling zones. And, this approach could be used with local ecosystems as well.

It is possible to arrive at this rule as a result of exponential change, 50 percent of lake is covered the day before it is entirely covered, if algae is doubling every day. The problem with this method is that a growing population has to be kept within the remaining limits, and those limits have to be exceeded to provide sustenance for those people. This might be possible with an increase in urban agriculture and with more appropriate technology, but it would wreak havoc on traditional diets and traditional agriculture.

4.8.2.3.3. The Acreage Method

Eugene Odum (1970) suggested using land area as a measure of human carrying capacity. Odum was one of the first to consider the implications of such limits. The minimum per capita acreage requirements, with a temperate area like Georgia as a model for a quality environment, is 2.02 ha (5 acres). The percentages are broken down in Table 48233-1.

Table 48233-1. Acreage Per Capita (after Odum)

food-producing land	30%	.606 ha
fiber-producing land	20%	.404 ha
natural support areas	40%	.808 ha
artificial areas	10%	.202 ha

The state of Georgia has a mean Net Primary Productivity (NPP) of 1200 grams per square meter per year ($g/m^2/yr$). Most of the state is a temperate deciduous forest. By comparison, the mean NPP of the entire planet is 782 $g/m^2/yr$—this includes desert and prairie areas—and this is only two-thirds as productive as temperate forest areas.

Using this figure for Palouse grasslands, for example, of 40 percent per person, and considering the difference between mean productivity, we can calculate an optimum wilderness area for that system, using the current population.

This calculation results in a figure of just over half of the area of the ecosystem for wilderness. Of course, as the population increases, then the amount of wilderness required also increases. This is not happening; wilderness is not being created or restored at the same high rate as population growth. Wilderness needs to be increased to provide the ecosystem services that more people need. At the same time, it might be prudent to decrease our populations.

If we use Odum's whole figure requirements, not just the natural areas, then the situation is revealed to be more critical. This current area calculation (is greater than the surface area of the ecosystem. The only option in this case is to reduce the human populations over several generations—perhaps by lottery, or reverse incentives, or allowing cultural autonomy—or to balance trade with low population areas.

4.8.2.3.4. The Minimum System Method (Process)
When the ecosystem is the smallest unit capable of recycling the elements of its membership, then for each type of ecosystem, a minimum area can be calculated that would permit the processes to continue to function. For example, organic carbon can be expired, fixed, reacted, or transformed. This method requires intimate knowledge of an ecosystem. For most ecosystems, we do not have that knowledge. Until we do, we should use a more conservative approach to determine a minimum or optimum.

4.8.2.3.5. Key Species Method (Top Predator and Genetics)
By calculating the minimum viable area for each kind of ecosystem, using the largest habitat of the top predator, and summing for all ecosystems, a figure can be calculated for a wilderness area for the planet (if wilderness is equated with ecosystems MVAs). Predation is a key to initiating and sustaining the diversity of ecosystems. Humans, by wiping out the predators have made the systems less healthy. The predator serves as a top-down limit for prey species, keeping them healthy by altering their behavior, and by removing young sick and old individuals. Of course, in the system, there are bottom-up limits also, as plants change their chemistries to attract or avoid predators of their own.

The idea of saving wilderness now is the idea of saving ecosystems complete with predators, most of which cannot compete with humans. Yet, the systems are crucial to human survival. The conclusion then is to save large systems, as wilderness, complete with predators, not only to keep the biodiversity strong, but to allow those systems to provide those things that humans cannot do without, such as clean air and ecosystem services. The ecosystems have to have viable populations to be stable.

The size and geometry of reserves can be approached from considerations of large predators such as Grizzly Bears and Mountain Lions. It is possible to determine the minimum home range of such species by means of radio telemetry and to calculate a minimum critical area by making some assumptions about the minimum population size needed for genetic considerations. But such a procedure does not take into consideration the problem of dispersal of the young, who may not be tolerated within established areas. To remedy this situation, some have suggested reserves linked by corridors of similar habitat for dispersal so that there would be essentially islands of habitat for people rather than islands of habitat for wildlife.

Maximum population density scales as mass, therefore the requirements of individuals for space increases more rapidly with size than the space available. There is an overlap in the ranges of large mammals and birds. Large mammals that are grazing herbivores are not territorial. As species decrease in size they tend to be more patchy in their use of the environment (but many carnivores having a healthy population size also exhibit this tendency), which leaves a lot of space unused. However, those populations may shift territory, so it would be difficult to fence off only the territories they use currently.

We can calculate the areas for a few keystone species for instance, using their home ranges. Home range is the area around the home of an animal, used for feeding or searching for mates, commonly shared by mated animals with offspring. Defended territory is usually a smaller area that an animal will defend actively. Animals also disperse and migrate, both vertically and horizontally. Keystone species can be top predators, such as the Sea otter, who preys on sea urchins, which graze on algae and kelp, the dominant food source, e.g., fig trees, a connector, such as mycorrhizal fungi, a habitat modifier, such as the beaver or African elephant, a mutualist, such as cellulose-digesting microorganisms. Co-evolving species appear to alter the structures of landscapes over which they evolve. They then tend to have the highest fitness and survive the longest in their physical landscapes.

Predators have different sizes of home ranges, and the shape of their ranges reflects various habitat needs. Some predators have relatively small ranges that have a linear shape. For instance, the skunk, an omnivore that digs subterranean dens along hedgerows, has a home range of 1 km^2 per animal; the range is linear around edges. The red fox, a nocturnal carnivore that also creates subterranean dens, has a home range of 10 km^2 per animal; that range is also enlongated rather than round in shape. River otters, piscovores living along rivers and valley streams, have a home range of 160 km^2 apiece, whose shape is guided by water courses, but also changes by seasons.

Other predators have larger ranges with other geometric shapes and may use several ecosystems. The Canada Goose requires numerous landscape features for summering and overwintering, roosting on open water, feeding in fields by day, resting on shorelines during day, and staying in protected coves in bad weather. Migratory birds are declining as a whole because not all of their territories are protected. In many cases, wintering grounds are being destroyed by logging and burning. These species need several kinds of habitats to avoid extinction. Owls are also vulnerable to habitat destruction, although they reside in one ecosystem. The Spotted owl requires 1000 hectares (10 km^2) of old-growth forest for each mated couple. Other owls have less stringent needs. The pygmy owl requires half the territory and survives in second-growth forests. As a key species the minimum area for a viable population is 250,000 hectares (2000 km^2).

Coyotes each require a minimum area of 700 ha (7-10 km^2) for a home range; although the range follows natural features, it tends to be much less linear in shape. An effective population of at least 500 individuals may be needed to maintain genetic viability of each animal species (Frankel and Soule, 1981). Since not all coyotes in a group breed—some become aunts or uncles and help care for pups—it is necessary to assume 3 coyotes per breeding unit. Using coyotes as the key species, the minimum area for a viable population becomes at least 525,000 hectares (or 5250 km^2).

With wolves, it is necessary to assume at least 3 wolves per breeding unit. Assuming a minimum viable population of 750, and a requirement of about 80 km^2 per wolf, the minimum area for a viable self-sustaining wolf population would be 60,000 km^2. Many species, such as wolf, use clusters of ecosystems, including corridors, such as roads or frozen streams, as well as fields and forests; they avoid wetlands and human cities. Larger carnivores, such as Siberian tigers, require even larger areas (two tigers require 10,360 km^2 or 4000 square miles. Five hundred would need over 5 million square kilometers). This system is quite a lot of work. But, the calculations can be simplified using three levels of tertiary predators across all identified ecosystems.

There is another way to calculate Minimum Viable Areas. That is to sum the requirements necessary for each species, since each species is genetically unique, not simply address the top predators. This is considerably more difficult, since we do not know how many species exist in any one ecosystem, where they are, or how much home range they need; nor do we always understand how the areas overlap. This calculation will have to wait on a complete inventory and monitoring program.

4.8.2.4. After we decide on wilderness numbers, how do we set it aside and protect it? Does wilderness have to be separate from humans?

There are species that cannot coexist with humans. There are habitats that are critical to the functioning of larger regions. There are habitats too fragile to bear human interference. There are habitats that are of virtually no use to us. All of these could be set aside and monitored from satellite (even airplanes can have some impact on some systems).

The wilderness that could tolerate small incursions, such as scientific research, would probably tolerate some human presence. Those wilderness areas that have coevolved with human cultures could simply be controlled by limiting human presence to traditional cultures or to sophisticated ecological cultures. Not every person in every culture wants a car and television. The allure of simple traditional cultures is such that many people would like to go back to them and live that way. Some wilderness areas could probably tolerate a higher impact from people. Traditionally, borders (between human and nonhuman habitation) have tolerated human impacts. Most borders are between cities and unused areas. These are permeable and undefended, except for the few reserves. The boundaries are fuzzy anyway, due to the ability of pollution and trash to reach any area.

The numbers look great, but how important is shape? These areas have to enclose a large percentage of interior space to protect interior species. The areas also have to be lined up with watershed and airshed patterns. The context landscape is also an important consideration. Historical developments, such as drought patterns, should be considered; for example, to accommodate anticipated changes from global warming, reserve designs could have longer north-south axes.

Figure 453-1. Wildlife Cedar at Altazor forest

4.8.2.5. *Summary: Service & Wisdom*

Wilderness provides necessary ecosystem services to each ecosystem and its inhabitants, including regulation of weather, developing and maintaining biodiversity, sequestering carbon, and maintaining watersheds. Wilderness is the source of evolutionary change. For humans, and possibly other beings, it has political and spiritual significance. Wilderness provides and maintains conditions conducive to human life, globally, regionally and locally. Maintaining wilderness areas permits continued global ecological sustainability. According to Reed Noss, "wilderness" protection and restoration must be the first major ecological conservation strategy.

Ecosystem conservation offers several advantages over a species-by-species approach for the protection of biodiversity. It directly addresses the primary cause of many species declines (habitat destruction), it offers a meaningful surrogate to surveying every species, and it provides a cost-effective means for simultaneous conservation and recovery of groups of species. The idea of representing examples of all ecosystems in protected areas extends back to the nineteenth century in Europe and in Australia and to the early twentieth century in North America. Ecosystem conservation does not remove the need to understand the autecology and the protection requirements of individual species. It is not a replacement for existing conservation measures such as the Endangered Species Act of 1973 in the United States. Not all species that have gone extinct in the United States since European settlement would have been saved by this kind of coarse filter, which does not protect all presently endangered species. We must save rare and endangered species along with this plan.

Conservation plans for all ecosystems should be developed, starting with those that are at greatest risk of degradation or conversion. Local conservation, in general, has to include key elements: Salvaging the hotspots, including Madagascar, Hawaii, Klamath, and Ecuador; keeping the five largest remaining frontier forests in tact: Amazon, Congo, New Guinea, Canada, and Russia; ceasing logging in all old-growth forests; saving wetland systems, rivers, shores, and marine hotspots; restoring some of the oldest landscapes, e.g., Mediterranean coasts, African wetlands, and Iraqi grasslands; and, restoring areas that are overused or underrepresented, such as grasslands and deserts.

Conservation plans have to include monitoring. This requires understanding the rates and locations of land-cover change, as the result of natural processes, natural disturbance and human interference, and understanding the processes associated with biological productivity. Both involve monitoring and assessment of landscapes that are changing rapidly due to extensive and intensified land use and natural disturbance regimes.

These plans must be kept in the context of human populations, cultures, and technologies. Human populations must be balanced with wilderness. If human populations cannot be reduced, then large areas of wilderness have to be restored.

Many wilderness areas and ecosystems are endangered, especially those that have a long history of human settlement, such as the eastern coast of North America, or those that hold desired resources, such as the beech forests at the tip of South America. Most ecosystems have little or no legal protection. They have been ignored only because they are inhospitable or resource-poor. Plans to protect them have to have a strong legal component.

Wilderness is not something that can be preserved in one desired state; it is always changing. But, the processes that are continuously creating wilderness can be preserved by preserving the boundaries that limit wilderness from human landscapes. The wilderness cannot be managed; it is that which is not managed by definition. But, people, technologies and interactions can be managed.

Partly, things change, partly we reinvent things. Now we need to reinvent wilderness, cities, homes, and intercultural interactions. We need to keep everything in a complete context. That means political changes and population planning, as well as just designating and protecting wilderness. We need to act as if we were wise, according to Jonas Salk. Wisdom is a kind of action, based on theory, and with an understanding of ignorance.

4.8.3. *Local Wildness as a Contradiction?* (Being edited)
Wilderness is usually described as large contiguous areas that are influenced by natural processes. Wilderness provides the chaos and turbulence that every system needs to keep being mixed. On an ecosystem level, however, wilderness is limited to the history of the system. On the local level, small areas of wilderness, sometimes too small to regenerate naturally, are granted the status of honorary members of human society. We thus show our willingness to allow some wildness to exist in plots of land or corridors through communities and cities.

We prefer edge habitat so as to move between other habitats. Urbanization is a characteristic of an edge species. Civilization produces edges that people like. Wilderness is a thing with a large interior and smaller edges. Wilderness is fragmented into islands and patches. So, there is no more deepness, no more interior to wilderness near human areas. What are other edge species? Raccoons, coyotes, crows, and rats.

But, wilderness by definition is independent of human control and does not require permission to exist. We divide wilderness into categories for our convenience, but even small areas function as parts of whole larger systems that affect and constrain human ecosystems. We need to set aside small areas of wilderness, even if the attempt is useless for the long-term, because the local should maintain its diversity, and the local will be integrated into new global forms. Of course, we must realize that there are minimum viable areas for ecosystems. But, in addition to these minima, we can thread wildness through fields and cities. Most approaches to design and the global are dualistic (wilderness-industry) or triune (wilderness-design-industry). A better approach would show how these interweave so extensively it is hard to just use boxes. The same is true for humanity and nature or science and action ethics.

We believe that our fields and cities are gardens created out of wilderness and that we need to keep gardening. Wilderness could be restored from gardens with sufficient ecological knowledge. And, we should keep the different gradients of wildness among systems. That requires protecting all sizes of wild areas, from local to regional and global areas. A very low percentage is being protected now, probably less than 7% of the planet, and most of them are being threatened by resource extraction, agricultural conversion, and the effects of population growth. Conservation can reverse this trend. We know that human civilization depends of large areas of wild systems for services that we cannot create or control.

Industrial culture offers great control over many aspects of the environment. One form of this control has been the setting aside of parks and wilderness areas for future generations; functioning ecosystems, such as wetlands, are being preserved, sometimes haphazardly, as the basis for human activities. We can coordinate this conservation and preservation locally.

Ecosystems are local, not global. Although we regard communities as being tied together globally, each community is alone—that is the real meaning of local—being independent, striving for 'survival' without regard for others. A restatement of Rene Dubos's imperative to think globally and act locally would be to think locally and act locally, but be aware of the global implications, causes and effects, of any action. Each culture has to be responsible for its own welfare. Preserving the local environment is one requirement.

The possibility of extreme change is rarely considered in wilderness design. We need to be creating neopoetic areas with rewilding. Neopoetic areas may be one of the largest kinds of wilderness, now. These areas need to be zoned, with other definitions of wilderness, as well as with all other categories of use, using a formal zonagraphy to allow varying degrees of isolation from interference and industrial disturbance. Ecological design addresses the determination of separate wilderness areas necessary for a healthy ecosphere, at every level, and an optimum human population, based on net ecosystem productivities and modified by appropriate technologies within ecological and cultural restraints.

5.0. Facing Culture Through Design

Human beings are mammals who live in groups and are good at imitation. These talents have allowed humans to create cultures to adapt to stressful environments. Cultures became useful in many ways, from externalizing memory to training the young. Many adaptive patterns were developed over the past 12,000 years, from agriculture and cities to technology and industrialization. While these adaptive patterns allowed great and dramatic improvements, their application in every circumstance is resulting in tragedies. Perhaps one solution is a global culture or a conscious framework for traditional cultures, but this solution would depend on understanding cultures and human motives.

5.1. *What is Humanity? Is Humanity Local?*

Human Beings are mammals—omnivorous, social, bipedal, featherless, symbol and tool-using, game-playing, neotonous, bilateral-hemispheric, culture-making generalists—who, as George Woodwell (1976) put it, live as "one species in a biosphere whose essential qualities are determined by other species." Mammals are bound by biological requirements that must be met if a population is to survive, although these functional requirements are rather minimal for humans, however, being only food, clothing, shelter, and reproduction. Like other mammals, humans change their habitats to suit themselves. Humans have modified animal and plant associations in a different way, simplifying patterns of energy and chemical exchange, solidifying themselves at the end of many food chains as a dominant species. Unfortunately, they often dominate their habitats. A dominant is a species with greater influence than any other in its biotic community, changing the lives of other species and the character of the habitat.

Due to the extent of its influence, humanity is a pandominant species. As such, humanity reclaims, overgrazes, clears, depletes, and wastes at a level that threatens the stability and existence of many systems. One of the ecological consequences of human activity is the degradation of wild habitats for human developments (food, housing, and recreation) and the introduction of novel elements into the biosphere—elements that have not been harmoniously worked in over time. The biomass, or demomass, of the human species probably far exceeds the biomass of any nondomestic species, and that biomass is supplemented by the tremendous biomass of domestic animals, which is four times greater than the human (Borgstrom, 1975). This biomass forms an equivalent population that consumes much of the same food, such as milk, fish, and grain. The domination of humanity is related to other characteristics as well, such as our large biomass (6 x 1014 Kcal), large annual increase (2 percent), high structural organization (information, matter), and our high energy use (globally, 13 times mammal equivalents).

This dominance has major effects on ecosystems: Transient perturbations in energy relations (from oil spills, burning); chronic changes/shifts of systems (from dams, irrigation, chemical wastes); species manipulation (from the import and export of exotics); and, interference competition with wild species, as opposed to exploitative competition, which can be stabilizing). None of these effects are exclusive to humans as a species, but they are excessive, rapid, compounded, and large-scale.

Probably no consequence of human development has had a greater impact on the natural landscape and ecological processes than the production of food. Patterns of eating have influenced the constitution of species and the very contours of the earth. Throughout their history, humans have used animals and plants for food and clothing. Animals were followed, herded, corralled, tamed, and finally bred. Plants were domesticated later. As technologies developed, human relationships with animals and plants changed. Hunting, grazing, and agriculture provoked large ecological disturbances. Early domestic animals were revered, but nondomestic animals were considered competitors or nuisances. Now, animals are treated as commodities processed in factories and wildlife is regarded as useless. Hunting persists, but mainly as recreation. A few plants provide the bulk of human diet; the rest are considered ornamentals or weeds. Humans are omnivores, although they have been represented as carnivores, vegetarians, or fructivores by different factions. The functional biological requirements are rather minimal for humans, however, being only food, clothing, shelter, and reproduction. Other requirements, such as respect, comfort, and self-fulfillment, depend on cultural systems.

5.2. *What is Culture? Local Cultures*

The word culture has been used to identify human groups, as well as describe their unique beliefs and artifacts. The word is also applied to emergent properties of other living groups from wolves and termites to bacteria and fungi.

5.2.1. *Animate Culture*

At first, humans were considered special because of their divine spark. Then, they were special because they were disconnected from nature by culture, a magical reification of the opposite of nature, a social structure that we could produce at will to overcome the constraints of nature. It has been argued that culture let us push out of the constraints that limit other hominids, like chimps and apes. Culture was once considered an attribute exclusively in the human domain.

If one defines, as Imanishi Kinji does, culture generally as a form of behavioral transmission that does not rely on genetics, then animals, birds, fish, and perhaps some insects can be said to have cultures. This definition is not limited by the kinds of mechanisms, such as copying or imitation, and it spreads across the continuum from guppies and apes to rich human culture, which need not be devalued by being part of the continuum with animals. Value systems and technical achievements are sometimes the results.

5.2.1.1. Copying & Animal Culture

Culture can be defined as the transmission of information through behavior; imitation is one behavior, teaching is another. Culture involves a mix of: (1) trial and error learning, (2) social learning through observation and imitation, and finally (3) teaching. Culture is one way of transmitting information. Other ways are genetic coding and individual learning, although individual learning is difficult and easily lost without a context.

Some birds learn through imitation. For the bower bird, the bower is an extension of its plumage and size, for courtship displays, but the extension changes faster than the biology. Evolution accelerates in this extension. When the environment supplies tools, new interactions and transactions occur. Culture is like an external bundle of secondary characteristics, according to Edward Hall quoting E. Thomas Gillard. Bowerbirds no longer pair off to mate nest and raise young. Males gather in clans and get ranked hierarchically. In spring, clans form around arenas for display. Each display court is called a lek. Females mate with the dominant males, those with the most baubles. How does female mate choice change?

5.2.1.2. Imitation & Human Culture
Human culture, and human behavior, need to be defined against a long evolutionary backdrop of deep history, the common ground we share with other animals. Perhaps human culture is transmitted through imitation.

What is required for culture? Many theorists require the following things for a group to have a culture: Language (for communication); dexterity for tool making and using; brain power for artifact design and making; social skills for home building; capability of governing or self regulation; and external memory (in customs or things). It can be argued that none of these things is exclusively human, but only humans easily qualify for having all of them. Wolves easily have language and social skills, but they have difficulty making and using tools (although they do sometimes use sticks or stones for training pups) or keeping external memories; some ethologists argue that wolves have culture, while others deny that they do.

5.2.1.3. Extension & Culture
For humans the extensions are more elaborate. A simple extension enhances the function of an organism, as knives are better than teeth for cutting. Extensions permit faster changes to answer environmental challenges without waiting for the body to change. Hall points out that externalization allows one to examine what was inside the head, to study it and change it as a thought experiment. Initially, extensions are low-context and this is what allows dramatic change. That means they are easy to learn and easy to change.

All organisms alter their environment and try to control it. Edward Hall describes two complementary processes of control: Externalizing and internalizing, which are ubiquitous normal, and continuous. The conscience is an example of internal control. In Northern Europe sexual control was internal and left to the woman. In southern Europe, the control was considered external, and doors and locks were used.

Culture is an extension system, but any extension leaves out some things. It can acquire an identity and a history. It can also allow sharing, not just of tools like knives, but tools like cultures, radios, poetry, and plays. Because extensions change so fast, they can seem lifelike and more important than the biological and ecological environment. They can also destroy the natural environment. Extensions, once they are outside the body and mind, can lead to detachment. This allows dissociation. They allow changes in perception, so that others are less alive or can be killed without moral problems. Theoretical systems are treated as real, and everyday life problems are dismissed or undervalued. Cultures can be ranked by use of extensions into high-context or low-context, as extensions decrease context and allow things out of context. Low context cultures are better able to use extensions without screwing up the integrity of the culture.

Culture provides a filter between humans and environments. So, culture can serve as another form of evolutionary filter. It designates what we attend or ignore. It has to screen less valuable information (to avoid overload, even in archaic times). Like a trigger, culture allows less information to activate the system. And this is the only way to increase information handling without making the system larger and more complex—of course, this is what stereotypes and metaphors do, also. Culture programs the individual or institution.

5.2.2. *What is Human Culture?*
What is the world like? How did the world get the way it is? And, what is the role of humanity in the world? All cultures ask and answer these questions. Some of the questions could not be answered from direct observation. And, many of the answers were not limited to observ-

able events. Ideas concerning humanity and the nature of the universe tend to form a coherent system in which ideas are integrated or rejected over days or centuries. Culture includes all of the expectations, understandings, beliefs, and commitments that influence the behavior of a human group. Culture exists in minds, signs, and things, but most importantly in places. The word culture, from the Middle English, meant 'place tilled' (from the Latin meaning to 'till, care for, inhabit, worship'). For the Romans and English, to have a culture was to inhabit a place and cultivate it, to be responsible for it.

5.2.2.1. Definitions of Culture

The classical definition was put forward by Sir E.B. Tylor (1871): "Culture … is that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society." Although the definition seemed to limit culture to 'man' alone, it definitely restricted it to human behaviors and artifacts. Others, including Claude Levi-Strauss and Leslie White argued that culture required imitation, teaching, and language, and therefore the concept could not apply to other species. Robert Boyd and Peter Richardson defined culture as 'information capable of affecting an individual's own traits; they acquire the information from other individuals through imitation.' Information is a broad enough concept, especially as information, to include behaviors and artifacts. The vehicle is identified as imitation.

Peter Berger defines culture as the totality of human products. Culture is everything created as a group, tribe or nation, physical or ideal, in the past or present. This embraces cookware, arrows, steam engines; artworks, books, legal codes; symbols, values, social structures. A cultural system surrounds the network of human interactions with raw materials, forms of life and other humans. A general definition of culture identifies it as the ensemble of values, worldview, aspirations, customs, technologies, techniques and physical artifacts that characterize a people and distinguish them from others.

5.2.2.3. Synthetic Definition of Culture

Culture stretches vertically to include the physical, economic and political. It stretches horizontally to include society as a whole. In fact, culture is concerned with all things and beings. It is organic, like Aristotle considered a work of art, and whole. So everything in it is interrelated in some degree. Many relationships are encompassed by the holistic perspective of culture: The relation of people to themselves, to each other, to objects they create, and to their natural environment, and to their cultural environment. These bear on psychological well-being, social bonds, material legacy, and on the association with other forms of life.

These many definitions overlap and can be combined in to a synthetic definition, with common characteristics: Culture is a symbolic system of shared beliefs, values, customs, behaviors, and artifacts that emerges as a unique, coherent whole pattern that orders the experiences and meanings of its members and that members of society use to adapt to changing environments and to adjust to each other, and that is transmitted to succeeding generations through learning behavior and language, so that culture and the environment constrain and construct each other over time as a complex of ecological, social and historical processes. This definition might be refined later.

5.2.2.4. Properties of Culture

Culture is imbibed through a process of social interaction. People acquire culture unconsciously through social interaction, as well as consciously, through apprenticeship or formal learning. The young, or new members of a culture, observe others and imitate that behavior.

Cultural models are internalized by individuals, so that part of culture resides in the mental sphere of people. Beliefs and knowledge are not shared equally by all individuals, thus culture is shared differentially.

Human beings use conceptual devices, such as symbols, to communicate abstract ideas about nature or society to one another. Through our linguistic capacity, we can use symbols as meaningful representations of reality. Public shared meanings provide a set of designs that allow an educated individual to survive nature and society. The understanding and practice of culture is shared in a culture. A culture has properties that are related to ecosystems and places (Table 5224-1).

Table 5224-1. Contrasted Properties of Different Levels of Patterns

— Nature —		— Culture —		— Design —	
Field	*Ecosystems*	*Place*	*Culture*	*Good Places*	*Good Society*
Process	Course	Dynamicism	*Conduct*	Action	Method
Autopoesis	Self-making	Identity	*Wholeness*	Individuality	Extension
Differentiation	Diversity	Uniqueness	*Flexibility*	Richness	Variety
Integration	Construction	Investment	*Adaptation*	Conviviality	Cooperation
Constancy	Stability	Regularity	*Endurance*	Consistency	Loyalty
Development	Productivity	Renewal	*Vitality*	Health	Harmony

5.2.2.4.1. Conduct as a Property of Culture

Conduct is the course of cultural behaviors through a behavioral landscape or field. New mathematical treatments of fields tend to be three-dimensional. Rene Thom's catastrophe theory and Conrad Waddington's epigenetic landscape are two such theories. The epigenetic landscape field can be used to explain why some people cannot kick a bad habit even though they know they should. The need path or chreod is deeper than the path of a cognitive chreod to better health. If the need chreod is too deep, one cannot explore alternatives with a cognitive chreod. The field also explains why necessity cannot be the mother of invention; the necessity path, starvation for instance, is too deep to allow exploration of a shallower path of designing. The broader landscape of leisure is needed. Conduct can be described as the stable path of culture through a landscape of possibilities. Once the course has been set, it is most likely to channel subsequent behavior, unless some event triggers a deeper course.

5.2.2.4.2. Wholeness as a Property of Culture

Culture provides an identity for its members. It tells them who they are, where they came from, and why they are special. Identity is basic to human existence. People are identified by their roles. A person is an incarnation of his and her group—even in industrial culture, one is identified as an astronomer or farmer. Identity is that persistent quality that serves nothing; it is. The relationship between identity and wholeness is a rhythm, with unique patterns. In fact, culture is concerned with all things and beings in a whole. To paraphrase Arthur Koestler, culture is a holon, a stable subwhole in a hierarchy that displays structural gestalt constancy and rule-governed behavior.

5.2.2.4.3. Flexibility as a Property of Culture

The rules of a holon lend order and stability to the whole, as well as flexibility. Flexibility means not being over connected, or not being too rigid or efficient. Than means that culture is able to slough off people or community structures and to incorporate new people and structures. Culture is able to keep some options and unused connections open. Some of the flexibility comes from different ways of establishing connections in specific places. Although culture is bounded, it is open to flows of energy and materials. In fact, it requires a steady input and output exchange flow. It requires order, but not too much order. It is a loose-fitting patchwork of ideas, relationships and things. It is tolerant of discontinuities and contradictions, and this gives it flexibility. Humans can tolerate inconsistency and operate with contradictory beliefs: Soldiers fight for peace; ministers save the unborn for starvation. If the contradictions become too great and maladaptive, however, then the culture can collapse. Cultures that become too isolated often stagnate, then collapse, even if they do reconnect.

5.2.2.4.4. Adaptation as a Property of Culture

The patchiness of culture is parallel to the co-constrained construction of a species and its environment. Culture has to balance between embracing change and resisting change. People show a desire for new things, but often fear and resist change. According to most theories of cultural adaptation (or integration or evolution), resistance to change is normal as a cultural process. Groups like the pygmies have specialized to fit the requirements of the environment, successfully. This makes it difficult to adopt other cultural arrangements. On the other hand, resistance to change itself is an adaptive mechanism. According to Betty Meggers, it works as a successful "cultural isolating mechanism." Isolation remember is what allows a culture to develop in the first place. But, then can it force a culture to become stagnant?

A primary culture is adaptive because it aids survival in the ambihuman world. Its ways of living are sophisticated survival mechanisms. Each way of life is a set of adaptations to the limits of the environment. Mutually constrained construction enforces coevolution, the emergence of a highly ordered complexity to full structuration. The cultural practice of polyandry in Tibet may be an adaptation to limited resources. With monogamy and every woman married, there would be more children to strain the resources available.

5.2.2.4.5. Endurance as a Property of Culture

The cultural system is stable and persists through time. It is a general property of some systems that acquired information is used to close the door to further inflow. A mature culture needs less information, since it works toward preservation, and closes itself off to information that does not fit the shape of the culture. The effect of maturity is to allow a maximum variability between systems with slight external differences, such as place or initial conditions. According to Harding (1960), when forced to act on changes, a culture will only accommodate those changes that preserve its fundamental character. Stability is the ability to maintain identity under the flow of external forces and disturbances. A culture has to be able to resist disturbances that are too disruptive. Culture also has to be resilient enough to recover from intermediate and small disturbances. It has to accommodate changes that contribute to its identity. Stability can be related to compartmentalization, communications, richness of interactions, and connections.

5.2.2.4.6. Vitality as a Property of Culture

To be constant and stable, a culture has to be vital; that is, it has to be productive, to be able to convert energy and materials into foods and structures for survival. The system is self-creating. It renews itself as its contents change, and as disturbances change the parameters of the system. The ideas and metaphors of a culture have to be vital, also, capable of adapting to a dynamic environment and to other cultures. What barriers are there to cultural renewal? How can they be overcome?

5.2.2.5. *Functions of Culture*

Culture has to deal with the facts of life, from change to death, so that people can survive in their communities in their places. Freeman Dyson distinguished three crucial biological inventions in the transition from unicelled to multicelled organisms: Death, which allowed differentiation of the future from the past; Sex, which enabled the characteristics to be shared and mixed; and Speciation, which increased diversity through separation and genetic barriers. Life can experiment with the diversity of forms and functions.

Dyson noted also that each biological invention has its analog as a cultural invention in human societies: For death it is tragedy; the fact of death is made a theme in ritual and drama. Great cultures have distilled great works from the fact of death. For sex, it is romance, where sex is turned into a thing of mystery and beauty, in dance and poetry. Speciation has been transformed into cultures and languages at the human level. The flexibility of social institutions grew out of their differences and places.

5.2.2.5.1. Culture Grounds

A culture orders a whole cosmos. A culture selects what is important from the previously undifferentiated phenomena of nature and presents it in myths and stories to be learned by people. People in a primary culture share a common image of their world—from the German word meaning 'man-image.' The image is a construct of human knowledge that reflects human awareness of a local environment. The image is constructed metaphorically, but treated 'as if' it were true. A traditional way of living evolves with people's experience and knowledge. The image guides their behavior. Grounding is more than the expression of a local place through culture. It is also the expression of individual behaviors through culture. Individual and collective entities have to be understood and balanced. Both are important parts of a whole system. Culture limits and constrains individual behavior with its conventions, but individual behavior can extend culture, by acting and communicating.

5.2.2.5.2. Culture Orders

A culture orders a whole cosmos (from the Greek word meaning 'to set in order') and applied order to the human face as well as to all of nature, and what was beautiful was also morally admirable. A culture selects what is important and what is important is often beautiful. Every culture strives for beauty that goes beyond utilitarian values. People structure their worlds with their own group at the center. With order and integration come stability and security, without which no one can survive. When human societies were small, the amount of control and security required was small. Primordial security came from knowledge. The industrial sense of security has been centered in the state, and now in the corporation, in retirement, insurance, housing, recreation, and even in credit cards. Primary peoples were responsible for their own food clothing and housing. The economic well-being of modern industrial families depends on wages alone. People are dependent on the goodwill of capital corporations for personal security. We have substituted insulation and insurance for knowledge.

5.2.2.5.3. Culture Explains

Culture explains the universe. It also explains the behavior of its adherents. By explaining reality, culture binds the human and ambihuman, and the past and the present, into a meaningful whole. Culture explains why traditions are necessary. It explains why things are as they are, and how they came to be that way. It can do this in stories, and sometimes stories need a special language to explain, such as Wataluma or Latin. In modern culture, a scientific theory is a statement that explains some aspect of the world and allows one to ask certain questions. Regardless of the features of a place, myths are created to give it special significance; giving mythical significance to a place strengthens a people's identification with it. People identify with their place and often equate their own characteristics with it; the Ituri consider themselves as bountiful as their forest, while the Mongols are as undeniable as the wind from their plateau. Knowledge allows survival in fragile habitats. The !Kung San of the Kalahari desert exist in small communities that enable them to continue traditional hunting and gathering without depleting their resources; they hunt eighty types of animals. The Hanunoo of the Philippines distinguish 1600 plant species, where scientists only know 1200 in the same area.

5.2.2.5.4. Culture Integrates
Culture provides an identity for its members. It tells them who they are, where they came from, and why they are special. Identity is basic to human existence. People are identified by their roles. Culture integrates the roles and the individuals into one society. Jurgen Habermas argues that the task of culture is to understand the meanings attributed to objects and events by individuals under concrete circumstances. A primary culture is adaptive because it aids survival in the ultrahuman world. Its ways of living are sophisticated survival mechanisms. Each way of life is a set of adaptations to the limits of the environment, which are integrated into the culture.

5.2.2.5.5. Culture Justifies
Another function of a culture is to justify human activities, in order to have those activities continue. Unless an activity satisfies a basic human need, it may not be repeated. The needs may be physical, psychological, or social, such as acquiring status. According to Abraham Maslow, the needs are hierarchical and higher needs cannot be addressed until basic needs, such as food, are satisfied. Jeremy Rifkin suggested that psychological needs can only be satisfied by the cosmology of a culture. In ancient China, people found justification of their world view in the matrix of nature; perceived cruelty in nature justified real cruelty by human beings. A common culture provides an ideal framework for public and private decision making. The Sami in northern Scandinavia have institutionalized ways of avoiding conflict, for instance, by shaming those who would impose their will. People in a culture may enlist ideology or religion to justify transfer of wealth to the rich and the leader. The shared religion also makes strangers act more peacefully without kinship. It gives people a reason to sacrifice their lives for an institution, which is nongenetic.

5.2.2.5.6. Culture Controls
Some human behavior is controlled and regulated through the use of space. Most foraging populations, furthermore, regulate their density well below the limits of the food supply. Culture controls many behaviors, from hunting to birthing. Women control sex, birth, weaning, and often population size. For Australian aborigines, women are regarded as controlling social harmony, health and connections to land, while men, with more time and strength, tend to control creative activities and hunting for prestige foods.

Cultures have been self-sufficient for thousands of years. Although some of them fail, others last for quite a long time. The Desana, for example, have existed in the Amazon for over four thousand years by maintaining an equilibrium with the environment. Ecosystems are local, not global. Although we regard communities as being tied together globally, each community is alone. Each culture has to be responsible for its own welfare. Preserving the local environment is one requirement. A culture is a way of doing things by a unique people with a unique identity, with a unique history, in a unique environment, communicating in unique ways, and using materials in unique ways.

5.2.2.6. *Effectiveness of Culture*

There are similarities of concepts between a culture and an ecosystem. Culture is a sloppy concept, like an ecosystem. Culture is also scalable, like an ecosystem, and can be nested. Properties of a culture resemble those of any system, such as an ecosystem. They include: Identity, openness, productivity, co-constrained construction, and vitality.

Like an organism, a culture has to satisfy needs to continue. The functions of a culture reflect its needs, which when expressed, are also the strengths of the culture. Like an organism in an environment, a culture engages in activities and interrelations, such as change and development. It can compete with or take-over other cultures. It can cooperate and trade. There will always be some conflict or misunderstanding, from having different images and metaphors, limits and rules of behavior. The strengths of a culture may allow it to persist for a long time; its weaknesses, though, ensure that it will eventually fall apart.

5.2.2.6.1. Strengths of Culture

A culture has social and ecological functions. The image a people have of their world makes sense of the overwhelming confusion of nature; it gives people a unique identity and justifies their behavior. Culture ties them to a place, whose qualities are known and preserved. These things are the strengths of culture, when they work.

5.2.2.6.1.1. *Personalizing a Place*. Primary cultures think of nature as presence: Things are personalized first, before being categorized. A noise in the woods at night is the voice of a living being or person. The natural world is seen as having human qualities. A core of anthropomorphism is necessary for understanding the ultrahuman. This core actually sponsors diversity in individuals and species. We understand other beings by expanding ourselves, not by shrinking them. This leads to relational knowledge. Symbolic associations and transformations are made between diverse entities. The social life of humans and other beings is not separate. Anthropomorphic thought increases the dimensions of the human intellect. By rejecting this thought, the experience of others is restricted and the scope of self-knowledge is reduced. The Pygmies of the Ituri Forest of Zaire see themselves as a part of the forest, an abundant provider; they regard the forest as mother and father, conceive of themselves as children of the forest, and live in harmony with it. The Pueblo Indians consider the sun to be their father and earth to be their mother. Earth and sun create an endless series of cycles that govern life; people and animals and seasons are part of the cycle.

5.2.2.6.1.2. *Knowing a Place*. Knowledge allows survival in fragile habitats. The Kayapo in the Brazilian rainforest practice seed selection and crop rotation; they fertilize the soil with wastes. They gather 250 types of wild fruits, 650 medicinal plants, and 100s of tubers and leaves. The Karen of the Thailand practice shifting cultivation, which is only possible with low population density and sufficient land for a rotation of decades or generations. Oddly, industrial culture considers that primary cultures have a shortage of economically-relevant knowledge. But primary people know how to find or grow edible and medicinal plants; they know how to make appropriate houses and cooking utensils with a minimum of effort and materials. Traditional communities have a rich biological knowledge of animals and plants, as well as a rich mythical knowledge of animals and plants.

5.2.2.6.1.3. *Adapting to Place*. A primary culture is adaptive because it aids survival in the ultrahuman world. Its ways of living are sophisticated survival mechanisms. Each way of life is a set of adaptations to the limits of the environment. The myths of the Tukano, for instance, do not describe their place in nature in terms of mastery of a subordinate environment. Instead, the Tukano learn that they are part of a larger system that transcends individuals. Survival and maintenance of the quality of life are possible only if all other lives are allowed to evolve according to their specific needs, which are described in myths and traditions. Myth limits the impacts a people can have on the habitat. For example, the Tukano are taught that only a limited number of animals were created and that these were placed under the care of the spirits. Tukano fishing is limited because the fish own the riverbank, so humans have no rights over it. In fact, humans are held accountable by the shaman if the area is overfished. The punishment for taking too many is also told in myth—it is human extinction. The role of the shaman is not to seek more animals or exemption from overhunting, but to restrict human use. Myth presents rules for regulating the birth rate and for social behavior, as well as for the harvest rate.

5.2.2.6.1.5. *Offering Security*. With order and integration come stability and security, without which no one can survive. When human societies were small, the amount of control and security required was small. Although societies have grown, human security has not. Primordial security comes from knowledge of the environment. Narrowness of experience is one source of insecurity. Although a culture can help people cope with fear, it cannot offer security against the biological fact of death. Michael W. Fox has pointed out that death awareness motivates much of human behavior. Many primary groups have worked acceptance of death into their myths. The Campa attitude toward death reflects acceptance: since the first Campas were made of earth, they return to earth after death; had they been made of stone, they would have been immortal. According to an Inuit myth, the first human beings lived on an island, Mitligjuaq, in the Hudson Strait; no one ever left and eventually there were so many people that the island began to sink under their weight. An old woman shouted: "Let it be so ordered that human beings can die, for there will no longer be room for us on earth." Her wish came true. Death was the solution to survival. Death is natural. But, the human longing for immortality, from Neanderthals to postmoderns, is also natural.

5.2.2.6.2. Weaknesses of Culture

Culture does not fit together into a perfectly integrated whole. A culture is a loose-fitting patchwork of ideas, relationships, and things. It is not complete. There are discontinuities and contradictions. Many ideas are arbitrary. A culture can be indifferent to its place or fate and overexploit natural systems. The balance of freedom and necessity ensures that no culture will ever fit its environment or its members perfectly. Fortunately, humans can tolerate inconsistency and operate with contradictory beliefs: Soldiers fight for peace or ministers save the unborn that they may starve (weaknesses are expanded in Section 5.8)

5.2.2.7. *Diversity & Universals of Culture*

These functional requirements of culture are rather minimal for humans, being only food, clothing, shelter, and reproduction. Throughout their history, humans have used animals and plants for food and clothing. They have been able to convert animal and vegetable resources into all their needs for food, shelter, and clothing. Other requirements, such as respect, comfort, and self-fulfillment, depend on sociocultural systems. But, the differences in local environments and cultures ensures a diversity of those things.

The origin of clothing, for warmth or prestige produced ecological changes in local animals. According to Mark Stoneking, body lice may have evolved from head lice after a new ecological niche, clothing in this case, opened for them. Using a molecular clock, he calculates that clothing appeared about 75,000 years ago in Africa. Perhaps it appeared first for status, but clothing allowed the move to colder climates. Much of the diversity of human clothing has to do with the diversity of localities. And, much has to do with the aesthetic sense and human invention. Clothing is often the first thing noticed when cultures meet. In the eyes of another culture, clothing differences are often exaggerated. For instance, westerners seeing Africans or Polynesians for the first time focused on the absence of clothing or on body adornment. Naturally, Africans seeing westerners for the first time emphasized the elaborate clothing and facial hair.

Behavioral difference may be noticed after a longer acquaintance. Behaviors and symbols may take decades to understand. Many gross operations of a culture seem familiar and may be comforting in their familiarity. All cultures seem to have certain things in common. Of course, many of these are referred to as soft universals, since everyone needs shelter. Other differences may be the result of contacts between cultures, because cultures are mimetic, that is, they copy one another. This may be the secret behind agriculture, cities, and industrialization. Other universals range from age-grading and athletics to weaning and weather control.

Perhaps cultures seem to have universal characteristics because humans are of the same species, have similar requirements and similar bodies. Even though a process may be universal, the implementation and symbolization of it may be quite different and unique. Some scholars have argued that these universals could allow a global human culture. That may be true, although the relationship of a local culture to a global culture may be problematic.

5.2.3. *Dependence & Constraints*

Our minds are not only nature dependent, but culture dependent as well. The wind, trees, birds are sources of signals and symbols, and so are gestures and words. A community implies that the experiencers share ways of experiencing or the same experiences. This enables an individual to go beyond a finite view, to see the embedded culture as one of many ways of relating self to universe. Culture evolves from the interactions of humans with nature; both are in a constant state of flux. Cultures may be thought of as parallel to other species [memes (ideas)=genes]. The study of human adaptation to nature is cultural ecology.

Culture is a codification of reality, a symbolic system that transforms physical reality into experienced reality. Culture codifies reality through expressions, which can be preserved and transmitted through generations through language. Different languages program events differently, therefore no culture or belief system can be considered entirely apart from language, or language entirely apart from place.

Four relationships are encompassed by the holistic perspective of culture: The relation of people to themselves, to each other, to objects they create, and to natural environment. These bear on psychological well-being, social bonds, material legacy, and on the association with other forms of life.

Culture puts real constraints on our actions, as well as our imaginations. The environment adds constraints. The structure of our bodies and minds adds more constraints. Culture may be referenced to the discrete events that brought it into being. But, the process is chaotic and arbitrary. We do not know all of the events or their progressive development. Even without a theoretical framework, the process of culture is abundantly inventive and beautiful.

5.2.4. *The Health of a Culture*

A healthy culture has many of the same properties as a healthy ecosystem. Unlike an ecosystem, however, cultures tend to grow beyond maturity to a point of collapse. At that point or sooner, another major difference manifests itself: Violence in the form of war. Big problems from the success of human culture include: Reproductive success, ecosystem conversion, then overshoot and stagnation, followed by stupidity and violence to try to rebalance the culture. Violence does sometimes work for a culture, usually by reducing the population and redistributing some of the wealth. In fact, every culture goes through a cyclic that may have from two to six phases. For example, George Modelski describes long-term cycles in cultures in terms of preference for order and availability of order, each of which may be high or low.

The time structure of the operation of a complex system is a set of phases. Moving through a sequence of phases can create a whole cycle. Phase one could be global war; afterwards, phase two initiates a new world power; then, plenitude and security erode, and the system becomes delegitimized; finally, a low pressure for order and a preference for wealth, combined with low available order, deconcentrates the system. Modelski suggests that nation states are in the second part of the long cycle, a phase of decline. The model predicts rising nationalisms associated with increased conflicts, perhaps leading towards a new global war.

In normal stochastic processes, from molecules to nations, things bunch together or move apart. We can identify cycles of this. For instance, great wars and dominant political powers can be also correlated to major innovations in discovery or technology. Cycles in politics are not just repetitions—they spiral outward, taking up the old ideas and processes—who says we do not learn unconsciously from history.

Based on this system, cultural historians William Strauss and Neil Howe suggest that modern history moves to the rhythm of life rather than just to institutional or economic cycles. They suggest an 80-year cycle, perhaps related to a human lifetime, composed of four phases: (1) The High, or first turning, is confident expansion as a new order replaces the old. Perhaps the most recent one began in 1945. (2) The Awakening is an inward turning away from the outer order, which is rebelled against. This phase may have started in 1964. (3) The Unraveling is characterized by waning public trust, fragmenting culture, changing values, and alienation. This phase may have started between 1983 and 2003. (4) The Crisis represents a major discontinuity, leading to a new order that replaces the old order. They suggest that this phase began around 2004; it might continue for twenty more years. Interestingly, C.S. Holling and his group used a more ecological approach to identify four phases of a cultural cycle. These phases are based on high or low values of capital and connection.

Table 524-1. Two Models of Cultural Cycles

Cycle Phase	*Model 1 (after Holling et al.)*	*Model 2 (after Strauss & Howe)*
1	Low Capital	Expansion
2	High Capital	Inward turning
3	Low Connection	Unraveling
4	High Connection	Crisis of discontinuity

These kinds of cycles may explain many kinds of phenomena in cultures. Order is certainly a major factor in a culture, as are connections and capital, ecological or financial. One wonders if a cycle of the life of a culture or one cycle within its life, could be explained by combinations of population growth, security, stagnation, overshoot and environmental challenges, such as drought. Stability seems a characteristic of archaic cultures. We can even state it in Newtonian terms: A culture at rest tends to remain at rest. According to Harding (1960), when forced to act on changes, a culture will only accommodate those changes that preserve its fundamental character. Groups like the pygmies have specialized to fit the requirements of the environment, successfully. This makes it difficult to adopt other cultural arrangements. Since cultures have been traditionally self-reliant, resistance to imbalance is a positive act. Resistance to change or other cultures, is an adaptive mechanism that may encourage isolation. Yet, isolation is what allows a culture to develop in a unique way. Yet, isolation may lead to stagnation.

5.2.4.1. The Growth of Local Cultures

Some cultures grow, and in growing, decide that growth is a good thing to have without limits. Many lucky accidents, such as the rediscovery of the Americas, gave some cultures an impetus to keep growing. Other positive developments, such as science and industry, followed the conditions created by plagues and environmental restraints. The Spanish became a megaculture after benefiting from their exploration and exploitation of the Americas and western Pacific. The English became a megaculture after establishing an empire from North America and the Caribbean to Africa and Asia. North America became a megaculture in the Twentieth-Century. Each megaculture was able to dominate part of the planet with its influence and to see some of its products or rules become ubiquitous.

Global capitalism undermined many traditional cultures by offering consumerism in the place of traditional cultural guides for behavior. Social roles seemed irrelevant by comparison, if the good life could be bought without effort. Yet, it did not seem to work in Europe and the U.S. Instead of being free from economic want to develop their potential as creative human beings, people became trapped in a consumer cycle. Self-actualization was postponed for self-gratification. Democracy seemed to be good for balancing a middle class in some cultures, but it ignored other cultures and economies.

By virtue of its demomass and political system, China is becoming a megaculture. Chinese products are dominating the economies of other nations.

5.2.4.2. Emergence of Connected Local Cultures

Trade and exchanges by various local cultures extend to distant lands. Over time, regional systems start to develop, with newer connections and technologies, which draw the cultures and civilizations into a tighter pattern. And much is lost, of ways of being and acting in a more natural less technological environment. The world is acquiring a global economic structure. A global political system is emerging, as there is increased vertical differentiation, evolving from nations and regions, that leads to differentiation into political groups and economic interests. The world does not function very well politically at a global level. It functions in the absence of a common culture or language. There is no world law, but there is a set of rules regulating international behavior; these are generally observed and understood. There is a small homogenous subculture, which belongs to the rich elites of every nation. This serves to integrate cultures to some extent. The modern world has become a very interactive system, especially with computer and communication technologies, which can lead to totally integrated mass communication and the extreme compression space and acceleration of time.

It is said that the emerging global system has no center. That is a good thing. But, it is expanding without limits and that is a bad thing. It could cause the disintegration of natural systems that are interlinked with our economic exploitation. Perhaps this emergence can be linked with a major cultural revolution, as identified by W.I. Thompson, Planetization, as there is absorption of a new consciousness surrounding the old. Other earlier revolutions resulted had a similar attendant process of miniaturization. The forest was miniaturized in clumps of trees; animals were miniaturized in artistic images; time on a lunar tally stick; plants in a garden; and, nature by culture in 1800 (under the glass roof of the Crystal Palace as Thompson notes). The question is whether consciousness can create a global culture.

5.3. *Local Design Factors: Adaptive Patterns—Agriculture*

Agriculture is a system of plant use that people developed towards the end of the ice age, when the weather and other conditions became much more variable. Changing climate after the last ice age forced many animals and plants to migrate or adjust. It is possible to look at agriculture as an adaptation to those conditions, which included drought, species shifts and extinctions. Changes in wind patterns brought more moisture to some areas and new populations of plants. Growing plants allowed people to survive longer droughts and the disappearance of large game animals. Of course, it is also possible that after 40,000 years of gradual but constant population growth, people had filled all the available open niches for hunting. In that case agriculture was an adaptation to the shrinking availability of land for hunting and gathering.

5.3.1. *Farmland Designs*

The lands used for farming took on various typical characteristics depending on its history. Land with native grasses was shifted by selection, although as a landscape it looked much the same as it did with native grasses (the Palouse short-grass prairie, for instance). Many prairies were shifted from diverse tall grasses to monocrops grains, resulting in soil destruction and erosion. Temperate forest conversion in Europe and North America resulted in dramatic changes, as the forest was cut and burned. As tropical forests were converted to farmland on the European model, people encountered diseases without having evolved resistance to them. A large percentage of wetlands was filled in for agriculture, which changed entire hydrological cycles and made the areas vulnerable to changes in climate, also.

Because of its scale, industrial agriculture tends to produce monotonic landforms. The land is often unbroken by natural bunchings of trees, shrubs, and flowers. Almost no land is left for any kind of buffer between areas. Often, crops 'leak' or flow into other areas. The land is often broken by roads for access. The nature of this type of agriculture encourages erosion.

The modern mutant agriculture promotes the myth that megafarms are more efficient with output per unit area than small farms. By pushing mega-technology into a marriage with megafarms, the costs of agriculture are inflated beyond the reach of most groups or even small corporations. The scale of larger acreages requires more massive machinery and amounts of chemicals. The scale of the monoculture undermines the genetic integrity of the crop, so it is more susceptible to diseases, pests and changes in conditions, requiring more pesticides and water—a classic case of the law of diminishing returns. Yet, the myth survives because of seriously flawed methods of measuring farm productivity. In fact, small farms have greater output per unit, with smaller chemical and mechanical inputs. They decrease the potential for adverse environmental and health effects.

5.3.2. *Timberland Plantation Designs*

Natural forests were husbanded in some places for thousands of years. Starting in Germany in the 1800s, entire forests were replanted specifically with harvesting as a goal. The trees were placed at 'optimum' distances apart, in rows that could be accessed more easily and safely by loggers and machines. Other tree species, shrubs, flowers, and herbs were removed or kept out. This model of plantation spread through Europe and North America to virtually every other continent. By this time the movement to preserve natural forests was advanced enough to have millions of acres set aside as parks, reserves or wild areas.

Harvesting a forest on the scale of a landscape can be represented mathematically as a catastrophe surface, where changes are most often discontinuous and negative. Initiating a plantation on that scale would also create discontinuous change. Destruction of soils and erosion would effect climate and the growth of the plantation. In addition to the Catastrophe Theory of Rene Thom, the application of Island Biogeography Theory of McArthur and Wilson can be used to explain the behavior of isolated areas as the result of timber harvesting patterns. As cutting patterns and plantations cover larger areas of a landscape, old-growth or natural areas lose territory, interior area and species.

With the predominance of artificial forests, it is important to consider the qualities of naturalness in the landscape. Forests are expected to meet the needs of society by producing timber, creating wildlife habitats, and providing recreational opportunities for people. But, forests are also expected to look natural.

The use of forests has to change, also. Use of forests exclusively for timber reduces opportunities for nontimber uses. Foresters need to broaden the base of materials taken from the forest, and not concentrate on one or two commodities, such as wood or mushrooms. The scale of cutting has to change, so that cutting is below the renewal rate of the forests. Perhaps foresters could invoke the Principle of Least Effort (also a principle in economics and cybernetics), by encouraging natural regeneration; let the forest do as much work as possible—it has millions of years of practice in some cases. They could sponsor contests to make the fewest cuts, or to go the least distance.

5.4. *Global Design Factors: Adaptive Patterns—Technology*

What does technology do, basically? It creates extensions, as tools, to our bodies, letting us access new resources and create new things. Something as simple as a harness can replace human labor with animal labor. Something as simple as a knife can replace the muscular effort of chewing large pieces of food, which can be rendered more tender by another tool, fire. The Greek root words, from which the word 'technology' was taken, meant art and study. Technology can be broadly defined as the material entities created by the application of mental and physical effort to nature in order to achieve some value. In its most common use, technology refers to tools and machines that may be used to help solve problems. Technology is a technique that lets us use resources to produce products and solve problems; this technique feeds back into culture.

5.4.1. *Historical Pattern of Technology*

People make tools to get food. Then, they make clothing, homes and other things for making life easier. Art, luxuries and sculptures follow. Clothing and tool-making is a universal in human cultures. In later agricultural societies, permanent settlement lead to the growth and intensification of settlement. The engineering of an infrastructure lead to massive buildings, monuments, and fortifications.

As tools increase in complexity, from knives and levers to computers and space stations, so does the knowledge needed to support them. Complex modern tools require libraries of information that has to be continually increased and improved, then spread. Technology first simplifies life, then complicates it. Digging sticks led to plows and tractors. Lean-tos lead to pit houses and balloon-framed houses. Domestication led to horses and to horse wagons. Paths led to trail and highways.

5.4.1.1. Considerations of Technology

Technology is defined by tools, as well as by its processes for handling materials, energy and wastes. Technology is also an intentional practice.

5.4.1.1.1. Materials in Technology

To be constant and stable, a culture has to be productive, to be able to convert energy and materials into foods and structures for survival. As culture extends human ideas into place, humans use energy and materials to create different structures in place. Materials were first limited to plant and animals. Materials cycle above and below ground, between the atmosphere and trees, between trees and insects, and squirrels and fungus. The material aspects are the physical products or imprints of culture. These range from paths and plant patterns to tools and structures. Tools start simply as choppers, scrapers and cutters. Structures include pots, clothing, and houses. Found materials gave way to modified materials and finally constructed materials, that is materials rearranged from elements with the use of energy. In fact, the extraction of materials, and later energy, became a primary economic activity in many cultures. The processing of materials became secondary.

5.4.1.1.2. Energy in Technology

Technologies require energy, and many kinds are available: Solar, nuclear, fossil, fire, animal, and human. Each has dominated some historical epoch. The industrial revolution increased the quantity of energy, but decreased the variety of energy resources. Carbon products are the largest source of energy. The earth is also a source of energy from tides and hot springs. The discovery of other forms of energy, such as fossil fuels, lead to technologies that could leverage them. Technologies require energy. The industrial revolution increased the quantity of energy, but decreased the variety of energy resources. Since phosphorus and fossil hydrocarbons may be in short supply, a good power source would be required, perhaps solar or nuclear. The three main uses of energy for industrial civilization are motor traffic, heat for buildings, and manufacturing.

5.4.1.1.3. Waste in Technology

Nicholas Georgescu-Rogen described the economic process as entropy-producing, where entropy is visible as heat, waste and pollution. Every life process generates waste that is recycled in biological or geological cycles. Nature wastes countless lives and materials. Resources may lie buried for millions of years by landslides or volcanic eruptions. Unfortunately, some technological waste is different: many materials have no processes or organisms to break them down and recycle them—no solutions have evolved; sometimes the quantity, of a toxin for instance, is immeasurably greater than natural toxins. Even natural disasters, such as volcano eruptions that devastate whole areas, are recolonized from outside. The impact of human eruptions around the globe mean essentially that there no longer is an outside. Humans have the capability to fill the entire atmosphere with radioactivity or organophosphates.

There are no sinks on the earth where waste vanishes. Things are only moved around; eventually they return. Early technologies dealt with waste by moving and storing it. Some things are dissipated into the earth's environment, the cosmos, which is an energy source and sink. Even this large environment may not be inexhaustible, as many analysts such as Eric Jantsch claim. Later technologies tried to burn waste to break it down into component parts that could be sifted out of ashes; the burning, however, resulted in air pollution and some toxic wastes that had to be isolated. Pollution is a symptom of imbalance and improper resource utilization. A serious problem is our lack of understanding of the extensive, long-term effects of pollution on the atmosphere. More recent technologies have found ways to separate out valuable components of waste. Others have found ways to neutralize toxic wastes with chemical treatments.

5.4.1.2. Technology as Extension & Intensification

Technology can be considered as an extension of human body; knives extend teeth. Or, it can be an extension of animal labor, such as the harness that allows single and multiple animals to pull a heavier plow than a man. Technology can be considered an extension of fire: Fire herded animals and made grasslands, Wood fires cooked food and provided warmth; wood fires also shaped metals and provided steam for power; coal fires provided electricity, and oil fires provide electricity and motion. Steam donkeys and steam engines provided work, heat, and motion.

A tool is an extension of the individual into a new kind of specialized animal (perhaps because it has a new essential property it can be a new pseudospecies. Neither the ecosystem nor the animal knows what it ought to do, hence the explosion and chaos. For humans, this is what a new ethic and cosmology is needed for: to tell us what to do. We need direction. Technology must become an art again to make good places.

Technology intensifies. There has been an intensification of tool-making during the past 3000 years. Population increased and new areas were exploited. The agricultural revolution was a technological revolution. The industrial revolution, by definition, was a technological revolution that resulted ultimately in men being replaced by machines. Only the Luddites faced this limitation, unsuccessfully. Human labor is increasingly dispensable. Industrial culture confuses mechanical with personal power. According to W. I. Thompson, industrialization is really an intensification of civilization.

Table 5412-1. Parallel Events in the Recent History

Ideas
Mechanization (Clocks)
Quantification (Grades)
Technology
Inventions of tools: Telescope, Microscope, Camera
Communications tools: Printing Press, Telegraph
Management
Bureaucracy
Social Science

Because of the exponential growth of technological exploitation, more primary metals have been consumed since 1940 than in all human history before then. Technology is bound intimately with the exploitation of a convenient source of energy, oil. Unless the trend is changed, reserves will disappear. There is a finite limit on actual numbers of molecules of a given resource in the earth's crust, but the practical limits to exploiting the potential are a function of technological activities. So we are importing materials from the past (oil) and the future (soil), for now. Humans are hunters and gatherers of materials whose renewal times are geological, not days or decades.

Recent industrial history reflects new tools, new livelihoods, changes in settlement and behavior patterns. All tools, from the simplest word to the most complex computer, are disturbers and rearrangers of primordial nature and reality; they are implements for working on something. They have addicted us to purpose. We look for purpose in everything; to seek an explanation of nature, and to justify the seeking. Humans are tied to their tools and machines. The basic difficulty with the quality of life resides in machines. Machines pollute air, water and earth. Machines of war threaten human lives. Machines displace forms of life; they take up space. They are a competitive species, whose members die, reproduce, evolve, and sometimes think.

5.4.1.3. Effects & Consequences of Technology

What are the effects of tools on human cultures? The complexity of tools leads to rules for their use, and for those who uses them, such as trade unions and clubs like masonry. Society is very adaptable to technological change, according to Kenneth Boulding. Perhaps too much so according to Rene Dubos, and the risk is shaping human behavior to tools.

The use of technology has a great many effects; these may be separated into intended effects and unintended effects. Unintended effects are usually also unanticipated, and often unknown before the arrival of a new technology. Nevertheless, they are often as important as the intended effect. The most subtle 'side effects' of technology are often sociological. They are subtle because the effects may go unnoticed unless carefully observed and studied over large areas and long periods of time. These may involve gradually occurring changes in the behavior of individuals, groups, institutions, and even entire societies. A nation needs to address the effects, all of the effects including unwanted ones, of technology on business, culture, management, and the environment.

New technology has been a primary force for change for decades; but some technologies, like computing or genetic engineering, may lead to enantiodromia. The clock itself, one of the basic parts of a computer, was developed by monks to regulate and limit the hours of prayer, to serve God better, before it was used for secular purposes, beginning in France, to control the trading hours of merchants. The use of new tools can be expected to have unexpected effects. For instance, mass-produced computers may lead to individual autonomy. New energy technologies could have the same effect. Technologies have the capability to minimize the use of resources.

The implementation of technology influences the values of a society by changing expectations and realities. The implementation of technology is also influenced by values. There are major, interrelated values that inform, and are informed by, technological innovations. These realities and expectations may alter the world image of a culture, especially as regards efficiency, bureaucracy, or progress. We should use new technologies, but as Peter Drucker says, make sure that we know that the technology matters less than the changes it triggers in substance and content. It should not replace an ecological perspective and critical thinking. And, we need to remember that knowledge itself can trigger change.

5.4.1.3.1. Control

Can technology be separated and kept under control? No likely. Technology has become autonomous. Can the effects of technology be controlled? Tools have effects on human culture, and on nature. What are the effects of tools on ecosystems? Disturbance of soils, and scale effects. What are the effects of tools on humans? The use of knives reduced the need for some teeth. Tools, simply by being intermediate between the hand and the object, may increase psychological distancing from things. Intimacy with the tool can replace intimacy with the thing. The increase in physical depositories, for memory, changes the kinds of memory capabilities. Tools may contribute to the loss of hand-eye coordination and perception of wild, yet increase hand-eye coordination of tools.

5.4.1.3.2. Risk

Energy demand has resulted in the use of high risk sources. With nuclear power, the burden of proof for safety is on the agencies themselves; its use in the absence of complete assurances of safety is a terrible threat to living beings. G. Hardin is even more adamant in his conclusion: Guilty until proven innocent. Even with inefficiency in traditional sources, there is no need to use high-risk energy generation. Buckminster Fuller claims that by using only proven energy resources, only proven technologies, and only at proven rates, within ten years all of humanity could enjoy energy income equivalent to United States in 1960, certainly adequate for a good level of luxury for all inhabitants. Nuclear and fossil fuel energy could be phased out during that time, as alternate sources are developed.

We ought to reestablish earlier energy patterns for regions, and use combined systems of wind, water, solar, organic, and fossil fuels for energy. Singly, these may be inadequate, but as a mosaic they could meet decentralized needs. The energy pattern should be pieced together organically from the potentialities of a region. The establishment of decentralized communities based on ecologically sound organically based agricultural practices, with local technology using local energy sources and recycled nonrenewable raw materials. Some of the energy crisis and risk could be avoided by using less consumptive settlement patterns and natural energy utilization. More risk would come from the scale of those operations also as they struggled to meet demand. They would also have more negative impacts on the environment at a larger scale. The modern industrial crisis is a crisis of too much energy use. Consumption and production of energy must balance, safely.

5.4.1.3.3. Several Consequences of Technology

The whole idea of technology, according to Evan Eisenberg, is not to eliminate work or to replace nature with synthetic artifacts; it is to restore the balance of work and leisure that hunters understood—it is to find the best way between the dirt and the mouth.

As technologies developed, human relationships with animals and plants changed. Hunting, grazing, and agriculture provoked large ecological disturbances. Early domestic animals were revered, but nondomestic animals were considered competitors or nuisances. Now, animals are treated as processed commodities, and wildlife is regarded as useless.

Machines are part of human ecology, like other tools. They too contribute to flows of elements, such as sulfur and nitrogen, although the machine contribution may exceed the total of all natural living and nonliving sources. Machines also increase flows of rare elements, such as lead or mercury to tens of times the natural flow. Machines also create new compounds that are suddenly introduced into a system that has no pathways to deal with them. They displace wild ecosystems, modify food webs, and create new energy flows within the system. Cars replace horses, and mowers replace deer and other grazing animals in simplified ecosystems. Video games may be the cockroaches, leaf-blowers may be the rats of the new world, taking more energy than they yield benefits. Television can be seen as a form of cancer that encourages the replacement of every living thing with new machines.

Buildings have impacts on ecosystems. They become kinds of ecosystems themselves, but not self-sufficient ones yet. We shape our culture, then culture shapes us, we build buildings, then they shape us, as Winston Churchill recognized of Parliament.

5.4.1.4. General Problems with Technology

Due to the increasingly widespread use of ever more complex technologies and the frequently unintended consequences, problems may arise in their use that are unrecognized or only partially addressed. Technological innovation, combined with accelerating population growth, lead to clearing of many forests for agriculture. Technology also promotes land degradation. Plowing causes erosion.

The combination of cheap goods and complex tasks can lead to sweatshop slavery and unsolved wastes. Some problems are solved, but new ones are created by unconsidered use—problems such as toxic waste or radioactive waste. Time and leisure are needed for technological innovations. People stressed or starving rarely invent their salvations.

5.4.1.4.1. Unintended Effects

Technology has reduced the globe to a single, closed system, which humans can share according to their financial resources. Our direct experience of the world has become shallow, in spite of faster travel. Travel used to broaden the mind, but now it narrows it. We travel in sealed corridors like boxed goods, comforted by homogenized foods and several 'world' primary languages. Technology has distanced human experience from the meaningful time and extent of experiences. Technology or social structure can mask the internal stress from fast economic growth. Technology has made the suffering of many domestic animals invisible to consumers of animal products.

5.4.1.4.2. Development & Dominance

We often arrange cultures in a taxonomic scheme, sometimes based on the technologies of cultures. Thus, we have the stone age being replaced by the bronze age, then the iron age, and steel age, the industrial revolution and the post industrial and computer revolution. Lewis Mumford suggested three basic divisions: Eotechnic, paleotechnic, and the Neotechnic. Ortega distinguished between the technology of chance, of the artisan, and of the technician. Walter Ong suggested the distinction between Oral cultures, Chirographic, Typographic, and Electronic. Marshall McLuhan had a similar division: Oral, Gutenberg, and Electronic communication. Finally Neil Postman defined three different divisions: Tool-using culture, Technocracy, and Technopoly.

Tools and technology are the chief instruments of progress. They improved our material circumstances. They were supposed to bring superstition and suffering to an end. Technologies depend on information. They also control information. New technologies advance to compete with old ones for dominance in a world view.

Technologies change institutions and the relationships between them. As an institution adapts a technology, its view changes. A new technology threatens other institutions, which have competing technologies, as the whole mass has considerable momentum and investment. As the nature of institutions changes, the nature of communities, cities and cultures, changes. Thus, technologies change the form of tools and whatever they shape, then change the quality of response to those changes.

Technologies change the structure of things with new metaphors. As metaphors (and totems) are good things to think with, technologies become things to think with. Technologies based on organic metaphors have the potential to change the quality of the built environment and it supporting wilderness.

Under what conditions can the effects of technology not be contained? Does technology always escape and produce its effects on the nonhuman environment as well as on other cultures? If so, then technology is always ecological, that is, it is always part of the environment. It always generates some change in the environment that it is part of. It is not the same environment after the introduction of the extension of technology. Any addition (or subtraction) is a change, and any change has many effects on everything. The conditions of survival for all change.

Technologies change institutions and the relationships between them. As an institution adapts a technology, its view changes. A new technology threatens other institutions, which have competing technologies, as the whole mass has considerable momentum and investment. As the nature of institutions changes, the nature of communities, cities and cultures, changes. Thus, technologies change the form of tools and whatever they shape, then change the quality of response to those changes.

Technologies change the structure of things with new metaphors. As metaphors (and totems) have been and are good things to think with, technologies become things to think with. Technologies based on organic metaphors have the potential to change the quality of the built environment and it supporting wilderness.

5.4.2. *Tools Small Things & Electronics*

We started by domesticating our world with tools. Tools promoted greater autonomy and decentralization. New tools have been developed to record images of everything from the planet to atoms; for instance, the Pancam creates billion-pixel images. The Gigapan system scans a landscape and stitches it together in 100 Gigapixels. The great resolution increases the interactive potential. Citizens can get tools and have knowledge for monitoring pollution (including mobile phone applications). All that is needed now a well-organized network of citizens to provide independent monitoring.

We begin using and mass-producing these tools before we finish testing them for durability and dangers, much less for their influences on our psychological and social states. These things have to be considered and monitored.

We can have better and smaller communication devices, as long as they do not cause cancers. We can incorporate biodegradable or reused materials, as long as they do not degrade into dangerous molecules. We can rely on autodiagnostic medical tools, as long as we are willing to accept machine and human error. We can produce long-lasting, high-quality, upgradeable appliances, as long as we understand that we have to change design practices and possibly the entire economic system.

5.4.3. *Technology of Houses & Buildings*

Most early buildings were pit houses, pole houses (covered with thatch, animal hide or shingles), or post and beam (covered with thatch or boards). The balloon frame house, developed in Chicago in the 1800s, made houses easier to build and more affordable. Lighter standardized studs held together with nails were nevertheless very strong. The balloon frame is still used with prefabricated materials on assembly-lines for manufactured houses.

Large buildings were built with masonry (bricks or blocks) for thousands of years. The height was limited by the strength of the masonry (and the ability to climb stairs). In the late 1800s in Chicago, steel was used to build a skeleton that could support a larger building. Glass 'curtains' were used to wall the buildings. Most skyscrapers are now built with (steel) reinforced concrete. The tube structural system is also used (trussed or bundled). Skyscraper heights were limited before elevators. The use of imported raw materials and cheap fossil fuels allowed corporations to build more of them. Beyond 100 stories, the costs exceed efficiency, although many skyscrapers are symbols of identity and economic success. Skyscrapers do have large costs associated with their extra height; the costs for foundation and support are large, as are the costs for multiple elevators and services such as water, lighting, and air.

Some designers claim that skyscrapers can be made ‘green’ because of the concentration of people reduces per capita needs for space and waste. Modular mass housing can be more efficient than the labor-intensive methods for building balloon frame houses. Buckminster Fuller suggested using aircraft manufacturing techniques to mass-produce houses. New styles of houses are reinventing post and beam construction with hay bale walls. Some companies promote self-designed houses, made of logs or other construction. Take-apart technology may allow kit or custom houses designed for disassembly (although the author remembers reassembling a grain elevator from Viola, Idaho into a studio on skids).

5.4.3.1. Material systems for Building
(Being edited)
It is likely that reinforced concrete building and balloon frame houses will dominate the number of constructions, although wood is getting certified and concrete is incorporating recycled materials and wastes to reduce its impacts. Salvaged materials can be reused in many buildings, saving good materials and avoiding additional impacts on the environment. Biodegradable materials are appropriate in some cases.

5.4.3.1.1. Concrete/Foam for Building
The principle of the minimum explains why a ball rolls downhill, why a stretched spring returns to its relaxed state when released or why a bubble is spherical. Bubbles form complex shapes, which are hard to define mathematically, including foams. Natural foams occur at every level in nature, from the structure of galaxies to bone and seafoam. Bone has a smooth dense outer layer surrounded by an arrangement of plates that are honeycombed with openings, by girders that support it like the roof of a large building. Its larger elements lie along the directions of the main stresses providing strength were needed and seemingly. The planet itself makes many different kinds of foam. For instance seafoam is dynamically born as air and water be together to create immense number of bubbles representing an oppressive power of breaking waves. It is so prevalent that can be detected by satellites. Volcanoes underwater produce a lighter law rock, called granite, that because of its foamy nature from the mixing of lava underwater, can float on the denser rock, such as basalt.

The connection among seafoam and volcanoes, the planet and pumice, are indicative of the global role of foam and how it ties in the innermost to outermost processes of the planet. Foam also plays a part in the history of the universe. Foam was present before cosmic birth, and this is evident in the structure asteroids, as well as how stars are arranged in space. Foam can be found at the smallest sizes imaginable and the largest scales imaginable.

Foams have great potential for building small or large structures. Sidney Perkowitz suggests that it is necessary to develop a new mathematics of shape called geometric measure theory in order to figure out the foam shapes and designs. He then points out that we have that as humans have a long history with foams from our bread and beer to our cappuccino and sparkling wines. Lately, we have invented more practical foams such as cork and aerogel. Aerogel seems to be a very interesting foam with proven scientific uses. Aerogel, which is sometimes called ‘frozen smoke,’ is used to collect dust in interplanetary space, because it can slow down the speed of that without damaging the particle of dust itself. Perkowitz also mentions foamed metal as a possible building material.

5.4.3.1.2. *Superadobe—Uncommon Good Groundbreaking*

By John B. Cobb, Jr.

The uncommon good is what the common good most needs. For the most part, the acts we perform for the sake of the common good, though admirable, are in no way proportional to the needs of our communities now. When we think of the longer term the near irrelevance of most of these acts is obvious. We live in the last days of modern global civilization. Much of it will, no doubt, continue for some time in many places, perhaps especially in the United States. But at a deep level, most of us know that it is not sustainable, and that means that it cannot last. Serving the common good, as this civilization has understood it, is better than seeking simply the good of individuals, a goal that this civilization has made far too central. But there is no longer any chance that it will sustain the global civilization as a whole. To say that civilization is unsustainable is to say that pursuing efforts to sustain it at most slows its demise. That may reduce the enormous suffering inevitably involved in the collapse of a civilization. It is worth doing. We should all do what we can. But service of the common good in this sense is not, at the deepest level, truly working for the common good. It falls short.

So what should those of us who are committed to the common good really be doing? We should be working for the uncommon good. This is the sustainable good that can be created in the midst of our collapsing world. It is putting in place the building blocks of a new, sustainable civilization.

Most of us have barely begun to ask what these can be. When modern agriculture collapses, how can those who survive grow food? When fresh water is globally scarce, what forms of agriculture will be possible. When fisheries collapse and grain-fed meat becomes scarce, what shall we eat? When there is no fuel for motor transportation, how shall we ship goods or travel ourselves? When modern, global finance collapses, how shall we order our local economies? When we no longer have steel and lumber, how shall we build?

Fortunately, we are not blankly ignorant or possible answers to these questions. As the global system of industrial agriculture collapses, we are already developing some local alternatives here and there. When the modern global financial system collapses, a few systems of local currency will already be in place to suggest other possibilities. And a great deal of attention is being given to improving our housing so that at least it will not consume energy at its current rates.

Nevertheless, the great majority of the improvements in housing are operating in the familiar terms of the modern world. The technological improvements are important. They work against the obvious unsustainability of modern patterns of habitat. They reduce the contribution of buildings to the heating of the planet. Enormous gains are possible. But for the most part they do not end the process of the deforestation of the planet. They do not show us how to build when we really decide that reforestation is crucial.

Today have come to celebrate what may well be an event of major historical significance. That is, we are here for groundbreaking for the kind of building that will be possible and functional in a truly sustainable civilization. This building models what it means to serve the true, long-term common good by an act of uncommon good.

This is the first public Superadobe building in the United States. When one creates something quite radically different, there are always chances that mistakes may be made, that the hopes for the building will not all be realized. Does that mean that we should withhold celebration until the building has proved itself?

I think not. Even if it turns out that this building cannot as such serve as model for tens of thousands of others, that further innovations and adjustments are needed, this will not detract from the importance of what is happening here today. We can appreciate the gradual improvements of the sorts of buildings that have dominated the modern landscape, but changes of that kind do not give us the new start that is required to build a new civilization. We cannot be sure that this experiment will turn out to be the one that does in fact point the way to the building of the new civilization. But we can be sure that this is just the kind of experiment that is utterly necessary if we are to build now for a sustainable civilization that may arise in the ashes of the dying one.

It would be quite wrong to insist that all building for the future sustainable civilization must follow this model. If our hopes are realized the new civilization we hope will emerge will be less, not more, homogeneous than the modern one that is ending. But it would be quite right to say that, like this one, it should be based on truly radical thinking about what is possible and needed in such a hoped for civilization. It should not be less original or less daring.

I personally had nothing to do with the decision of the Claremont United Methodist Church to make this land available to The Uncommon Good for the purpose of constructing this building. But as a constituent of this congregation, I take great pride in this. This, too, is an uncommon good in the service of the true common good to which all our churches should be devoted. Although our Christian churches, and especially the Protestant ones, have succumbed to the mindset of the modern world to a great extent, there remains within us, at our core, an element of resistance. We are, at least to some small extent, countercultural. We share responsibility for some of the thinking and understanding that have guided modernity on its path to self-destruction. But we have not given ourselves entirely to that thinking and understanding. As its apocalyptic consequences unfold, I hope that our deeper commitments will show themselves again and again in acts that, at least in the modern culture, express uncommon good.

From where we stand today we can look eastward to the Claremont School of Theology. I have been retired for twenty years and claim to credit for what is happening there. But just as The Uncommon Good is creating the kind of building that fits with the true needs for the future; so also, I think the university project of the School of Theology is the kind of education that fits with the true need for the future. I am proud to be a part of that institution as well, if only in an emeritus capacity.

In our meetings and conferences, we will be grieving the dying of modern civilization, but our focus will be on celebrating the beginnings of a new civilization that we find all around us. I have discovered that the city of Claremont as a whole is deeply committed to moves of uncommon good for the sake of the real common good. The Uncommon Good, the United Methodist Church, and the Claremont School of Theology are by no means alone. Sustainable Claremont works with us with the support of the city as a whole.

There are many reasons for discouragement and even despair. Our national government has had a chance since the seventies to lead the world away from its disastrous course, but it has in fact only speeded the modern world toward its self-destruction. Our current leadership in Washington is worse than irrelevant when we ask the deeper questions about the common good. But globally there are loci of far more positive responses. And even in the United States there are, in this regard, what George Bush sought, a thousand points of light. One of them, one of the brightest, is right here in Claremont. And the clearest, most consistent expression of this spirit is The Uncommon Good, under the leadership of Nancy Mintie. It is for me a great honor to be allowed to take part in this truly important part of its work.

5.4.3.2. Walls

Walls are useful for the isolation of plants, animals and people. Cities became walled, originally for protection, although they led to separation and the distinction between outside and inside. Walls were one response to attacks. Further centralization, bringing local farmers under the protection of cities, was another. In Italy, did changes in class and equity lead to first private gardens, then public gardens, to areas walled off from others? The walls failed to lock out nature or drought. Walls are an example of the Principle of Separation. Limited flow, or nonflow, can be critical to the design of buildings.

More diverse patterns may result in more diverse social interactions, such as nurseries located near administrative offices or a bar located near a work area. The network of working and living can become much more dense if it includes pedestrian paths gardens and public spaces. Within each building walls and floors could be movable so that people could customize their own living or working spaces. As part of the participatory process, workers and builders can be simply given design principles and constraints rather than final blueprints.

5.4.3.3. Floors & Ceilings

All buildings over one story have floors and ceilings to protect the interior of the building. The floor provides a stable base for walking and for furniture; it can also house the heating system. The ceiling often holds insulation and ventilation systems, which reduce noise and guarantee air circulation. The height of a ceiling can make the space more or less comfortable and inviting. The texture of a floor can make it more or less comfortable for long periods.

5.4.3.4. Air & Water Material Systems

In many buildings water is pumped up and air is pumped down. Smarter buildings collect water on the roof and let it flow down; air is collected blow ground and allowed to rise. Water systems have always been a challenge as clay pipes leaked, iron and steel pipes rusted, plastic pipes decayed and broke, and copper pipes were very expensive.

5.4.3.5. Furniture

Buildings contain different sets of furnishings depending on the major purpose of the buildings. Office buildings need chairs and desks, filing cabinets and computer stands. Apartment buildings have couches, beds, table, and chairs. Many larger buildings dedicate the first story or two to local businesses, such as restaurants or clothing stores. A large percentage of the floors may house apartments, with offices taking up the remaining floors. Of course a significant part of the building is given over to elevators, stairways, storage, insulation, and air and water systems. In his books on design, Victor Papanek shows examples of good design: a Secretarial posture chair by 'Team Design' in Stuttgart (1960s), the Director chair (from 1860s), manufactured by Telescope Folding Furniture Co. in Granville, New York, and the Sack chair, by Piero Gatti, Cesare Paolini, and Franco Teodoro (Italy, 1968). Papanek emphasizes that furniture, from chairs and tables to bookcase and computer boxes, could be built to last, rather than built cheaply to become obsolete.

5.4.4. Summary: The Importance of the Local

Many of these design problems may be regional and global, but they can be addressed on a local scale, decentral and human scale. A locality can have the authority, the power to take responsibility and make decisions, for global problems that impinge on the local. It may not solve the global problem, but it will affect it, especially if other local communities exercise their authority.

5.5. *Local Design Factors: Adaptive Patterns—Urbanization & Civilization*

A city is a place where a large number of people live permanently. The classical city-state, was a place where the citizens depended on and maintained the whole, which cared for and outlasted the individual. The Stoics declared the cosmos to be the great city "of gods and men." The citizen became related to the cosmos as a whole, in the same way. For those in Mesopotamia, the whole city, and not just the temple, was conceived as an earthly imitation of the cosmic order, a sociological middle cosmos, established between the macrocosm of the universe and the microcosm of the individual. Through the priesthood, the one essential form of all was made visible. The early Sumerian temple tower, with a hieratically organized city surrounding it, became the model for the Hindu world mountain Sumeru, for the Greek Olympus, for Aztec temples, and even for Dante's Purgatory. The Sumerian city was organized in the design of a quartered circle. This design has been a favorite for cities and utopias, as well as for many cosmologies.

The whole city, and not just the temple, was conceived as an earthly imitation of the cosmic order, a middle cosmos, established between the macrocosm of the universe and the microcosm of the individual. Through the priesthood, the one essential form of all was made visible. The ideal landscape became the middle region, the garden between the complete order of the city and the complete chaos of the wilderness. The garden is cultivated from the wilderness as a middle landscape. The garden is a human order, but not usually sacred.

Cityscapes still contain gardens. Gardens and parks have been designed to express an idealized view of natural and agricultural scenes, since Sumerian times, at least, over 5000 years. Many names for the landscape—grove, lawn—are drawn from the imagery of the garden. The complementary aspects of landscape planning are the invariants of a given area and the artistic imagination of a planner. Conrad Aiken recognized that "The language and the landscape are the same, for we ourselves are the landscape and are the land." The city expands at the expense of gardens, fields, and then wilderness.

Many other cities were placed at the intersection of rivers or trade routes. Cities have distinguishing characteristics, such as permanent buildings, specialized buildings, monumental buildings, and large populations, which have increased over the millennia, from 2000 people to 50,000 or millions of people. Another characteristic is the density of the population, as a result of the shape, size and number of buildings. Cities in general are not self-sufficient; they rely on outlying areas for food and resources. Cities are places with surpluses that can be traded for things from other groups or cities; cities become central places in an area that provide services for outlying areas. The specialization of occupations in a city promotes trade of special goods. Specialization and unequal distribution allows people to become stratified in distinct classes, based on specialization and differential rewards. A city is also a place characterized by organizational complexity, with universal rules and central institutions.

As people are attracted by the advantages and excitements of cities, the size and number of cities increases. The spread of cities increases. Their areas are added to that of the vast agricultural lands, which together make up the physical impact of human habitation on the surface of the planet. The characteristics of cities change also, as their sizes and shapes are formed by desire and consumption. They become more "ideal" and more uniform, and with less and less to make them different and unique, they start to resemble ideal noplaces.

5.5.1. *City Patterns*

The earliest villages and possibly the first cities were established near water, near hunting and gathering grounds. In general, cities formed in areas where there was surplus and where larger groups of people were needed to deal with surpluses. Many of the first larger cities (500 or more) were located on waterways needed to irrigate crops. Permanent special buildings were needed to store surplus. Permanent buildings were built as homes, since people were living in one place all the time. Buildings began to increase in size to express faith in the place and the gods of the place, but also to express new differences in status or wealth as the labor system became more hierarchical.

Some cities were built as religious centers, others on trade routes to facilitate trading. Some cities built walls to protect their surpluses, wealth or people. Soldiering became a specialty. Cities came to resemble artificial land forms, such as mountains or canyons. Only certain plants or animals were kept in the cities. Almost the entire land surface was covered with buildings, paths or roads.

5.5.1.1. The City as an Ecosystem

The city was an adaptive exploitation of shifting environments. It was an adaptation to an ecological niche and a cultural niche. At first cities allowed for the coexistence of hunters and herders with the local farmers and residents of the city. The city is exploitation of a geographic site, which has a multilevel history from geology to plants and humans. The structure of a city might be like a cell, a specialized structure with a transmissible memory in the nucleus. Or like a sponge; the city cannot use sun to get energy but must use surrounding environment (plants) and other organisms in the water. Sponges must circulate food brought in, using energy from that food. A city has own metabolism, that is a network of circulatory structures used for exchanges. Water and wood (energy) are carried by channels to cells of organism (homes in this case). Channels also carry wastes.

As an ecosystem, a city has fewer plant and animal species. Many factors influence its balance with its environment. Water flow is a factor affecting the landscape. Household wastes are another factor. A network of corridors perforate the landscape; the number of small patches increases, and there is a reduction in other kinds of patches and corridors. Flows include energy, information, people, materials, and pollution. The net productivity of the city ecosystem is negative, due to massive imports of food and energy.

The size of a city grows, apparently without limit. During the mass migration from 1800 to 1991, urban population in developed countries rose from five percent to seventy-three percent. A mass migration in less-developed countries, from 1940 to 2004, the city population rose from three percent to over fifty percent. As cities increase in size, there is less flexibility for change. Land use planning and design becomes more important.

This size expansion has caused problems, effects, and side effects—that is, main effects that are unwanted or unanticipated. Villages lower connectivity to the landscape by increasing patches and corridors. Agriculture gets more homogenous, decreases fallow areas. Stream corridors are destroyed by environmental degradation. Connectivity is lowered, the matrix is minimalized. The nutrient mineral cycles are disturbed. The atmosphere is disrupted, resulting in drought and storms. Microclimates change, with heat islands and dust domes. There is lower photosynthesis and productivity, with lower diversity leading to homogenization (with cosmopolitan species) and inefficiency of use of energy and materials, and decaying infrastructure (roads, sewers, buildings, houses).

Urban ecosystems and agroecosystems, however, are less resilient than natural ones, due to the constant expenditure of human and fossil energy to maintain them. Cities need the environment for resources, food and water. People in cities tend to organize the environment by controlling markets and transportation on which the agricultural systems depend. Cities also produce large quantities of waste that have to be absorbed. Cities pollute air and modify climate. They are heat traps by absorption of solar and the production of heat.

5.5.1.2. Changes from City Living

The city is a consolidated area, a permanent part of the landscape, with stable home sites and larger, permanent houses. There are impressive public buildings and monuments that can lead to civic pride and use. The city offered opportunities for specialization, for choosing a mate from a wider pool of candidates, for excitement and stimulation, and for wealth. The city has a critical mass for inspiration and invention (in art and science). Of course, the city offered better protection from invading groups and it offered a more stable food supply

Living in a city also had disadvantages. It meant one had a smaller living space, lower standards of living, and a less varied diet. There was a greater chance of disease, nutritional deficiencies, and crime. The larger population meant an increase in competition and possibly a decrease in personal rewards. Public art styles could be limited. Due to the large populations, cities tended to ecologically degrade the surrounding areas. Although cities were fine adaptations to the climatic and environmental changes as the ice age was ending, they were vulnerable to larger groups of enemies and to longer environmental problems such as long droughts, over ten years, or series of changes.

5.5.1.3. How did Civilization rise from Cities?

A society based on cities, with a complex social organization, engages in a whole series of changes. Rather than reciprocity, economies are based on a centralized accumulation of materials. Social status is changed through tribute and taxation. Formal records-keeping arises, from knotted strings to cuneiform. A state religion develops, where the leader takes an important role, as for instance as god-king.

Table 5513-1. Urbiculture Summary

Change	*Leads to*	*Which creates*	*And changes*
Permanent crops	Irrigation	Salinization, exhaustion	Kinds of crops
Permanent buildings	Storage, property	Possessions, greed	Movement
Massive monuments	Status	Competition	Relationships
Trade	Common value	Standards	Shortages
Managers	Rise of elite	Taxes, power skew	Hierarchy
Transportation	Roads	Crowding	Perception
Water/Baths	Increased use	New reservoirs	Shortages
Walls	Protection	Separation	Inside/outside
Centralization	Concentration	Intensification	Obedience
Culture mixes	Violence	Laws	Behavior
Ecosystem replacement	Degradation	Protection	Invasions, disease
Unsustainable use of water and wood	Distribution	Drawdown, money	Money
Specialists: Artists, clothiers masons	Luxuries	Redistribution	Production patterns
Crowding density	Disease	Immunities	Health

This table (5513-1) is not able to show multiple causal chains or how changes lead to or influence other changes.

5.5.1.4. Intensification & Civilization

Cities are an intensification of trade and agriculture, and the things that surround them. Gravity a fruitful metaphor for intensification, for desire or crowding. Gravity is a universal long-range force. It is like centripetal, where the center of gravity is the center of the city. For the earth, the center is the sun. But, the sun is part of another gravitational sphere. As a metaphor gravity might explain why people are attracted to and move to cities: Intensity. Opportunity may increase due to the concentration of people. The number of links dramatically improves the possibility of better or more communications. Although gravity may explain the intensity of compression or miniaturization, it has trouble explaining the intensity of expansion. The metaphor raises some questions: How is danger related to intensity? Is it being exhilarated by the closeness of death? If the populations increased, would intensification have been necessary?

Cities are where most people live, where most resources and energy are consumed, and where most wastes are produced. The city becomes a center for intensification and excitement, but it also causes environmental challenges to appear faster and larger. A city changes the local environment around it, pulling in medium size cities, as it did in Mesopotamia, and reducing the number of small satellite cities, which are made continuous with the influence and attraction of the center city.

Urbanization was the result of permanent settlement and population growth. The growth of the settlement and intensification followed. There was specialization and engineering of a more complex infrastructure, with canals, larger buildings and massive monuments, and fortifications. Religion and trade enlarged in scale. Specialization As result of surplus food and larger population, special people can create a flow of specialized objects. The population has to be large enough to support a market.

Jane Jacobs asserts that cities are at the root of all economic growth, from agricultural, manufacturing, and technology growth to the information explosion, and therefore import replacement is the cause to all economic growth. This idea challenges one of the fundamental assumptions of Classical and Neoclassical economists, who consider the nation-state to be the main player in macro-economics. Jacobs argues that it is not the nation-state, but the city that is true player of this world-wide game. She speculates on the further ramifications of considering the city first and the nation second, or not at all.

The advantages of urbanization included consolidated area and stable home sites, with larger, permanent houses. Public buildings and monuments became more impressive. This formed a critical mass for inspiration and invention, including art as well. Measuring and writing, inventories and commercial dealings followed.

The disadvantages, however, included population increase, an increase in diseases and the danger of violence. There was a limit to public styles of art, ecological degradation of surrounding areas, and increased vulnerability to collapse. There seem to be limits to our personal space and levels of tolerance to human intensification, also. Urban intensification leads to the question: Is there a limit to human numbers? Perhaps space, but is there a psychological limit? People in cities seem to do well with high-contact, high-proximity living. What happens when people are crowded or feel crowded? Physical complaints, emotional complaints, sexual dysfunction, or feelings of fear, seem to be expressed often. There may be limits of crowding. Are there social limits, in terms of the number of people one can tolerate?

We may have requirements for personal space, home space, and wild space. Psychological limits may be the basis for some of the great failures of human life, for instance, the "failure of perception." We cannot see slow change or anticipate it. No one really sees the incredible interdependence of humanity and nature, of diversity and success. We do not seem to be able to see others as feeling human beings.

5.5.1.5. The Complex of Civilization (or Neolithic Revolution)

Many phenomena interacted during the Neolithic revolution. Not simply agriculture or urbanization, but profound economic and social shifts occurred. Agriculture, by taking over an ecosystem, allowed a short-term increase in biodiversity followed by a long-term decrease. To increase control, new tools such as hoes and plows were developed; the fields themselves were engineered with added irrigation systems. Gradually other ecosystems were taken over. Land use became a formal ownership to reflect the investment in all of the above. Land ownership was a logical step with permanence, as individuals dedicated themselves to a relatively small area. The technology of tools advanced, as did the engineering of fields and water systems.

Permanent settlement resulted in more permanent buildings, as well as in massive buildings and monuments, fortifications and religious centers. This led to an increased infrastructure to supply water, access, transportation and waste. Sedentation and surplus allowed larger populations and increased fertility. The subsequent trade in foods required better paths and transportation. Food storage and trade become concentrated in cities.

There were dramatic economic shifts that included trade, craft specialization, professional art, record-keeping, writing, direct engineering (pottery), and standardization. Personal property increased dramatically; one no longer needed to carry everything one owned. Records were needed to supplement the memories of individuals, since many individuals were required to keep track of stores, trade and rations. This required specializations in new trades, from potters to smiths and artists. Managers were required for recruit labor for fields and hydraulic engineering. Labor shortages on public projects required recruitment of labor from within the city or from outlying areas. Animal labor was applied to some activities.

This lead to many personal advantages. People had more property. It was not necessary to make everything for one's self, or know how to. One could trade for needs or luxury items. There was a new kind of leisure time, for doing nothing, as opposed to joining societies and telling stories. Ale was on tap for the entire year, to permit voluntary dizziness as a recreation; one no longer had to wait for trees to provide fermenting berries.

Unfortunately, the advantages lead to disadvantages. For instance, more work was required, especially to contribute to public projects and taxes. There was less overall leisure time. Trade for things required trust, which was a more difficult commodity between strangers. Records had to be kept of all the new kinds of transactions. Extra property had to be stored somewhere and protected. The distribution of luxuries and necessities was skewed, so some people had much more than others, in terms of things and respect.

Social and political changes were equally dramatic. With the distribution of power and materials, a political religious elite arose. And, to protect that, there was a rise of military organization, which allowed royalty and kings to replace or diminish religious leaders. Public ideologies replaced tribal or personal beliefs. Social hierarchies became more pronounced, and wealth was redistributed according to rank in them. Warfare became necessary for protection, or to acquire needed resources, or to control the social hierarchy.

There were advantages to these changes as well. People could expect uniform laws and protection from theft or violence. The stratification provided stability and identity with place or specializations. There was a greater diversity of jobs and places than ever before.

And, these advantages lead to disadvantages. A worker could be conscripted to work on public projects or to serve in the army. Workers had to pay taxes in the form of percentages of food or wealth. Social stratification could deny one access to luxuries and other things, and the stratification was not always fair. Bureaucrats, as well as medical workers or farmers, might have higher or lower status at different times. Power was also distributed differentially in society. In the larger population of the city, people were more vulnerable to violence.

Labor shortages to harvest crops lead to recruitment and some specialization, especially with tools and irrigation (engineering). The surplus of crops, with its necessity for allocation and storage lead to record-keeping and perhaps writing. With labor specialization and records came further specialization, especially with crafts (art) to make standard containers for distribution and professional art to provide necessary images, decoration and luxuries. Economic interaction shifted from reciprocity to formal exchanges. Trade expanded to include special products, tools and artworks.

Concentration in cities permitted and promoted these changes. Permanent settlements contained working houses. Supplies and control required a new infrastructure of massive buildings, better roads, and fortifications. This paralleled the rise of a religious elite to control the unknowns of weather and crops. And, this was followed by a military elite, which took over protection and combined it with universal gods, which lead to the rise of royalty and kings. Heroic buildings increased to provide palaces for royalty. Warfare was necessary to procure foods in times of famine or to protect the stores from less fortunate cities.

The increase in personal property, combined with the redistribution of wealth, lead to social hierarchies and classes. Public ideologies were developed to attune the people. Civilization provided immediate advantages, including supplemental animal labor, more property for everyone, especially the opportunity to have luxury items, the use of records instead of memory, which allowed verification and less misunderstanding, some leisure time for doing nothing, and the production of ale, as a mind-altering substance. Unfortunately, there were disadvantages, such as an increase in the amount of work, not only for production, but also for public projects. Leisure was reduced overall. Living required more work and materials for records, as well as trade and trust with a larger group of people. Personal property had to be stored and protected.

Social political changes include the rise of political religious elite, then the rise of military organization, then the rise of royalty and kings. Public ideologies followed, as did social hierarchies and warfare. Increases in personal property paralleled rationing and the redistribution of wealth.

5.5.1.6. Discussion of Cities: Ideal or Trap

Is the city a human ideal? An environmental ideal? It can offer ideal environments, as well as different kinds of physical environments, from streets, and squares, to religious monuments and parks. What is it about a city that commands awe? Increasing populations can lead to intensification of production, through labor or mechanization. Is the city a trigger for intensification? Interdependence becomes overconnected and then a trap. First cities were of bricks and concrete. John Thackera thinks that cities are held together now by human attention spans, which may be more gaslike than solid. The technology that dominates attention, such as the wireless infrastructure, just adds a new layer, as people still live in brickworks. Certainly, the city has always been an incubator of new forms and ideas. And, the medium for cultural transmission has been ideas, more than genes or bodies. And, there may even be standard units of cultural transmission by imitation, such as memes (Richard Dawkin's phrase for the unit of transmission; see section 7.8 for a more detailed discussion), of which cities, agriculture, and fashions are examples.

How did cities start? Was a city formed by neighboring villages? Thucydides used the word 'synoecismus' to refer to the union of several towns and villages under one capital city. Was the city a result of technology—The wheel, cart, or metallurgy? According to Rod Brooks, cities started from a subsumption architecture of organization, where higher levels of behavior subsume the roles of lower levels to take control (also called bottom-up organization). So, people start with villages, and get the kinks worked out; who lives where? Who does what? This fits with the idea that cities were adaptations to permanent siting, slow overpopulation, and changing environmental conditions.

When the villages are working, a few towns can be made. Coordinate the logistics of streets, sewers, water, lights, and law. When the towns are successful and reliable, a capital city can be made, adding a layer of law, taxes, schools, maybe trading and heroic institutions. The cities can be combined into a state or empire, which has new responsibilities, such as taxes and international affairs and defense. The empire subsumes the other levels, but lets them operate independently. Of course, there are advantages in the group. And there are further emergent structures. Especially international trade and forms of education. Of course, at some point, the cities are no longer adaptive to the environment.

How do cities end? Abandonment? Collapse? If the top level collapses, the others can continue to function. This is what happens with certain kinds of collapse. How does civilization steer? Does it push or pull? Pushing can result in a backlash or revolt. What is best for the individual is not always best for the species. What is best for the person is not always best for society.

Is it possible to have cities without states or vice versa? A city is an adaptation to keep economic surplus in one place. A state is a political unit governed by a central authority. Like a city, a state has to delineate rights and responsibilities for citizens, regulate social relations, e.g., marriage and family, support a religion or ideology, integrate networks of communication and transportation, control redistribution, control punishment, and have a monopoly of police, military forces, and weapons.

How is size important? Is it centrality important? Ancient big cities included Uruk (10,000 to 40,000) and Harrappa (20,000-25,000). Mohenjo-daro of the Indus Valley Civilization was one of the largest, with an estimated population of 41,250. Later, Nineveh and Carthage each had 700,000. Alexandria was large (~400,000 by 32 PE). Rome had an estimated population of 1 million by 5 BPE. Baghdad exceeded a population of one million by the 8th century PE. The largest cities now include Tokyo, Japan (28,025,000), Mexico City, Mexico (18,131,000), Mumbai, India (18,042,000), Sáo Paulo, Brazil (17, 711,000), New York City, USA (16,626,000), Shanghai, China (14,173,000), and Lagos, Nigeria (13,488,000).

The best cities are no longer the largest. The best are considered Vancouver, Copenhagen, and Zurich, which are usually less than 2 million. For a long time cities required larger numbers of people to be intense enough for stimulation and creativity. But, now new technology provides the stimulation and could allow cities to be significantly smaller, perhaps 10 or 20 thousand. A growing population creates environmental resistance to itself, in the form of reduction in the reproduction rate as the population approaches carrying capacity. Due to various time lags, e.g., to increase when conditions favor or to react to unfavorable crowding, the density can overshoot the capacity. Human population is controlled to some extent by self-crowding. The overshoot has to be on a local scale, never on a global scale. The Russian geochemist S. Vernadsky concluded that the property of maximum expansion is inherent in living matter as it is for gas expansion or heat distribution (and ideas in cities?). The pressure of life can be measured in terms of velocity. For cities, immigration can increase fast and cause overshoot and subsequent oscillations. What if all cities overshot simultaneously?

Is there a trend to larger cities? Should it be continued? Should arcologies replace unplanned cities? What about limits or nesting into optimum size groups? The degree of aggregation, as well as overall density, which results in optimum population growth and survival, varies with species and conditions (this is Allee's Principle); undercrowding, as well as overcrowding may be limiting. Aggregation can enhance group survival. Fish in a school may tolerate higher doses of poison than individuals. Bees can create more heat to survive than individuals. Applied to humans in cities, aggregation is beneficial, up to a point. But, bee or termite colonies can get too big.

How important is connectivity? Cities are unavoidably entangled in global nets, now. Cities used to be limited by the local carrying capacity. With global nets, self-correcting feedback can take too long. Localization makes feedback visible and more immediate. It would make more self-reliant cities.

How can we look at humanity? First we were wolves, catching animals and eating them. For thirty thousand years. Then we were cows, standing in places eating grasses, for ten thousand years. Now we are termites, swarming over everything in furious dances of labor and status, for the past five thousand years.

Are we urban by nature? Have we changed from hunting to urbaning? Of course, we may be preadapted for cities. We are clever social animals. We prefer edge habitat so as to move between other habitats. Urbanization is a characteristic of an edge species. Civilization produces edges that people like. Wilderness is fragmented into islands and patches. So, there is no more deepness, no more interior to wilderness. What are other edge species? Raccoons, coyotes, crows, and rats.

We are foragers and predators. What are the needs in human nature that a city answers? Perhaps the city is what wilderness was, according to Eisenberg, a place of passage, a place to be brave and test yourself. Humans have always worked to abstract their specialness. The city seems to be another myth of separateness and independence from nature. The city is the laboratory of human creativity, kept apart from the mother of nature. Lewis Mumford saw city life as a compromise between the hunting stage and the farming stage. The female principle of home is wed to the male principle of predation. Perhaps the city is a throwback to hunting. People are more likely to wander, and are less attached to a place?

Are cities unnatural? Is urban living a preadaptation? We are of course social animals. We prefer edge habitat. We are hunters and foragers. Why is the city growing everywhere? Especially Africa, South America and Asia. Parts of Manchester and Detroit are being abandoned.

Are cities declining? Certainly, there has been a decline in the quality of living spaces, irrespective of energy or resource use. Some cities have declined in population as areas of a city are deserted. The decline of cities due to the replacement of creative architecture by architecture that lacks organic order and connection, may be due to a declining interest in planning, as a result of economic values, suggests Eliel Saarinen.

Are cities the ultimate creation of civilization where people can enjoy culture free from want or physical extremes? Or, are cities a gross alteration of nature that destroys human life and dignity—a gross ecological error. As long as cities grow without negative feedback, the second will occur. When ecology helps the city ecosystem fit in the surrounding ones, then the achievement is worthwhile. The city depends on its environment.

5.5.2. *Large Buildings*

The first large buildings were probably for multi-family homes, like longhouses or malocas. In cities, large buildings were built for storage, then for religious ceremonies, and palaces. Over centuries large buildings were built for other reasons, also, for parliaments and courthouses, for sporting and political arenas, for factory manufacturing and storage, then for offices and malls. Large buildings not only covered more ground, but also were built much higher, often 20, 50 or more stories.

The change in the scale of buildings required changes in lighting, air and water circulation, and movement corridors (horizontal, diagonal or vertical). Stronger or thicker materials had to be used. Building methods advanced to make it easier to build higher. The Boeing Everett Plant has a tremendous volume and floor area (4.3 million square feet); other plants and warehouses are also large. The Dubai International airport has a tremendous floor area. The planned Abraj Al Bait towers in Mecca, Saudi Arabia are expected to have over 16 million sq. ft. of floor space, in addition to being over 1600 feet tall (By comparison, the Pentagon in Washington DC has 6.6 million sq. ft.). Larger buildings required more materials and capital, as well as labor and social skills.

5.5.3. *Small Place Design*

(Being edited)

As cities enlongated over miles, many people tried to limit the sizes of neighborhoods. Some cities redesigned parts of their downtown as small public places (for instance, Portland, Oregon). Some cities created a public center, for daily social activities as well as ceremonial social events. These centers were sometimes combined with parks or fountain, and paths too and from other buildings or parks.

5.5.4. *Zones: Neighborhoods & Campuses*

Neighborhoods encourage identity formation with the place. In Sarasota, Florida, neighborhoods acquired their own identities as art areas or quiet places to live. A neighborhood seems to be the largest social unit in which tools and things could be shared safely. Or to which residents have shared responsibility. A neighborhood is an environment in which the patterns of responsibility are all known by all.

Over time, there have been different models of a college, from cloister to campus, business, partnership, intentional community, on-line community (internet node), and participatory network. A college is a place where classes of people—students, faculty and staff—work together to design, construct, live, and learn in a sustainable setting. The campus is an ongoing, experiential community, an intentional neighborhood in which residents are joined by educational purpose. Campuses are often set apart from other communities, regularly on high hills. Some campuses are designed now as neighborhoods, with the functions and amenities of one.

5.5.5. *Whitaker Bayou*

By Jennifer Bacher, Megan Capo, Daniel Dias, Jordanne Kauffman, Alex Koetje, Crystal Miller, Soyeon Reu, Jennifer Saiani, Steve Scheiber, Greg Tariff, Amanda Tarr, Morgan Thomas, Alex Willman, Mikaela Raquel W., & Cassandra Wolf

Whitaker Bayou is a first-order stream that flows along the east border of campus and continues into the Sarasota Bay estuary. Most of the Bayou's shores are no longer natural, but are lined with sea walls, coastal defense structures constructed inland to reduce the effects of strong waves and to reinforce property boundaries. The Bayou supports a lotic ecosystem where animals, plants and microorganisms interact with water, soil, minerals, and the atmosphere. Many of the plants are exotics introduced by residents.

Whitaker Bayou provides an outlet for runoff for the northern portion of Sarasota County. The main stream originates in Manatee County to the north and flows southward, emptying into Sarasota Bay. A major tributary called Tributary A is located east of the city and joins the main stream just north of Myrtle Street. Whitaker Bayou drains roughly 9 square miles. The stream slopes range from an average of about 3.9 feet per mile to 7 feet per mile. There are 6 sections of Whitaker Bayou: The mouth of the Bayou, a section north of Tamiami Trail, a junction of Tributary X, Central Avenue section, Junction with Tributary A, and on Tributary A at junction with Tributary X.

The stream geometry at is relatively simple. In the Bayou's four-kilometer length to University Parkway, the maximum width and depth are 65m and 1.8 meters. From Sarasota Bay, a narrow entrance leads to a wider reach downstream of US 41, the Bayou then narrows at the US 41 Bridge and runs as a waterway with parallel banks to Dr. Martin Luther King, Jr. Way. A tributary (X) enters from the east between the two bridges, and the channel then narrows between Dr. Martin Luther King, Jr. Way and Riverview Drive with another tributary entering from the east upstream of Riverview Drive. From that tributary to near University Parkway, the stream is a narrow, deeply incised and straight channel, with a large tributary (A) joining it between the 38th and 40th Street bridges. The stream then runs under closed to partly closed canopies for much of its run upstream of Myrtle Street.

The Bayou participates in the local water cycle of evaporation and precipitation. This cycle is important for the operation of the stream. The chemical characteristics of the water, however, have been modified by wastewater, debris, and pollutants such as sewage, pesticides and petroleum products that drain downstream.

The water does host brown algae and contains some large seaweeds, such as laminaria and focus. Focus is a leathery seaweed with a brownish-green color. Mosses are present on parts of the seawall. Zooplanktons were in evidence, mostly small crustaceans and fish larvae. We observed small fish and minnows. A black racer snakes was seen on a crepe myrtle tree on campus. Small Floridian lizards, anoles, roam the bayou perimeter Small turtles have been seen previously; there are rumors of an alligator from time to time. Squirrels seem to have a flourishing population. Rabbits are also known to roam the area at night. Typical Florida wetland birds, such as cranes, ducks, and pelicans regularly visit the Bayou to hunt.

The seawall decreases interactions with soil. People use the seawall to dock gasoline-powered boats. Ferns and grasses have been planted on many properties bordering the Bayou, including Ringling property.

Whitaker Bayou has some historical significance tied to the colorful history of the area. It is likely that the Calusa people fished the Bayou for many centuries, building thatched stilt houses that stood in the streambed and margins of the Bayou. The Spanish explored north and south of Sarasota County beginning in the 1500s. They did not leave a written account of the area or native peoples, although they did diminish native populations with diseases and violence. The Bayou was named after William Henry Whitaker, reputed to be the first permanent settler of European extraction. He is credited with planting the first orange groves in the state of Florida, which he acquired through trade with Cubans.

Whitaker bayou has been a dumping ground for residents, accumulating junk, blocks, wire, televisions, and shopping carts. It has a reputation as disgusting, unsanitary, and toxic. The urbanizing neighborhoods contribute a high proportion of metals (aluminum, arsenic, cadmium, copper, lead, mercury, and zinc) as well as phosphorus, ammonia, and nitrogen. Too much sediment reduces the amount of light reaching the bottom; too much junk reduces the amount of growing space for aquatic plants. Since 1988, nutrient management has decreased the nitrogen levels by about 50 percent and contiguous sea grass has increased by about 30 percent. The runoff & wastewater also introduces higher levels of freshwater to the normally brackish conditions of the waterway. This depletes nutrient levels necessary for marine life. By 1990 the city of Sarasota demanded wastewater treatment plants to meet new treatment standards. In 1996, the bottom layer of water and sediment from the bayou did not meet class III standards for oxygen levels. A survey of benthic microinvertebrates resulted in zero organisms recovered. This suggested that there was a non-point source interruption in the natural cycle. No natural pollutants or metals were found, though, and there was noticeable nutrient enrichment. Meanwhile, algae blooms and chlorophyll levels skyrocketed and the abundance of phytoplankton and algae diversity plummeted.

5.5.5.1. Discussion of the Seawall

Seawalls protect from erosion, they also prevent runoff water from naturally cycling through the ground and back into the larger bodies. The Whitaker Bayou that runs through our very campus is in fact contained by a seawall. Rather than the metal and concrete seawall we have in use now, I believe there is a happy medium that satisfies both the erosion issue and the health of the environment.

Seawalls are not just solid slabs of vertical concrete jammed into the ground. Although they are indeed all constructed to prevent erosion, many different designs are available for seawalls. For more turbulent waters, a caisson-type porous seawall might be used. This type of seawall has grooves all along it to help break strong waves and create less water damage to property. Alternative seawall designs may not be as easy for turbulent waters, but for a body of water like our Bayou, there are a few options. The Whitaker Bayou, as it runs through our campus, is generally low at most points. Though it does tend to rise, it generally does not get too turbulent. In some places of the Bayou, the seawall breaks away from the solid concrete and becomes more of a cobblestone wall. I believe we could change many more areas of the seawall to reflect that, allowing more natural water circulation. There are more material and design options, including making the seawall out of wood, or even replacing the seawall with a boulder wall. Each of these options would allow for more natural water circulation than a solid concrete seawall.

Environmentally speaking, seawalls are a modification of the natural habitat. Considering water conditions constitute for the health of just about every ecosystem, a structure such as a seawall that prevents part of the natural water cycle is a bad thing for the environment. As mentioned above, a wooden seawall would partially help with this problem. It is not the perfect solution, but it is a start. Another very important issue to be addressed is water runoff along seawalls. Many waterfront properties along seawalls have concrete patios extending right up to the seawall, and the larger the home or estate the more concrete is used. The reason this is bad, is because any water runoff going into the body of water is full of whatever was on the concrete last. This can include oil from lawn mowers, chemicals from various cleaners, and even animal waste. A boulder wall is a good solution to this problem because it lets the water soak into the ground, where it is naturally filtered and then given back to the body of water, in this case, the Whitaker Bayou.

A simple change in material, whether wood or more porous stone, or a change in design such as a boulder wall, could be a healthy change from the Whitaker Bayou's seawall. The Bayou remains at a generally low level, and I believe the erosion would still be controlled by one of those changes. As far as the environment's health goes, many seawalls claim to be environmentally friendly, but are nothing more than metal that does not rust. For the environment's sake, a boulder wall would provide the most natural water circulation, but a wooden or cobble stone solution would still be better than what we have now.

There are also natural alternatives to sea walls, or additions that could better the health of Whitaker bayou. With natural banks and foliage removed, replaced with sea walls, habitat is lost. Replacing the foliage in the Whitaker Bayou would not be as hard; there are new methods of planting to ensure growth. Having these plants would ensure a healthier and varied marine life, which would enrich the body of water overall.

A general fear of planting mangroves is that the seed will be eaten, or will float downstream. The natural success rate of growth in the original location is not guaranteed, but with a new method developed by Bob Riley of Melbourne beach, things are looking brighter. Riley's method is to plant the seeds encased in a split PVC pipe (itself a possible pollution problem). The pipe stabilizes the seed and protects it from wild predators. The method has shown results and is worth consideration.

In places where the seawalls cannot be removed, planting mangroves is an option. With the typical tidal level at the bayou the plants would more than likely flourish. Mangroves are well known to fight against erosion but they do more than just that. The leaf litter shed from mangroves provides a primary food resource for some marine life. Which in turn helps the food chain, which will diversify the wildlife at the Whitaker Bayou.

Mangroves provide a habitat for a range of creatures whether temporary or permanent. The roots often provide shelter and become a nursery environment for juvenile fish, mollusks, and crustaceans. Once those organisms are given a place to thrive other wildlife will follow. Insects as well as bird and reptile species will adapt to the area, which in turn will improve on the quality of the water and its life.

There are areas in the Whitaker Bayou with mangrove or mangrove-like species there are areas that could benefit from added foliage. Mangroves can be a compromise where sea walls cannot be removed in areas such as the Bayou Studios. The general health of the Whitaker bayou can be improved drastically in a cost effective way that the Ringling students could take part in.

5.5.5.2. Discussion of Roads

There are many roads and bridges that are near the Whitaker Bayou. North Tamiami Trail, Dr Martin Luther King Boulevard, and Riverside Drive all cross the Bayou. Bridges entail a whole other slew of pollution problems. The biggest of these is litter. Though a lot of litter on nearby roads also ends up in the Bayou, litter thrown directly off the bridge obviously goes directly into the water. Ringling Oaks, Walker Circle, Bradenton Road, Panama Drive, Sylvan Drive, Whitakers Lane, and Alameda Avenue are all roads that run by the Bayou (Google).

Though cars are large contributors of pollutants to the Bayou, there are also several that might come as a surprise. Sediment comes from loose soil particles and erosion. Usually sediment is held in place by plants. When roads are built, these plants are ripped up and the sediment is left. The next rain then carries the sediment into the water. Though this may not seem like a big deal, it actually is. The sediment does not sink as one may think. It actually settles on the surface, which then blocks sunlight from getting to aquatic plants and can choke and kill fish.

Over 4000 toxic chemicals are found in cigarettes. These chemicals are also in the cigarette butts that get thrown onto the road and washed into the Whitaker Bayou when it rains. These chemicals are then absorbed by the plant and animal life that depend on the Bayou. If you were to catch a fish that lived in the Bayou and eat it, you might be consuming the toxins found in cigarettes.

Construction of roads and bridges is another large contributor of pollution to the Whitaker Bayou. The large equipment needed to build a road or bridge often create pollution similar to cars such as exhaust, rust, and brake linings. Several kinds of chemicals and adhesives are often used in construction. The asphalt cement that is used to make roads also contains several toxins. Debris from construction scraps can also end up in the Bayou. The roads and bridges that surround the Whitaker Bayou are necessary for the day-to-day transportation of our community, however they are also quite a "roadblock" for the cleanup process of the Bayou. Run-off is the largest problem associated with these impervious surfaces. A solution to this difficulty will need to be created in order for the Bayou to be restored to a state that we can all enjoy.

5.5.5.3. A Comprehensive Plan & Design

The residents around the Bayou have shown sensitivity to its presence, in particular filing suit against a yacht club going up in December 2008, both for the space being too close between the houses, and the proposed 285-slip boat storage, as well as the concern of damaging the water quality, which had been improved recently. The concerns were with the sea grass beds and manatee habitats. The resulting suit has halted the construction for now.[5541-1]

Perhaps the most problematic of the nearby residents come the issue of how deep and wide the Bayou should be, compared with where it stands. Nearest the Sarasota Bay, the Bayou stands at about 1.5 meters deep and 30 meters wide and averages out at 2.5m deep to 40m wide.[5541-2] The Whitaker Bayou is part of the whole Sarasota Bay watershed, and water-sampling sites exist up to 800 ft or so from the bank of the Bayou.[5541-3] Much of its border is held up by man-made seawall, and in some locations the dirt and grass has overcome the seawall and spilled into the creek itself.

A comprehensive plan could allow the Bayou enough room to spread out naturally, to let the seawalls be removed, and erosion as it naturally should occur will allow smaller plants and native animals to grow and flourish in the resulting soil and crevices that would form. Filter feeders and mangroves could be used to comb through floating debris and clean the water, and man-made reefs put in the deeper areas would provide enough area for fish and marine life to flourish. The area is already moderately populated and clean enough for numerous avian species and fish to live, so recent improvements by organizations such as the Sarasota Bay Estuary Program and others must be noted.

While ecologically this plan would be substantial, it's unfeasible for several reasons, one is obviously that removal of the seawall would ruin numerous homes and structures next to the creek. Seeing as that the seawall was built to hold up these structures in the first place, erosion will quicken and worsen over time if the natural order of the creek's boundaries is not restored in some way. Another plan would be to elaborate on man-made reefs and dredging of the Bayou's garbage and waste dump near the crossings of Tamiami and MLK. There are areas that could be expanded like the Martin Luther King Park. If it were dredged inward and widened, something of a dock, pier or patio could serve as something for local residents' wildlife viewing and fishing. Boat use exists in the early half-to-quarter kilometer of the river and should probably not be expanded, as the depth would need to be increased, and therefore damaging the shallow seawall. People have enough boats. They should go golfing or something instead.

There is little that could be done in case of most flooding or massive change in sea level rise, storm or bay surges, or any other disaster, as the poor planning on erosion and seawalls will claim structures and installations close to the water. A replanting of the seabed and local flora would be best, and careful observation and management of pollution would do well for development and future preservation.

With restoration plans, the mangroves can be brought back successfully without removing the ever-convenient concrete seawall that many structures depend on. Properties along the bayou will only benefit by the return of mangroves. The natural and pleasantly chaotic beauty of nature will eventually return to the bayou in full force.

It is important to take in to consideration the effect the landscape can have on the water. Ideally we want the Bayou to be a safe place for fish and animals to live and eat. Also, the cleaner the water, the more pleasing it will be to look at and to boat on.

When providing landscaping around water and the seawall, it is important to create a buffer to minimize and potentially reduce the amount of run off. Planting plants native to Florida will reduce the runoff of chemicals and fertilizers. All this plants listed below are low maintenance and will be easy to care for. They also have a medium to high drought tolerance, which is very important in Florida; these plants have to be able to survive during the recurring Florida droughts. As of now there is nothing that is stopping harmful runoff in to the Whitaker Bayou. Stream banks should be landscaped with the Florida native plants Florida Gama Grass, Saw Palmetto, and Blanket Flower.

5.5.5.4. Social Considerations

The neighborhood and college involvement can play a huge role in management of Whitaker Bayou. Currently, there are being efforts through the Sarasota community to maintain and restore the bayou to a more ecologically balanced environment and for the use as a navigable waterway. Volunteers at Ringling have also come together in an effort to clean the Bayou adjacent to the campus. Looking into different organizations within Sarasota and finding out which ones the college could team up with, would be an excellent way to get involved with others within the community in an efforts to clean up our waterways.

Wes, Inc. has partnered up with several property owners and property developers to help restore the bayou to a more ecologically balanced environment. The main reasons for their involvement are, one, the want to improve the water quality and Marine life. The second reason is to allow commercial boat sales operations to continue during winter months. They also believe that the changes that will be brought to the Bayou, it will improve current property values and allow for public and private boat and canoe enjoyment.

Ringling has already undergone being involved with the clean up of the Bayou. Students work with environmental specialists in cleaning up the trash along the College campus and Bayou. With more volunteers, the college could put more time and effort into maintaining the bayou adjacent to the campus. Some of the suggestions they would like to put more time into would be, sorting of the trash such as recyclables, testing the water along with getting more supplies such as tools and nets.

Having community classes to help educate the importance of the waterways, could greatly improve the willingness for community to come together. When a person knows why he or she should be doing something and not just being told the need to do it, more and more people are willing to give their times to either help clean or to educate others to help make a difference.

Not only is the clean up and maintenance of the bayou the right thing to do for the well being of the environment, it also allows the community to come together and meet one another and to make a difference in the lives of each other. If the volunteers that help clean up the Bayou would help to educate those who do not know what can be done to help better the community. The city could come together in an effort to restore more then just the Bayou itself but other water areas in the city.

5.5.5.5. Resident Actions

The word needs to be spread about these unnatural seawalls, and how they are negatively affecting the environment of our bayous. By circulating flyers around residences in proximity to the water's edge in these regions, it would help for both awareness and activism against their further construction. They would address residents on how they might contribute to the prevention of pollution, and be advised on how to do their part. Topics would cover how one might control and properly use fertilizers and pesticides, and even debris from reaching bayou banks. The impact of this information will hopefully be enough to forestall immediate bayou harm for the future, and postpone any additional development for seawalls. I believe it all starts by changing the attitude within the affected communities by allowing their numbers to multiply out of local concern for the cause. The more people that are aware of the problems, the better our chances are in making a difference for the overall improvement of bayou safety.

There are a certain amount of actions that can be taken to keep our interactions in the Bayou (and ultimately the Sarasota Bay) self-sustaining. But I think if there truly is to be public involvement in helping the Sarasota Bay, I believe that telling the public something they can do, instead of something they should stop doing would be more helpful. After all, it is much harder to break a habit than to create a new positive one. As far as cleaning the bayou from the state it is currently in, I found there currently is a group of property owners who are debating the possibility of having the Bayou dredged, to remove the trash that has accumulated at the bottom for decades. Which seems to me like a good idea, as long as people can keep the Bayou clean afterwards so it does not go back to its current state. But something else I also came across is the fact that dredging can cause the destruction of hard bottom habitat in which oyster live. In which case there are oyster restoration programs in which workers have been placing fossilized oyster shells to attract new oysters, and artificial reefs made out of cement.

Ringling College hosts annual Bayou cleanup as part of their student volunteerism programs. Many students spend an afternoon picking up trash in the surrounding areas of the bayou, and in the bayou itself. Not only do the students get involved in this annual project, but the Sarasota Bay Estuary Program has ongoing efforts to cleanup the bayou. This program would be much more successful if Ringling College was more actively involved. Being a land owning institution along the bayou, it is only fair for the school to take on added responsibilities.

When taking the sophomore level painting classes, roughly half of the time in class is spent at locations around Sarasota for landscape paintings. These areas are far enough off of campus that they require transportation, be that personal or through carpooling. These class periods are great experiences that greatly enhance the artist's ability. It is depressing that the school does not have an on campus locale for landscape painting. The bayou would be a great spot for these kinds of paintings, if not for the fact that it is in dire need of cleanup.

Something that everyone can do in their yard is to plant Florida native plants that not only need less water to survive but also attract wildlife. This also means removing exotic and introduced species of plants, which can be very adaptive and aggressive, thriving to outbreaks. Something that can also help is reducing hard surfaces; instead of using concrete for driveways and patios in the yard, there are alternatives that are more permeable and allow water to be absorbed by the ground. This can reduce storm water runoff, a big problem to the Sarasota Bay, and help replenish ground water that flows slowly back to the Bay.

As far as dumping goes, Florida has regulations that should be kept but enforced more strictly. People may not really change their habits until things get obviously bad. The first real step towards helping the environment is educating the public on these issues so that health-generating choices can be made in the future. Cleaning up Bayou is important. The Bayou is not a dead place; it is a living place.

Another consideration is to remove the seawall altogether and construct a graded shoreline. This action would improve boater navigation and improve water quality and marine life. This would also allow commercial boat sales operations to continue during winter months. It would improve current property values by enhancing the bayou's appearance. It would also allow for public and private boat and canoe enjoyment.

Further steps could also be taken to improve aesthetics along Whitaker Bayou. The relocation of an FPL main power line currently located on the West side of the Bayou could offer a more natural looking shoreline. The addition or improvement of parks along the bayou could increase recreation and community involvement and appreciation, as would the removal of fencing along the shoreline in MLK Park for example. The addition of trails along the bayou or a kayak launch would increase recreation, especially low-impact recreation. The simple cleanup of private docks and seawalls could make a huge difference in appearance.

5.5.5.6. Summary of a Whitaker Bayou Design

Whitaker Bayou is of course a wetland, and wetlands are more fragile than many other ecosystems. So, any design proposed for the Bayou has to consider the problem of net wetland loss and the cumulative impact on the North American continent or regional biome. Planning for the bayou has to consider land-use principles. Finally, it is important to follow guidelines for ecological design.

Somewhat poor water quality in Whitaker Bayou might be attributed to destruction of natural oyster beds when the waterway was first dredged for water traffic. Oysters, being filter feeders, have the ability to clean out much of the waste that can enter the water from direct or indirect sources. They can filter up to 30 gallons of water a day, and they also live together in such a way that they begin to form reefs that then attract other marine life, further serving to diversify the life in their ecosystem.

In the wide area of the Bayou, especially where it is less navigable anyway, we might consider creating small mangrove islands, separated by 40-50 feet from each other and as far as possible from the edge of the channel.

As bridges already exist, it might be nice to rework them so they have additional features such as standing or sitting areas. Bordering the Bayou are already concrete walkways and seawalls. Where there are wooden platforms, they could be replaced with newer wooden platforms, lending a functional and visual diversity to the Bayou. In fact, with the addition of small pumps and wall features it might be possible to have a waterfall and recycling stream that would add to the amenity of the site. Some revegetation might be necessary, but natural colonization or recolonization could be encouraged.

Any project for the Bayou has to have a restoration plan, a maintenance plan and a monitoring plan. These are long-term commitments to the health of the stream, as the stream is a dynamic entity, and we expect the system to provide both pleasant and unpleasant surprises.

5.5.6. *Ringling Campus*

By Scott Adams, Ellis, Jarrah B., Jillian Birolini, Carson Gilliland, Damien Hickel, Taylor H., Claire Huang, Krislin Kreis, Sean L., Carinda R., Sara Toftegaard, and Tylor Winsor

Every college exists in place, in an environment with resources. Every environment is embedded in larger environments, as Ringling College for example, is embedded in Newtown, Sarasota, Sarasota County, Southwest Florida, the southeast Atlantic Coastal Plain, the North American continent, and the planet.

As a learning community, the college provides the requirements for its community: Homes, food, energy, water, recreation, a conditional environment, and exposure to learning experiences. In addition to housing, the college provides classrooms and information centers, including libraries, information technology, museums, and a bookstore.

The campus becomes a physical expression of what the participants learn and teach, as the college is integrated into its proximate community and environment, through self-sustaining, inspirational, wild designs. To accomplish specific goals for buildings, the college plans to incorporate a wide range of elements, including passive solar heating, photovoltaic panels, and micro-wind-powered electrical generators. On-site treatment of waste is accomplished through a sewage treatment biomachine or composting toilets. Buildings are designed with local materials and benign construction methods, often with living roofs and local energy generation, for effectiveness and comfort.

The campus would employ many strategies, from recycling water to using local food and native plant species. The campus ecosystem incorporates the local Whitaker Bayou into its design as permeable barrier. Where necessary, the wetland and dryland are restored. Buildings are integrated into the campus with corridors (paths, sidewalks and minimal roads), appropriate transportation, and informal connections. Links are made to the large community, other communities and other institutions.

The college recognizes and cultivates its community dependencies, such as public service, electricity, safety, and larger road networks. It strives to create partnerships with neighborhoods and other institutions. It works to anticipate potential problems, from reliance on an industrial metaphor and its speed and momentum to various habits, cultural traps, short economic horizon, and financial limits. As it implements its designs, the college monitors the design process, campus systems, and participant responses. It promotes continuous self-assessment and adaptive management.

A college campus should be a continuous process. Students (and staff and faculty) learn more by designing, building and maintaining campus, not just individual art but the whole social environment of living, making, and sharing art. And, now, to fit an environment that is a limited and connected system, a college has to have a long-term ecological perspective. Ecological design encourages the participation of all members of the community in the design process.

5.5.6.1. Environment

The most immediate environmental concern for the campus is Whitaker bayou, which has been used as a dump for all sorts of contaminants and pollutants ranging from glass bottles and needles to shopping carts and wrappers. The water is a brown murky color and signs of life are limited to a number of fish that usually end belly up from the chemical pollution. In the social environment, Ringling is wedged between the busy Tamiami Trail and Newtown, a predominantly black community spread along Martin Luther King Boulevard. To the north are a dog racing track and apartment complexes. To the south are business areas close to downtown Sarasota. This location attracts predators on trusting or naïve students. The college has increased its safety with regular patrols, information reminders and spaced emergency call units.

Ringling College has stepped up its commitment towards achieving an environmentally friendly campus by designing new LEED-certified academic and student housing buildings, while cutting down wastes, using energy-efficient lighting, waste disposal and recycling bins segregated into four different categories including, plastic bottles, trash, paper, and aluminum cans, and by only using the campus sprinklers at night to maximize the amount of water taken in by the plants. The segregated recycling bins will also help reduce the already alarming 81% of garbage that is never recycled in many buildings.

Campus environments designed for a greener way of living could include recyclable water and energy, building designs that use less energy and materials, pleasant ways of moving about the grounds, and cheaper but healthier foods. These things can be done in various ways that are safer and less expensive.

As an art and design campus, many people are sensitive to what is aesthetically pleasing as well to what is inspiring. An important effect of working towards a 'green' campus is that it offers an exciting way to live for students. An inspired community is one that can sustain itself indefinitely into the future. Even after life on campus, many people will most likely continue to live in such a fashion, furthering the effect it has on the environment.

5.5.6.2. Flows & Paths

Because of its use of energy, water, and materials, the college has large flows of inputs and outputs. The outputs, of course, include at objects, healthy students, and waste. Because of the nature of Ringling College, the participants apply art and design to the campus itself, through charettes, meetings, and voluntary designs. The purposes and goals of many of these designs, beyond creating an aesthetic impact, are to: Reduce impacts on the environment, reduce pollution, reduce concentration effects, minimize heat island effects, generate usable energy, collect and recycle water, and fit into ecosystem limits and global restraints. Specific performance goals for the campus include: Reduction of energy use by 75%; reduction of per capita water use by 85%; treatment of sewage and wastewater on-site to produce drinkable quality; recycling, reusing or composting at least 50% of waste; replanting with native vegetation; and, the use of permeable pavements to control water runoff.

5.5.6.2.1. *Energy.* One goal for energy is to reduce energy use by 75%, yet continuing to be part of the local energy grid, perhaps even selling excess energy back to it. Building designs would use less energy and materials. Buildings need to be designed in ways that would use up less electricity by using the sunlight as a way to light the entire building and possibly using the ambient temperature of the earth to cool it down. Solar energy could be collected by solar panels; wind energy could possibly be captured by small wind turbines. Possibly some gravitational energy could be generated by microturbines placed in the Bayou to take advantage of stream flow and tidal differences.

These days we have several different ways of making energy from wind, water, sun, basically using the natural elements in the world to create electricity. It has always been the dream of millions of people to not pay bills, especially water or electric bills. Recently people have discovered that if they buy a solar panel or a wind generator they can make their own energy and be relatively self-sustaining. Although it is more costly for middle class people to install these power-making objects, a college has a perfect opportunity for making the necessary changes. The obvious way to make the school more energy efficient is to add solar panels to the roofs of each building. Of course Ringling College is located in Florida where the sun shines over 300 days per year. Another form of power that would also be beneficial to the school would be to put wind generators in and on buildings. Some architects say that there is not always wind to justify savings to balance the turbine costs. There is actually a way to construct a tunnel around the turbine to make it more effective. If you ever walk through a narrow corridor with openings at both ends of the tunnel to the outside, you tend to notice it being windy. Windier than it was outside, this is because of the funnel effect. Any amount of wind gets funneled through and the speed increases. It would be a perfect place for a wind generator because even the smallest amount of wind can be doubled inside the funnel. So if the school could put several turbines inside a built tunnel structure it would effectively produce energy.

5.5.6.2.2. *Water.* Ringling acquires some water from its wells and more from the city water system. Water could also be taken from the bayou or Sarasota bay and treated with the same processes used by cruise ships and tankers to remove pollutants and to make potable water. The technology is tested and available. Another way to conserve water is through recycling. The Bellagio hotel in Las Vegas feeds its fountains with recycled water from the hotel. The water in the fountain gets cleaned and reused in the hotel. Reusing water could benefit the campus in several ways. All of the water that goes towards drinking fountains can be cleaned and reused, and the same with the sink and shower water that people use in dorms. Just doing those things could save the school and the environment so much money and water.

The goal for water use is to reduction per capita use by 75 percent. Rooftop capture of rainwater could contribute to landscape irrigation and production of fruits and vegetables. Water is necessary for every single aspect of life; it is vital for every creature. It goes with out saying that a college campus uses a lot of water. Watering plants, having running water for the dorms, water fountains for drinking and for display, tons of water goes in and out of the college every minute. The ultimate goal is to conserve water at every step and try to reuse as much as possible.

5.5.6.2.3. *Wastes*. Waste is one of the biggest problems on campus. So much of the waste is from the type of linear flow associated with convenience foods and overpackaged stuffs. Trying to figure out what to do with waste, from human waste and 'yard' waste boxes, containers and plastics is a problem. We have no easy way of getting rid of much of the waste. Recycling helps, especially if the material can be remade into other products, such as plastic planks or rubberized sidewalks. Every building now has four recycling bins. The campus is a good size for composting schemes for cut vegetation. One real waste issue is what comes from the toilets. The problem with this is reusing toilet water is not an easy process. Human feces has so many toxic substances in it that in order to be filtered out completely it would take a large facility one which the school does not need to have. Human waste could be collected in composting toilets and used for fertilizers.

5.5.6.2.3. *People*. Buildings are integrated into the campus with corridors—paths, sidewalks and minimal roads—appropriate transportation, and informal connections. Links are made to the larger community, and to other communities and other institutions. The layout of the campus is being redesigned for walking. Places are being planned for opportunities for relaxation, hanging out and for educational activities, such as drawing and watching.

The campus layout is carefully designed so that people can reach point A from point B in the least amount of time possible, but at the same time not feel rushed or stressed. This layout would consist of natural landscaping to present interesting vistas and shapes to walkers. Walking and bicycles would be the preferred methods of transportation, in order to lessen carbon emissions and fossil fuels burned.

5.5.6.3. Buildings

Central services buildings are basic and include: Library, Information Technology, Bookstore and supplies, and Museums and Galleries. Special Use buildings include classrooms and studios. Starting to apply art and design to campus can start with buildings, not only goals and designs, but also strategies and elements. General building strategies include living roofs, energy generation, construction methods, local materials, and effectiveness. In fact, every building would be expected to be a beautiful, efficient example, capable of generating its own energy and collecting its own water. Buildings would be integrated into the aesthetic design of the campus, with its native ecosystems and other human structures.

When looking at Ringling's campus we see an attempt at a greener way of living but it is nowhere near being able to be self-sustainable, which should be the end goal. We have a few small solar panels set up and some trees placed around the grounds. This is but a small step to achieving something it can be proud of. We provide the basics a campus needs: A main building, housing, classrooms, dinning hall and a recreational room. We have designed things in a way that make life easier on faculty and us the students and now we have to look towards creating a campus easier on the environment.

The campus could consider establishing its own rooftop or landscape gardens to supplement commercial food with homegrown organic vegetables. Buildings need to be designed in ways that would use up less electricity by using the sunlight as a way to light the entire building and possibly using the earth to cool it down. Every buildings might include: Timed lights, so power is saved more efficiently and controlled; double paned windows (or triple or quadruple) and insulated walls to outdoors for insulation and maximization of natural light; aerated concrete to provide more insulation; timed sink use or shower use for the dorms and waterless urinals; revolving doors at the base of the building, hooked up to something that would create more power for the building itself; a playground on the roof, a sort of carousel, which would be wired to something in order to create more power for the building; greenhouses on all rooftops, growing vegetation to be used by the kitchen staff in the cafeteria or commons; different flooring plans associated with whichever scenario needs it—tiling for an area that should be cooler in temperature, carpet for a place that is less cool. Also, air system would be integrated into the buildings, which pull cool air from the ground. All light bulbs in buildings will be more energy efficient (Pharox 60 LED Light bulbs). Solar power panels would be placed on the roof of the building, or at a nearby structure for energy purposes. Finally, foliage and vegetation around buildings would make a more biologically and environmentally friendly area, as well as cool and frame the buildings.

A few ideas to begin improving our campus include building all new buildings with insulated concrete, building greenhouses on rooftops that supply the campus with food and using recycled materials for floors and furniture. Little by little we can implement these improvements for a greener home. Overall, the buildings should be taller, with at least three stories each and with the administration building and library as one in the center of campus.

Branching off the main building should be cafeteria and bookstore and the dorm rooms and studios/classrooms branching off from there. A large parking garage for all of our cars instead of the current rock lot sprawl would save on space and increase security all day and night. The fine arts building and sculpture/3D building can share a large outdoor space, with plenty of area to weld and hammer and blast projects to smithereens. Then the counseling center, career services and student life can fit into the main building as well, unless the library needs an exceptional amount of space.

Figure 5563-1. Searing Administration Building at Ringling College 2009

5.5.6.4. Doing

Ecological design leads to participation, to learning by doing. Students, as well as faculty staff and neighbors, would participate directly in all aspects of the design, from planning and construction to daily operations and improvements (the adaptive feedback so necessary to flexible management). Working through design would make the processes more visible to everyone. The experience of building would be a natural complement to abstract classroom learning, for students and faculty, who would share the experiences of building responsible, sustainable constructs through everyday living. The goals and benefits of the college would become intertwined with environmental and social goals as the college participates and supports it surrounding community.

5.5.6.5. *Ringling Buildings*

The campus plan outlines the shape of the campus, without designating specific new buildings. Designs for other buildings, such as Interior Design or Illustration, are being finished. Five buildings were built between 2004 and 2009, while the campus plans were being refined. Two have LEED certification. Several older buildings were restored in 2010 and 2011. Several more buildings were moved and then restored. Several new buildings are expected to be started in 2012, including the library.

For over six years, the students in Applied Environmental Design classes have been designing buildings for the campus, working within the campus plan and with the designated contractors to contribute improvements and enhancements to the designs approved by the administration. The next two buildings, including the library, will have significant student inputs.

5.5.7. *Design for a New Kimbrough Library*

By Loralei Hurlock, Taylor Reed, Gabriella Ricci, Lindsay Sasseville, & Yoav Shtibelman

The Kimbrough Library, built in the 1980s and last renovated in 1994, has become inadequate. The library ran out of shelving space in 2006. Now, Ringling College has to create a library design that will accommodate the current 1360 students, and be flexible enough to serve a potential student body of 3000. It is time to expand and create new and more efficient spaces for students to study, research, create, and elaborate. The current location of the Kimbrough library does not seem to contain many obvious faults, but there are multiple factors, big and small, that can make a significant difference to the environment and to users and stakeholders. As the community continues to grow rapidly, and with a reputation to uphold, the College needs keep up with technology and appearance. Here are the issues we found with the location of the current library and how we intend to address fixing these inconveniences and issues.

We chose to design a new library to replace the current library, which is facing many problems due to an increasing number of students relying on its services. There is insufficient space for storage, offices, and sitting areas. There are no provisions for conserving water and electricity. Kathleen List, the head of the library, spoke with us and asked us to integrate specific requirements, such as the number of rooms, levels, stations, sitting areas, and specific dimensions, into the design. Our design combines all these requirements with many energy and resource saving features. Therefore, our challenge was to create a space that would meet these growing demands, as well as reduce impacts on the environment.

5.5.7.1. Background

Our team is composed of five very different individuals who have a variety of perspectives. This has already proven to be helpful in our decision to design the new library. First we sat down and dished out our likes and dislikes of the current library on campus. As time progressed we developed a steady schedule to remain productive.

Meanwhile, we each talked about the size and shape the building, and that is when we hit our first roadblock. Having no idea where the library was to be located became a small issue, so we waited for our next meeting to really begin seriously to talk about design. Outside of class, the group did research on the construction of other libraries all around the world. We shared our likes and dislikes, which we will continue throughout the process. We invited the Kimbrough Library Director to share with us the discussions so far: The location, how many rooms, and how the departments would be arranged throughout the building. This information helped us start to design the interior of the library.

The next meeting consisted of visiting the proposed location, which is where the 3D labs are currently. Our group walked around to get a feel for the ambience, the track of the sun, as well as movement patterns. There was talk of a dome and a glass wall facing the bayou, a patio for the café; the landscape made a huge impact on our design.

Having visited the site, we generated computer model with two of our group members, Yoav and Lindsay. They helped us decipher an efficient or productive shape of the library. We also assigned each other different jobs in this design project so that we so claimed an area of expertise. Yoav created the environment we were given to work with which is right where the 3D studios reside currently. Yoav created the exterior, dealing with the entrance, the café viewing area, the rooftop, how much of the landscape we are using, as well as the overall appeal of the library on the outside.

Lindsay has taken on the interior and has a line drawing of what the inside layout will look like. While we are wrapping up the semester we have started the process of bringing our finalized ideas to the table to see what else we may need to tackle to finish our vision of the Kimbrough Library.

Gabriella drew up the final sketches on what could be our rooftop. As a group, we have discussed a rain run-off where all the plants below would be distributed rainwater. She researched other examples of roof rain run-offs before she applied it to a drawing. She also drew an aerial view of where the library will be on campus compared to the roads and buildings around the area. In this sketch she did not want to show too much detail, but just the basic footprint.

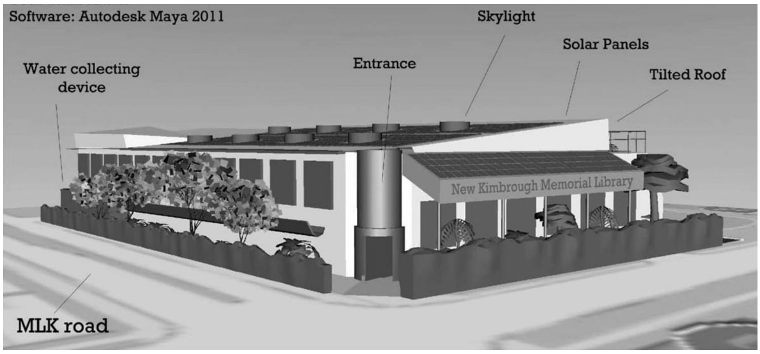

Figure 5571-1. Front exterior of Library (Y. Shtibelman)

5.5.7.2. Location Siting & Environment

Location is most important. The library is not currently as centralized as it could be. Having the library located on the North side of campus would not allow for easy access, especially due to having one entrance to the building in the first place, but it could be quite more efficient being located near the four main corners or Ringling, where it would be more conveniently centralized. Another concern is the noise and traffic along Route 41 (Tamiami Trail), which is next to the library. Our new design will support the students with areas and rooms that will separate the students from noise and distractions. The Kimbrough Library's new location has been chosen to be where the 3D Design building and parking lot are right now, next to the Bayou. This location is a lot easier to access, especially for pedestrians and guests, who may not have visited our campus before. Ringling is known for being an accessible campus whether it is the labs, the studios, or the library, so we believe everybody should be able to have very easy access to their largest resource.

The new library will be built in the area between Martin Luther King Jr. Street and Bridgeton road where the Brandenburg facility is located today. The size of the library is 400-500% larger than the current one in the dimensions and will be able to contain up to 500 students in the sitting area. What is currently a parking lot will be transformed into the new building, with 90% of the plot being dedicated to the building itself, and the last 10% to a small parking lot for the librarians. This small parking lot could easily be converted into an outdoor café or an outdoor extension of a reading area to allow patrons to be outside in a sheltered area. The old parking lot and the existing building will be torn down while the sidewalks and retention ponds will stay as they are.

Another large factor, which can also be an issue, is the current plantings. Ringling's campus includes over 1000 trees: Oak, Ficus, Banyan, and many Palm trees. We will have to build around any 'Grande' trees, which are trees that are considered nonremovable, therefore our design will work around those and incorporate them with the building. Rather than wiping the majority of the 'junk' trees out and starting fresh, we may also consider replanting some trees, not because we want to get rid of them, but we need to shift them around to situate the library. We cannot ignore the environment just to please an abstract design. There are many small natural habitats in and around the Bayou. If there was no research on these living habitats, we could be potentially wiping out species on the campus, which is definitely against what Ringling stands for. Instead, we would prefer to incorporate ourselves into nature than harm it, as we can learn a lot from nature if we give it room to develop.

Another concern is that there is currently only one entrance to the library for both the main floor and upstairs. This creates even less accessibility to the library, as there is no efficient entrance for the physically disabled or way for them to get upstairs. We are designing a more efficient library that allows everybody easy access to the actual library itself, as well as the resources within. On top more efficient entrances and exits, the new Kimbrough Library needs to be spacious as well, so it does not feel as cramped as it does on the main floor of the current building. An open area, as well as allowing easy access to resources, can also relieve the tension we currently are experiencing with the shelves making it difficult to get around and the random placement of chairs, tables, and computers. We need the new design to be organized in such a fashion that will encourage students to function at their full ability, but be comfortable while doing so.

We also do not want this new building to compete or clash with the other buildings, such as the Student Life building, North Hall, and the Academic Center. Since Ringling decided to expand and renovate those buildings, the appearance of the school has changed a lot. We want the design to be unique, yet fit in with the new appearance, as one building should not stand out and make the others look unimportant. With the rising student population in mind, the new library will be 40,000 square feet, which is a major improvement from our current size and will surely be needed and much appreciated as majors and minors expand. We are adding multiple rooms for group studies, as well as personal study areas, because there are not many areas to do so currently, as it is all basically combined into one area on the bottom floor. Ringling's popularity is on the rise and the community is expanding quickly, so to have easy access to the library, as a meeting and discussion spot for students and guests, is a definite improvement.

A complaint heard many times by the students, sometimes faculty too, is that there is not enough available light that is natural. Natural lighting is very valuable to ever major in one way or another, so to have a space to work in that has natural lighting would be ideal. Surely, when the sun sets there will be enough indoor lighting to substitute and help students, but it is artificial, and natural lighting is key during the day. With skylights and large windows, we feel our design achieves this exactly, even when the time and sun position alters. Perhaps, if there were a top floor that was exposed to outside, say a garden, that would be the ultimate resourceful workspace, especially with how easy light and color affect each other.

After covering the current problems of Kimbrough Library, there are still things the new design needs, which have to be met. Issues, although unfortunate, are not always necessities, but wants. A much discussed need for the new library is to be connected, somehow, with nature. In the primary design of the library it incorporated a garden, which our team feels should be reconsidered and added back into the new design. In more than enough cases, it has been proven that if your thoroughly satisfied with your surroundings, you are going to be much more inspired and productive too. When the campus planner and administrator decided they needed a new library, they mentioned that their main priority is functionality, which we made as our design's central focus. We feel that by making the environment a part of the library atmosphere, it will increase the functionality of Ringling's students and some needs of the community too. Another need Kimbrough Library has is the need of larger grassier areas. These are needed as places for artists to work and to be inspired by their aesthetic surroundings. Moreover, along with the much-needed natural surroundings, we need to incorporate a balcony area, where students can get a different perspective of the campus. We should also be taking advantage of being right next to the Bayou, by expanding the students' boundaries without really taking too much area. That will also create more walking areas with natural lighting, for those who want to work too. If you go inside the library, there will be large windows for natural lighting, but they should be tinted as to save money on air conditioning and treated for hurricane protection.

Another requirement for the new location of the library is a place to accept deliveries. Since the North side of the building is fenced in and we cannot add a door, we decided this would be a great way to utilize the space, while being somewhat discrete about deliveries. They will be receiving many items, including books, furniture, and equipment. We decided that the inlet off of MLK would be a good place for deliveries, so as to avoid having to relocate when they decide to cut Old Bradenton South off to create a larger campus.

Another addition to this area would be a retention pond located between the library and the bayou. A retention pond is a type of BMP (Best Management Practice), which manages storm water runoff to prevent flooding, which is a common issue here in Florida, and it improves water quality as well. Other than the fact that when it rains, flash ponds form from the flooded water, it should make sense to turn it into an actual functional pond as a landscape element. The cafe and sitting area will overlook the pond area, which allows students to be closer with nature and can feel inspired just by being at the library.

After examining at the grand trees graphic from the master plan, there does not appear to be any major trees that will be taken down. They are all on the outskirts of the pond and near the delivery area as well. We do not want to take out more trees than we are putting in, as they add shade for those who enjoy working outside. The Ringling campus is a home for over a thousand trees, including oaks, ficus, banyan, and palm trees, which provide natural shade and just are simply aesthetically pleasing. These trees, as well as flowers would surround the library and that lush green grass that our campus maintains so well. The cafe is going to be designed as a common meeting place, a large space very like to the typical Barnes and Noble atmosphere, which will alleviate the cramped sensation that the current library has in the common meeting area. The new design will not only have larger areas within, but outside the library as well. The current design only allows for a little seating area in the front and shares a lawn with the Goldstein building. The more spacious areas create alternatives for working areas. The Bayou is a natural accent to the campus and we should embrace it and use it to our advantage.

Moreover, we feel our new design encompasses the 'going green' feeling in a few ways. Primarily, on the roof will be solar panels for reusable energy from the sun, along with large skylights for natural lighting during the daytime. Being a very wet and rainy location, we feel it is a necessity to add a runoff water system and that water will be used as irrigation for the plants and trees surrounding the library. Another addition to our design that will bring in more natural light is large tinted windows located on all sides. You will be able to see clearly out of them, but by tinting them will result in less use of air conditioning.

Furthermore, we would like to add more beneficial trees and flowers surrounding the building and around the retention pond, along with the few grand trees, mostly oak trees, that will be untouched. A Florida American Elm tree is perfect for this area, especially near the pond, because these trees prefer damper areas. Unfortunately, they have low drought tolerance, but with an irrigation system, we should be able to prevent them from dehydrating.

Another issue that happens too often is while it's raining, irrigation systems are still functioning, so if we added rain sensors to our irrigation systems, we could conserve water that way. Florida Elm's are also a good source of shade, along with Magnolias. These aesthetically pleasing trees enjoy moist areas as well, which are well drained and preferably an acidic soil. It has medium drought tolerance, but once again with an irrigation system, we can prevent these plants from dehydrating and dying. A type of flower that would benefit from our climate and we can enjoy its natural beauty are Spiderworts. It is easy to plant, due to the fact that it does not require a certain type of soil, as well as it has good drought tolerance. Planting multiple Spiderworts can act as a low border, or just cover ground. Another beneficial shrub that would act as filler and also beneficial for wild life, as food, is an Elderberry tree. They are small shrubs (not all plants need to be significant in size on campus), but they tolerate moist soils and seasonal drought in our southernmost temperate climate. Mimosa ground cover, Muhley grass and other native plants are already being used on campus.

Our design of the new Kimbrough Library excels in efficiency and functionality compared to the current design. It will be more energy efficient, 'green,' as we use an abundance of energy, as well as large windows and skylights as a source of natural lighting. The lighting is very important, not only for students who work with light and color, but also to create a relaxed, comfortable, yet creative atmosphere. Just like the interior, the exterior has been designed to integrate all the needs of the students and the environment. The new café, which could be open 24/7 for the convenience of hard working students, looks over the retention pond, which creates one large meeting space for students and faculty, while being connected with nature. We believe our design incorporates the useful aspects of the current Kimbrough library, as well as what it lacks to support an incoming generation of gifted artists.

5.5.7.3. Exterior Design

The building will have two levels according to the campus plan and regulations. The small trees in the parking will be moved and planted around the building. This action will save the need to cut these trees and will provide as another source for shading the building. The shape of the building is a rectangular to use as maximum space as possible. The building will be isolated from the other buildings around it by the following boundaries: North—Martin Luther Kind road, West—Campus gardens, East—Bayou stream, South —Bayou pond.

The entrance will be located in the western facade. According to the future master campus plan Bridgeton road will be closed to automotive traffic so students will approach from all directions across campus. In front of the entrance there will be small, shaded sitting area. It will be similar to the current sitting area with five cement tables and benches to be able to resist extreme weather. It will be capable to fit thirty people. According to the head of the library, the sitting area will be used for students who wait for their friends outside.

Inspired by the Selby library downtown, which uses a double-door system to keep outside air from coming in, we choose to install revolving doors. The current doors of the Ringling library, release a lot of air when open, changing temperature and making the air-conditioning work harder to maintain temperature, which increases energy use and decreases its efficiency. Also, it makes noise, which affects the quiet atmosphere of the library. The revolving door will serve as a barrier between the outside and inside air. It should be much quieter, and it could be automatic as well.

The south part of the building will contain the sitting area and small cafe where the students can eat and drink light snacks while reading.

The southeast wall will be made out of glass to bring in natural light and to display the view towards the bayou. The natural environment will be brought in by planting grass as the ground for the inside and outside sitting areas. This area will be supplemented with plants. If live grass is not an option, synthetic grass could be a possibility.

The pitch of the roof leads the rainwater to the rain collector device on the north side of the building creating a waterfall effect over the windows. This will save money from having to buy city water in the long term, and the rainwater will be used for gardening and toilets. The roof will have solar panels. It is hard to estimate how many solar panels can fit exactly on the roof but our estimate is between 35-45 single units.

In case there will be a storage batteries the collected energy will be used at night to light the building. In case it's not a closed system the energy will be used immediately and then pump surplus energy into the city grid, and the city pays for it. The initial cost is high for a large amount of solar panels but over time it will be a good investment. Between the solar panels are 8 skylights to provide natural cost-free lighting during the day. The panels will provide most of the light during a sunny day but all the rooms will be have lights to be used when necessary. The lights in the building will be automatic and will turn on and off with a motion detector.

The back of the roof will be dedicated for gardening. Using this Garden will help to reduce the heat of the building. This area will not be open for all the students. It will be available only for maintenance, the library staff and students with permission. The garden will contain different native plants according to the library staff choices as well as section for experimental gardening. We recommend that Ecology of Design students will be able to maintain the garden as part of their class assignment.

The second level will contain meeting rooms for students, teachers, extra storage, media room, and option for other offices of other departments, such as IT or ARC. The meeting rooms will overlook the ground level.

In conclusion, the design fits the other college buildings in its similarity of shape and structure. This design reflects only a few of the possibilities of energy and resource saving features. There are many opportunities to explore other features that could be incorporated. We recommend consulting with the campus staff and professional engineers to refine the design.

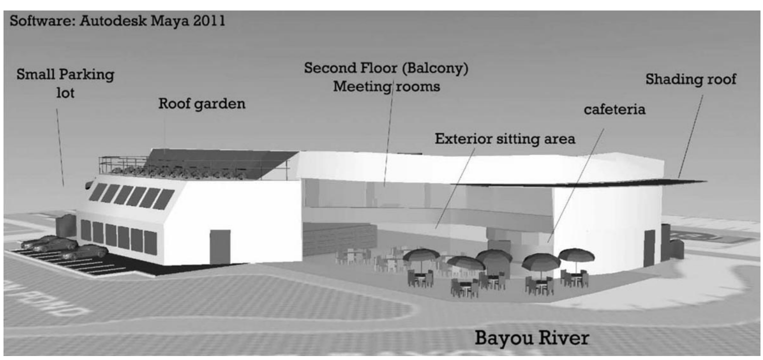

Figure 55713-1. Back of Library

5.5.7.4. Interior Spaces

Traditionally, public libraries have been designed to house primarily books and space for people to use these books. Design was concerned with how many books and the amount of square feet per user of the library. "Determine the library's inventory and it space needs follow" was the saying (p. 3). Anders Dahlgren's outline of library space needs categorizes space within a library into six broad types: Collection space, reader seating space, staff work space, meeting space, special use space, and nonassignable space (such as mechanical room, restrooms, and handicapped accessible entry ways).

From this mundane start, to categorize space, the author then switches to the end user and the objectives of the library. The library design is based on who will use the library, how they will use it, and goals of the community. This publication does not talk about design from the artist viewpoint, but from the pragmatic viewpoint of the function of the building as a library. Boring as it may be, form follows function, so how the library will be used is vitally important.

I do appreciate that the author acknowledges that libraries can no longer be mere storage for books and a place to sit around and read them. Designing a library requires creative thinking into the future (the author says at least 20 years out) in order to guess the potential uses and technology that may be in place in the future. The author does describe the potential impact of computers on collections. Digital media may reduce the printed collections, especially of periodicals, but computer terminals take great dominance in the function of the library as more printed works become digitized.

Following the technology change that has occurred in libraries, the function and needs of library staff also change. Knowing how to run library computer databases becomes just as important, if not more important than knowing how to find books in the stacks. People want to be able to find the information they want quickly using the technology available to them. Since libraries are sources of knowledge, then quick access is important to keep the "design population" coming to the library. Additionally, Barnes and Noble has set the standard for bookstores. Some of the features at Barnes and Noble stores are filtering into libraries. For example, the author indicates that more and more libraries are seeking to accommodate a coffee shop or café setting within the library. These services are not only to meet the needs of various meeting held in the library, but also to entice people to come into the comfort of the local public library. With the widespread use of the Internet, the library must find ways to attract people to come into its halls to justify the expenditure to build service.

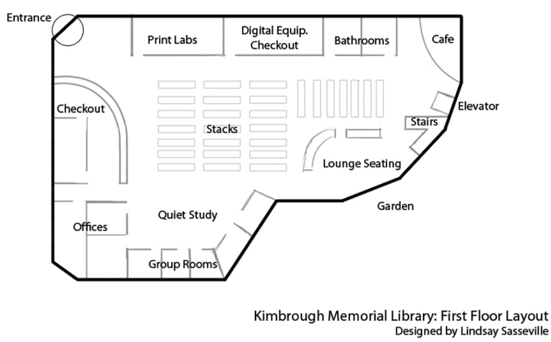

Figure 5574-1. First Floor plan of Library

5.5.7.1.5. Use of Natural Building Materials

The building material for a structure, especially one with high environmental standards, is a very important aspect to consider. Two vital considerations for building materials are: They be natural, and they enhance the energy efficiency of the structure and its surroundings.

We can start by answering the following questions: Why should we put forth the effort to use more naturally friendly building materials when designing our homes, offices, and libraries? Why is it important for any building for that matter? Why is it vital to consider our environment during the building process? There are many answers and reasons to these questions. Firstly, an energy efficient building can reduce energy consumption. In most cases generating energy puts out carbon dioxide emissions, so if we can decrease energy and fossil fuel use in our building designs we can reduce emissions. A healthy building can also offer material and resource conservation, which we cover mostly throughout this discussion. But an energy efficient building can too provide healthy indoor environments for people; safe, free of mold, VOCs and other harmful chemicals. Lastly our energy efficient building should be able to conserve water and care for the site around it as well as its own infrastructure to prevent general pollution.

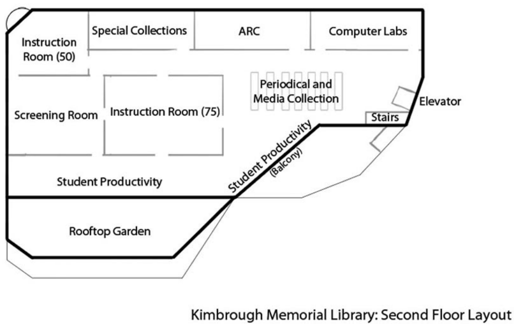

Figure 5574-2. Second floor plan of Library

We researched different materials that can be used throughout the interior and exteriors of the new library building. All of these materials offer longer-lasting and more benign alternatives to mass-produced materials that often harm the environment. We investigated a variety of materials that are available for use throughout the exterior of a building, and then considered materials that can be used in the interior of the building that would both benefit and prolong the health of the environment around it.

To start, let us discuss the materials and technology we can utilize throughout the interior of the library to improve durability and health. I am going to address interior materials first, exploring different floor and wall coverings, then onto plumbing and lighting, then finally computer screens and furniture, identifying the pros and cons for each one.

There are many options of natural materials that are available when it comes to flooring for a building. First there is natural carpeting which can be made from woven bamboo, hemp, jute, recycled plastic, sea grass or even wool. Another option for flooring is natural linoleum, which is made of linseed, cork, tree rosin, limestone and jute. Natural linoleum lasts up to 40+ years, it is biodegradable, non toxic, and easy to maintain. It comes in many colors, patterns, and borders; you can even use it for countertops and walls as well as flooring. Natural linoleum is a lot less expensive than hardwood flooring, but do not let this stop you from using classic hardwood floors if that is the style desired. Wood can be FSC (forest stewardship council) certified and harvested from sustainably managed forests to create beautiful flooring and doors. There is even the option of using bamboo for hardwood flooring as it grows especially fast, endures a lot pressure, and takes a lot of force to be damaged. Walls and ceilings can also be generally produced with natural materials like wood or stone.

As well as natural flooring, an energy efficient building can also feature a variety of natural options for insulation. In such a hot climate it is important for the insulation of the library to be thick and prevent any dilution of the cold air-conditioned flow on the inside. Some efficient natural materials that can be used or insulation include newsprint, salvaged cotton, or formaldehyde-free fiberglass. All of these natural options are much healthier for the buildings surroundings and inhabitants.

After the construction of walls and ceilings, paints and finishes need to be considered when it comes to the interior of a building too. To stay eco-friendly and energy efficient we can use low VOC paints (VOC stands for volatile organic compound, which is harmful to all living things). We can totally eliminate the use of solvents and VOC paints because they evaporate too easily at room temperature and contribute to poor indoor air quality.

Lighting and plumbing are considered, also. Another environment conscious technology that would be great to use in the new library is low flow toilets and faucets. Since the 19th century human kind started using toilets that would flush sometimes up to 7 gallons of water into the sewage systems. Low flow toilets literally use .8 gallons to flush liquid waste and 1.6 gallons to flush solid waste. Standard bathroom faucets use up to 4 to 7 gallons per minute when aerators use 2.5 gallons per minute. Waterless urinals can be used with the goal of saving approximately 30% of water during everyday operation.

LED light fixtures are key to any energy efficient buildings. LED uses less energy to provide the same amount of illumination level as any other light available. Motion detectors can also be used in and even outside of the library to optimize times of operation for lighting located in separate rooms from the main stacks area. A large windowed area in one corner of the library as well as use of skylights throughout will really maximize the available natural light within the interior, reducing the need for overhead lighting in work areas.

Some heating and cooling systems are designed to save energy and thus eliminating the money used on utility bills. These energy efficient air conditioning systems use about 10% less energy than a conventional air conditioning unit. Often these systems will be timer operated allowing better temperature control, only using the minimum amount of energy to cool any particular room in the library.

The most beneficial thing to the health of the students is the use of LCD monitors on our computers. The library is already replacing CRT (cathode ray tube) computer monitors with flat panel LCD monitors that create a projected 59% plug load of energy savings. CRT monitors are bulky and the screen is not actually flat, only the glass covering the surface is flat. CRT monitors also emit electromagnetic radiation; they are made from heavy lead and glass that effect eyes negatively. Overall CRT monitors weigh heavier and have higher power usage than LCD. LCD (liquid crystal display) monitors are slimmer, saving a lot of space and offer a 100% perfect flat screen. LCD emits very small amounts of radiation, they are light in weight, have low power usage and absolutely no glare, safe for eyes and eliminate distraction.

It is necessary to cover some of the technologies with the highest potential to be the best alternatives for the interior of our building. Some of the most important materials are very situational because of the content of the building, a library with students needs computers and scanners, it is vital these technologies save us energy (because we use them so often) and are do not harm our health. Our plumbing and lighting can be replaced with energy efficient systems, our air-conditioning too, resulting in the school saving money, money that can go to many things!

Another beneficial technology that can be used within the interior of our new design is energy efficient elevators. Since the new library will feature multiple floors, one or two energy efficient elevators can be used on the inside while the use of stairs could be encouraged by prominent and accessible staircases seen on the outside of the building, making the elevator a further walk and less enticing. Anywhere you can save money by going energy efficient is the best way, there are elevators available that reduce energy usage by 30 to 50 percent.

As the second part of the overall discussion of natural building materials, we will now explore the available materials to consider for the exterior of the new building. First, we went over materials available for walls and pavement. We then moved onto selecting designs to encourage natural lighting and airflow. Lastly, we discuss the available water catching systems and effective ways to use water and vegetation throughout the landscape.

The most important thing, even when considering interior materials, is to always use locally manufactured materials if possible. This not only reduces shipping costs but you are also supporting your community in more ways than one. So to start, some of the most well known natural materials for exterior use are recycled steel, aluminum, and fly ash concrete. These materials have efficient insulation and also create maximizing light outdoors; even recycled glass can be mixed into the concrete pavement minimizing heat gain during the day. Another great alternative to pavements on the outside is a technology known as reclaimed rubber. A company called Rubber Sidewalks takes tires from landfills, shreds them and composes them into panels that fit together to form sidewalks. The rubber walkways are beneficial in more ways than one. This material is good to the trees allowing roots to move freely and bend the sidewalk; no trees need to be taken out because of damaged concrete. Some surveys have been taken and it is known to feel good under the feet and sound is reduced. The most important things rubber walkways provide are saving trees and reducing tire waste!

This part of the exterior materials section will cover a couple of designs to benefit material use and environmental factors. First, on the outdoor patio area castellated beams can be integrated into the design to reduce the quantity of steel (or material being used) and encourage air movement. Above the beams can be exterior shading devices that protect occupants from significant solar heat gains. If the roof is colored white this will help keep upper floors cool.

On the subject of the roof, it is important to reconfigure it for solar cells. These systems can harness energy from the sun slowing our process of global warming. Scientists say that on a bright, sunny day, the sun provides approximately 1,000 watts of energy per square meter on the planets surface. If we can collect all of that available energy we can easily power our homes and offices for free. The rood can also in some parts be covered with drought-tolerant plants to increase the total landscaped area around the site and to naturally insulate the restrooms. Rainwater can also be collected for plumbing by either a large canopy or cistern; this water can also be used to irrigate landscaping. When considering landscape it is important to think of trees and arbors placed in areas with south and west facing windows for shade, as well as possibly climbing vines to shade exterior walls for cooler insulation.

This awareness of energy efficient building techniques is so vital because tremendous amounts of natural resources are needed in order to construct and operate any building. If we construct these buildings to use their resources more efficiently they can minimize pollution to the renewable resources vital for our futures sustainability. Many studies have shown that energy efficient buildings ultimately cost less to operate and maintain. It is also known that when a structure offers a healthy indoor environment the productivity of the working inhabitants increases. These materials meet our stated objectives or goals.

5.5.8. *A New Illustration Building*

By Sarita Rajpathak & Rachel Lueneberg

Our new design of the illustration building, Christ-Janer, commonly referred to as "CJ" is based on the existing layout to retain the enclosed feeling of the space that already exists. The changes in this design reflect the needs of the illustration department as well as accommodate for an ever-increasing number of students every year. Aside from the new gallery space, illustration lounge, and two added stories, the building features some unique adaptations to make the most of the environment surrounding it.

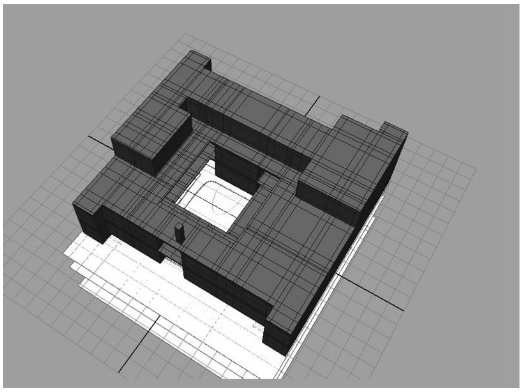

Figure 558-1. Exterior of Illustration building

5.5.8.1. Description of Spaces

On the first floor, the existing CJ-08 will become a small auditorium for guest speakers, visiting artists, and demos. CJ-09, next door, will become a gallery. The walls will be clear glass panels that will allow for work to be displayed upon hanging panels from the inside of the gallery ceiling, providing double the wall space, one side viewable from inside, and the other from the hallways outside. Accenting the gallery just inside the courtyard will be a fountain where students may sit and draw or take their breaks during classes.

On the east side of CJ will be the 24-hour process room, lounge, and computer/ traditional labs. The process room features 4 large tracing closets, bookbinding and paper cutting equipment, and plenty of open table space for production. Located in front of the process room will be the lounge filled with couches, chairs, small coffee tables, and vending machines, some of which would serve hot food and drinks. North of the process room would be the computer lab and print station. South of the process room would be the traditional lab, with plenty of easels, end tables, model stands, lights, and ventilation. The restrooms on this floor would also be twice the size of the existing ones, and faculty offices would fill the entire southwest corner of the building.

The second floor in our design features a semi-continuous walkway that would also provide a covered walkway for the first floor. A bridge to the next-door parking garage would extend from the west side of the building and also be covered by a canopy. The gallery would continue on this floor as well, though only the window facing the courtyard would be glass. To the east of the gallery would be a smaller room serving as a photo studio geared for photographing illustrations, 3D sculptures, and large work that cannot be scanned. Some of the bigger classrooms would line the west side of the building, and restrooms would be accessible on this floor as well.

The third floor and roof would be partially open aside from a few classrooms featuring large glass windows allowing for natural light that might serve well as landscape painting or figure studios. The outer portion of this floor's design makes use of the roof for garden space and foliage. Students might sit and have their lunch with friends or teachers may use the space for class use on nicer days. The center of CJ would remain open allowing for light to come through into the courtyard, as well as leave the fountain below visible from all floors. Emergency stairwells are located at every corner and an elevator system is accessible from the inside of the courtyard only.

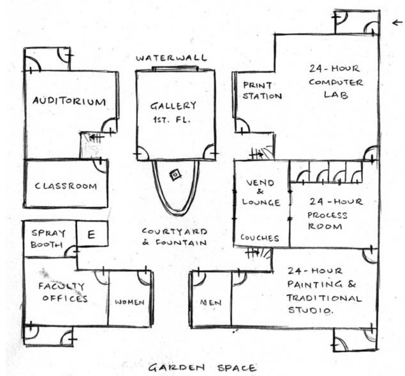

Figure 5581-1. Plan of first floor

5.5.8.2. Description of Materials

The floors would be poured concrete; second and third floors would become the ceilings for the floors below. The walls would be prefab, prestressed concrete panels. The walls in the rooms would be painted with a latex paint in pastel colors. The outside walls would be planted with several species of lichens, which would change colors according to the seasons and as they aged. Several outside walls would be left in natural concrete, which might age with several kinds of fungus and aerophytes. The floors would be covered with 'green' carpeting. The roof would be covered with a sod and sand mixture, and then planted with various sizes of native Florida plants, such as Muhley grass, mimosa, and small palms.

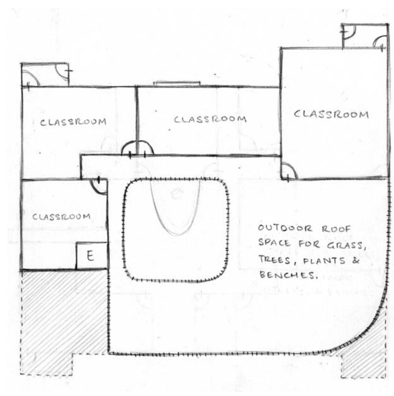

Figure 5582-1. Plan of second floor

5.5.8.3. Conclusion

This design of Christ-Janer is not only plausible but it takes into consideration most, if not all, of the needs of the illustration department, student and faculty alike. Special features of the building, from the water wall and roof garden to the outer wall treatments and plantings would provide relaxing and inspiring ambiences that would reduce any nature-deficit disorders as well as increase contact with plants insects and birds.

5.5.9. *Recreation Building Proposal for Ringling College Campus*

By Curtis Anderson, Javier Aparicio Lorente, José Antonio Díaz, Justin Farris, Ximena Fernandez, Alex Levielle, Katrishia Powell, Ximena Romero, Stephanie Russell, Grace Sigona, Gabriella Thompson, & Porter Vinson

The Ringling campus was designed along the old suburban paradigm of high-maintenance grassy quads separating buildings named after high-profile donors. Part of the new design will emphasize vegetation zones near and on the top of buildings. Investigations of this configuration, combined with lighting and robot guides, indicate that it will be pleasing and offer equal or greater safety than a traditional campus. The center can also function as an area for students to rest, observe and work on their interpretation skills.

A large part of student wellness comes from physical activity. As artists, students at Ringling College remain mostly stationary when working. Heavy class requirements and lack of sleep can cause undue stress upon the body. Diet and exercise are key to maintaining a healthy lifestyle while under the rigors of studio work. Sarasota offers beautiful weather and scenery. However, around the college there are no parks within reasonable walking distance and few roads that are suitable for jogging. It is imperative that Ringling creates a holistic and safe environment just for this.

There is a serious lack of recreational facilities in campus. Besides the small gym constructed five years ago as part of the Ulla Searing Student Center, there is no other space specifically intended or used for student leisure, physical exercise and recreation. In order to offer students and staff different choices for their physical health and entertainment, we wanted to create a space not only to suffice these needs but also to bring the community closer together and to invest in people's well-being. We also intend to offer students many more services than the ones they count on nowadays. We plan on including a large, two-story gym; a swimming pool; a small soccer field and a multipurpose track that could be used for tennis, basketball or volleyball; a healthy-style cafe; garden roofs and some other amenities.

The design addresses gaps in the functioning of the campus maintenance, as well as the transition to less-intensive landscapes. The design made the following assumptions about maintenance and pedestrian reactions to it: People want easy access to walkways; they do not sharing them with motorized equipment, due to noise and safety concerns; yet, they enjoy seeing or participating with gardeners working in the landscape. Some of these can be accomplished by physical or time zoning, and yet others by reducing the need for them.

The design of the building itself facilitates easy access to the main parts of the campus. Its shape blends well with the landscape. The rotary paths leading to the center would reduce the amount of traffic overall. Furthermore, the design of the building is useful without the appearance of a temporary utility shed dropped in between designed buildings.

The design addresses information about the interactions among students, staff, and residents or visitors, and uses that information to stress some interactions and reduce others. The design addresses alternatives as well, including the elimination of a special maintenance staff, with the requirement that students and teaching staff would assume responsibility for recreating and maintaining their own campus.

Within the design of the new building, there would be a room for a racquetball court, which can be multi-purpose. It could be used for volleyball, badminton and other indoor sports. A rock-climbing wall can be on the back of the grass ramp, and a soccer field behind the facility can also be multipurpose, such as for football or field hockey. There is also an Olympic size swimming pool inside the grass walkway. The pool is located behind inside the ramp, which will let through a lot of natural light.

The design of the building itself facilitates easy access to the main parts of the campus. Its shape blends well with the landscape, because of the artificial hill, and blend well with the other raised elevations found on the Ringling campus. To keep the campus consistent, we recommend that there be various mounds spread throughout the campus to not only provide more areas to sit and relax, but the inside of each mound could also be used for storage or a small building. The rotary paths leading to the annex would reduce the amount of traffic overall. The design of the building is a work of art in and of its self, and would not be cumbersome to look at the way some of the older facilities are.

The objectives of this center are to provide optimum access to the ecological body of the campus, while at the same time minimizing disruption of the activities of learning through bustle and noise, while adding an iconic structure that expresses the function of the building and fits in the style of the campus. This particular flexible, open design favors the fulfillment of the stated objectives.

5.5.9.1. Location

For a final location for the recreation building we chose the space where the Appleton, Harmon and Idelson Residence Hall are currently located, by the new Goldstein Residence Hall and behind the Ulla Searing Student Center. These three old residence halls are planned to be knocked down in the master plan, the gap they leave would be the ideal spot for the recreation building to be located. Once the North Campus is constructed, following the objectives of the master plan, this location will be in the center of campus, completely surrounded by residential buildings, making the recreation building accessible to all resident students within a few steps from their rooms. This area of campus will then host three of the most important buildings on campus, mixing residence spaces, administrative offices, classrooms and now a recreation center. The area would make a good use of the space, turning it into a social space, very much like a student plaza that connects the different faces of life in the college.

Our preliminary studies showed that this deign would accommodate increased activity during the day, but not in the evening or night. Yet, its proximity to other buildings and housings would allow for pedestrian traffic during quiet times. Historically, this part of the campus was individual housing. The location would have changes over a 24-hour period.

Assumptions of this design: The horizon would become higher, with 3-5 story buildings in this area relatively close to US41. But, it would be balanced by recreational areas and several blended buildings, such as the Annex.

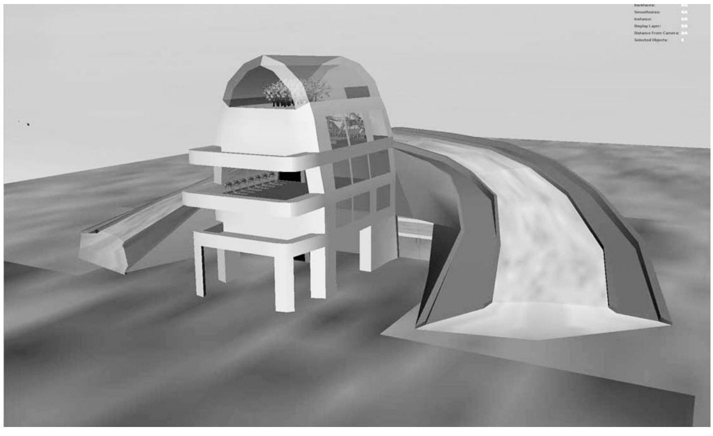

Figure 5591-1. Elevation of the Recreation Building

5.5.9.2. Exterior Design

The exterior design respects the geometrical shapes of current and planned campus buildings, yet seems lighter through its use of glass and open spaces. The recreation building will have five floors, occupying a footprint of 240 square meters and a total area of 760 square meters. The shape of the building is staggered, built from 20x20 square sections. The first floor has six sections, and the number decreases as the floors go up; the second floor has five sections, the third floor four sections, the fourth floor three sections, and the fifth floor only two sections. However these sections are only observed from a construction point of view as they are joined inside to create larger spaces. This particular design will allow more light to pass by and illuminate the common plaza among the three other buildings in the area, which will be an open space for students and staff to interact with each other and enjoy the Sarasota weather.

An important design feature is the intent to break boundaries and bring the outdoors in, while creating a versatile space. The inclusion of native species and gardens will help create a peaceful environment to aide in the pleasure of recreational activities. The design considers several options for gaining renewable energy, for example small sets of solar panels strung along the outside wall of the pool area. The design features 4 floors of exercise and recreation equipment, with a path running at an angle up the side of the building, connecting to the third floor. The structure is to be built using the cast silt method so it resembles a horseshoe shape, with the building in the middle. This will reduce all costs of construction, from materials to carbon dioxide production, and reduce maintenance on the building itself. The goal for this new facility is to provide a safe and inspiring area for students and faculty to practice personal fitness as well as provide the campus with extracurricular sport stimulation.

The building has a L-like shape but with a bigger angle at the point where the two parts of the building meet, an angle of 120 degrees that opens the building more and connects it with the Hammond Commons cafeteria and the west side of campus. It will be constructed of mainly sandy rocks and glass to provide natural light to the spaces inside. These kinds of materials were chosen because they are easily available in the area, reducing construction costs and also making it easier to find in case repairs are needed. In general, the materials used are very similar to those used in the Academic Center or other buildings of the school, keeping costs within budget.

The first floor of the building will host a swimming pool on the west side, which does not have an overhanging floor above. The roof of the swimming pool is made out of glass that can be removed at times to make it an outdoor pool. The light regime would allow the pool to be illuminated most part of the day and photovoltaic cells on the roof of the pool to collect electricity. This pool area will be surrounded by hedges to contribute to the privacy of the space, and it will also be surrounded by grass so that when the roof and walls of the pool are open people can enjoy all the benefits of an outdoor pool. The North side of the pool connects with the dressing rooms and the main entrance to the building, where the elevators and stairs will be located for easy access to all the floors. The East side of the first and second floors is actually an open space, supported just by the necessary pillars, that will hold a football field and multi-purpose sports-track.

The third and fourth floors will have space for a fitness center with a fully equipped gym, a running track and studios for all sorts of activities such as dancing or martial arts. This fitness center is one of the major improvements that the building offers, doubling the size of the current fitness center. The healthy cafe will be located on the fifth floor, offering students and staff a more balanced diet and a wide variety of smoothies and fruits to chose from. The cafe will have a balcony with tables outside for people to be able to enjoy their meals both indoors and outdoors, with a nice view of campus from above.

Finally, the roofs of the building are going to be living gardens that will cool down the building and will help collect rain water that can be used in the toilets. If this building were to be converted from a recreational space, its open spaces and big areas would allow it to be used for almost any other purpose.

5.5.9.3. Discussion

The building is to be built using the cast silt method, used by Paolo Soleri at Arcosanti in Arizona, so it resembles a native hammock landform. It would use sand of course. This will reduce all costs of construction, from materials to CO2 production, and reduce maintenance on the building itself. This technique would only be used on the running hill, as the main building would need to be built with steel and stone with a façade.

Using this design, in this part of the campus, would reduce machine traffic, as well as machine-human conflicts or competition for space. It would also provide numerous advantages for other kinds of interactions.

As interactions are shifted by the design from competitive irritants to engaging opportunities to participate in more aspects of the campus life (not just operations, but the expression of a living place dedicated to learning and expressing), the stakeholders (not the best word, but one indicating participation in the place of the campus) may become more relaxed and productive.

During the design stages of the project, many aspects were reworked and redesigned. For one, the grass ramp was at first not connected to the building. It was proposed that it would not only save on materials, but would also add more functionality to the building if the ramp and building were combined. Also, the ramp was raised to the fourth floor, so that there would be easy access to the lounge area, including the smoothie bar and playground.

Further thought was put into the ramp's location and spread. It was concluded that the ramp should wrap around the building, enclosing it, so that the surrounding property is not wasted by the wings of the ramp protruding out.

Figure 5593-1. Recreation Building and ramp from above

The addition of this new Fitness/Recreation center would provide more stimulation for students on campus as well as well as aide in the right decision to participate in psyical activities. The current gym is underused and this new, and much larger, recreational building will provide a more engaging area to make people want to exercise. Large groups of students who are friends will find the ability to interact in large groups at the same time in one building. It is a fun space designed to help student wellness. The design accomodates all these needs, and with the enw soccer field being placed next to this building, it could be forseen that the overall student health and happiness with increase dramatically. This type of building is worth the investment to help students and faculty alike feel more inspired and engaged as well as refreshed. It is definitely a necessity which this campus is not currently meeting.

The building would be open 24 hours, so that the students and faculty that have unusual schedules can still fit in exercise wherever applicable in their busy lifestyles. This might be only one of two buildings open all day and night, but its facilities, including refreshments and table areas, and flexibility make it ideal. The overall purpose of this building is to promote physical health.

5.5.9.4. Lobby & Special Areas

The lobby area would have two doors: The main door at the front of the building and the other entrance at the left of the main door of the building. This other entrance would make it convenient for the people that walk in the building from the courts outside the first floor. The main door would be a revolving door, which are more energy efficient and also allow large number of people walk in at the same time. The second door would just be a hinged door at the east side of the building.

The lobby would have a desk that would be very close to the main entrance of the building; this would make it easier for the person in charge to monitor the people that walk in the building. For that same purpose the elevator would be located behind the desk so people need to pass by the person at the front desk to get to the elevators.

This building would also have lounge areas that would be located near the entrance and near the elevators. This would be done to make the lobby area more inviting and comfortable for people entering the building. Because we are thinking this building would become one of the main buildings people would spend time, it would provide a place to relax and sit down.

All the furniture that would be used for the lobby areas would be constructed from recycled materials. One of the ideas for the furniture is to utilize used tires to create the sofas and chairs. That material is easy to work with and it would also make the chairs and sofas comfortable and they would also look good. To create the front desk and the tables for the lounge area, recycled wood would be used. The floors of the lobby area would be made of recycled glass. This would make it easier for cleaning and drying, since people would be walking with wet feet from the pool being close to the main entrance of the building.

Big double-glazed windows would be located at the lobby area, this lowers the U factor and it also lowers the solar heat gain coefficient. Energy efficient bulbs would also be used to save energy at nighttime, when they would be needed for light.

5.5.9.4.1. *Physical Fitness Machines & Studios*. So in the new gym there will be a greater variety of machines for specific muscle groups. All the muscle equipment will be on the second floor while the Cardio equipment stays at the first floor for those cardio people and meatheads up stairs. The listed equipment may include: Bar bench, more dumbbell weights, seated row machine, leverage seated row, leg press machine, bicep and triceps curl machine, squat calf machine, and others. I hear that in every workout plan it's a must to experiment with different workout exercises and having that variety will help. The Center will have enough space for as much equipment as needed.

Weight lifters would have more space for free weights, dumbbells, squatting racks, and benches to assure that they get a full workout. More space also means more studio area for classes, private sessions, presentations, etc. Basic exercisers. A larger recreation area would a vast increase in cardio equipments such as treadmills, stair climbers, bicycles, and ellipticals. As for the equipment in the fitness center we as group wanted to spread things out, so we could open up space for things like extra studios for classes, private workouts, etc. in this particular section of the proposal, I will mainly cover the cardio aspect of the gym and also cover some of the classes and studio space offered.

The exercise equipment could all have the ability to store the energy they build up from continuous use. A building that is self-powered by the people who use it everyday would be ideal. The cardio section of the fitness center would take up half of the second floor along with the free weights and exercise equipment. We would want treadmills, stair climbers, bicycles, and ellipticals along with other self-motivating equipment.

5.5.9.4.2. *Swimming Pool.* The pool area would be located next to the lobby area, at the right side of the building. To make the pool more environmentally conscious; recycled glass tiles would be used to build the pool and an energy saver filter with a timer would be used to maintain the pool clean; and save energy. Salt water would also be used to fill the pool. Having a salt-water pool, they would not need to add chlorine to clean it, because the salt in the water works as chlorine.

The floor around the pool area would also be made of recycled glass to keep it easier to clean and it would also be very resistant of water. The pool would be 10 meters deep, which would make it possible to have a diving board. The size of the pool would 10x20 meters; this would make it big enough for people to swim comfortably and also to participate in other recreational activities. This area would also have a ceiling that can be opened or closed when wanted or necessary, for instance, when days are sunny; in this way people can enjoy the natural light and the building will also consume less energy.

There would be chairs and tables around the pool area, so people could relax and also take breaks from swimming. This furniture would also be made of recycled materials. Some of the possible recycled materials for the furniture would be recycled plastic or recycled tires. These materials would be appropriate for a pool area because they would not get damaged with water.

Another essential thing for the pool area is a locker room. This would be located inside the pool area, to make it easy and comfortable for the people using those facilities. And there would be separate changing rooms for men and women. Lockers would allow people to have all their belongings when they are changing clothing or taking a shower. Inside the changing rooms there would also be showers, toilets, sinks, an area for people to use hairdryers and a small lounge area at the entrance for people that wait on others. To save water low flow showerheads would be installed in the showers. For that same purpose ultra-low flow toilets would also be installed in the changing room.

The pool area would also have a small cafeteria that would offer healthy snacks and water for the people using the pool area. This cafeteria would be located at west side of the pool and would also have some tables with chairs for people to eat their food and relax.

Figure 5543342-1. Blueprint of pool and lobby area

5.5.9.4.3. *Café.* This Café will be located on the third floor of the Recreation Building. There will be a variety of wraps, sandwiches, salads, soups, and anything healthy you could think of. We will also have smoothies, fresh juice, fruits, coffee, protein shakes, water, and power drinks. The whole idea behind the Café is that anyone can go in and pick what they want to eat and how they want it. As you go in you will find a refrigerator with the different types of lettuce wither for you salad or wrap. You will then stop to select the toppings of your choice and the dressing you would like. You will move along to several cutting tables where someone will cut and mix everything together with the dressing and either put it in your salad bowl or give you several options for the wrap. Next you can either continue to buy a soup from several options or just pick what you will drink and then finally go to the paying area to pay for your food. In this drink area is where you can find several natural juices or smoothies of your choice. In the end your food will be charged depending on the toppings you add and the amount of things you add. Some sandwiches will be already prepared, but you can also make your own and choose your bread and what you want to have in it. The lettuce containers you pick in the beginning will be used to put your wrap, salad or sandwich at the end. The shapes of the containers will be constant with the shape of what you choose so another plate is not wasted. These can be used to take left overs as well because they will be made out of plastic so they will be strong and durable but at the same time recyclable.

This Café will also have an outdoor area where you can sit, relax and eat. It will be in a third floor so the breeze will be nice during lunch time and there will also be some umbrellas to cover from the sun. This outdoor area will have plenty of seating for students that want to go during lunch or during dinner. We would also like to keep the space clean and open because a big problem that happens now in the Café in the Academic Center is that when it gets full there is very little space to sit or even walk around, and most of the time all of the tables are taken. The furniture will be artsy but sophisticated. I believe that a big problem that the Academic Center has is that is looks like a hospital with all the big white walls. We are in an art school so I think this Café should show that. Inside and out we will have it decorated and the walls painted in various colors with different designs on them.

All of the materials used for the interior and exterior of the Café will be non-toxic, reusable, renewable, or recyclable. We want to make this a green building and keep the tradition in Ringling after the Academic Center. To reduce energy we will try to use the natural light as much as possible by having big windows in every room. Fluorescent lights will also be used because they are the most energy saving lamps. Twenty two percent of the energy used by the lamp is converted to light, unlike other lamps that need much more energy and do not light up as well. To keep the area fresh, cool and sound-proof, we will use insulation in the walls, ceilings, and floors. For the kitchen and bathrooms we will use low flow heads to reduce water use. The toilets will be like the ones in the Academic Center where less water is wasted. I think that for the flooring a ceramic tile would look nice. These are recyclable and highly durable. They are also freeze-proof and easy to clean and maintain. They retain their heat and emit it slowly, which is good for climates that are warm during the day and cool at night, such as Sarasota. They come in many varieties such as glazed, unglazed, mosaic and quarry tile and in variations of sizes, surface textures and colors. The unglazed are cheaper, but the glazed are water resistant, which would work better for the Café since most of the time people are spilling things, and retain their hard quality and surface color longer. The only bad thing about this specific tile is that it is energy intensive to manufacture, so it would definitely be something to think about. Another thing to have in mind is countertops and even flooring of alternate materials, such as bamboo.

We would really like for this café to be a place where people could really go in and relax. It will be a place where they can work but at the same time just relax with their friends after a workout if they would like. In general I think the whole building should be a place where they can just come, work out for a bit, and then just relax after a long day. It will definitely be a place to eat healthy, and even those who are picky can find a variety of things as well. They can not only find a variety but they can also pick exactly what they like so they can eat exactly what they like and how they like it.

5.5.9.4.4. *Roof Gardens*. Gardens have been around for centuries; they were for a means of food. Roof top gardens started to appear in Roman-Byzantine Empire as a way to show status. Now roof top gardens are appearing all over the world. The roof gardens are to be placed on two different roofs at different levels. And the elements they contain such as furniture, rain barrels, etc will be made out of recyclable materials. The vegetation in them is to be native of Florida, and particularly of Sarasota. This will reduce maintenance on the building itself. The gardens will help isolate the traffic noise, reducing noise pollution in the area. The garden acts as a cooling and heating element for the building.

One of the main characteristics of the new design will emphasize wild vegetation, for wildlife and birds, located on the roof tops of the building, These gardens will compensate for all those natural habitats that might have been affected during the construction.

The objectives of the gardens are to reduce the ecological impact of the building, to increase native habitats on campus, and to put in effect a better ecological use of school properties while providing a recreational area for the student body and other members of the campus.

For our roof top garden, the combination of a Zen garden and activity area will be incorporated into the space. We will be using the space as a garden. The building will house two separate roof top gardens. One will house a rock garden with fountains, to make the space feel relaxing. This garden will also have a fish pond. There will be easily movable chairs and tables. This will allow students to move the tables around to promote collaboration. The ease of moving these tables would also allow for yoga classes to take place, during sunrise and sunset.

The other roof garden will be set up as a lounge area. There will be a garden to surround the students with nature. We chose over sized sofas and chairs to make the students comfortable in the environment. There will be smaller tables and chairs set up in a collaboration area, this could also be arranged to have group meetings.

The goal of the space is that it is comfortable to the students as a place they can work and enjoy the fresh air, and sunny Florida weather. This will be the function that the garden will have for the student body but it will also help the building by not only helping the building with sustainability and LEED credits but it will also cut down on energy costs for the school.

The rooftop garden team paid special attention to the current landscapes and grass areas of this campus. The team studied how much these areas are used by students for studying and relaxing. We took into consideration how beneficial and inspirational it would be to provide outdoor areas like this. We went out in the community to find out what the students thought the current campus lacked. They expressed their eagerness for more recreation activities that were not necessarily traditional sports. This is why we believe an area designated for studio classes such as yoga, aerobics, and Intensity a combination of cardio and aerobics class, would be beneficial. This area will have a great panoramic view of the campus and it will be surrounded by vegetation. These classes would take place mainly at sunset and sunrise, providing more privacy to the participants since fewer activities occur then.

We have included rooftop gardens in our design because with them we will be able to enhance the vegetation of the area. These gardens will provide habitats to native species of birds and insects by including native flora. This gardens would have a very unique view, the plants that have been suggested are very colorful, they will be neatly arranges among the edges of the building, partially isolating the rooftop gardens from the rest of campus, making this a very unique place. The suggested plans are the following: Golden Dewdrop (*Duranta repens*), Coontie (*Zamia floridana*), Silver Palmetto (*Serenoa repens*), and Tickseed/Lance-leaved Coreopsis. These are just suggestions, It might be worth to consider other species such as: could also include a few small trees, like native cabbage palm (10-11 ft tall), which grows slowly, a few taller shrubs, such as native firebush (4-6 ft, and groundcovers like mimosa. These plants have been chosen for their low maintenance requirements and for the diversity in, colors and textures that they offer (see Figure 5593-1).

Roof Top gardens need to have an extra structural support, to help support this garden. It needs extra structural support, with a layer of thermal insulation, which helps the building keep a constant temperature. Then the thermal instillation is covered with a thin layer of water proof membrane to help in the elimination of mold and leaking. After there is a drainage membrane that helps with the area that helps with the absorption of the water,

This leads into the growing medium for the plants which is usually dirt, rocks, or wood chips, this leads into the plant life layer.

The rooftop gardens on this building will be a key in energy saving since they reduce surface roof temperatures by as much as 50 degrees Celsius during the summer. Reducing the temperature of the building itself decreases the need for high levels of air conditioning.

Studies show that buildings that host rooftop gardens lose 30% less heat in the winter and are cooler in the summer. Moreover, they generate sound insulation, which will reduce the noise of traffic and create an even more peaceful and relaxing atmosphere.

We want these gardens to be of low-impact. They will follow the rules and regulations set by the Florida Friendly Gardens. We will use only native plants that are accustomed to the weather conditions. Having native plants like the ones previously mentioned will increase the population of native insects and other small animals, which will promote the preservation of them. In addition to the gardens having native plants, they will reduce the watering and maintenance requirements, saving money and energy.

In order to maintain the gardens in the most environmentally efficient way, we will have outdoor compost bins in which the cafe will deposit their organic waste. This compost will be use as a natural fertilizer for the plants, eliminating any risks of chemical contaminations. We will manage yard pests responsibly with a minimum to no use of chemicals. Rain barrels will be located in the gardens. Rainwater will be collected and used for the irrigation of the plants. We will implement micro irrigation to assure the use of the water collected and eliminate any loses of it.

The proposed design of the installation of roof gardens on the top of the recreation building is finalized including imagery of how the place would look and how the furniture and other appliances will be balanced with the vegetation.

This design is intended to improve the different learning areas that Ringling College provides to the students. They will learn how to take care of their health and to improve their artistic skills with the provision of areas that invoke all the senses and promote interaction with the environment. This building will be an icon to the campus, fitting the style and values of the other recently-built, LEED-certified buildings.

The flexibility of this design is ideal for the campus master plan since the components of the proposal should work in any location. This project could even be adapted to a different state. Its efficiency would still be consistent. This model for rooftop gardens should be taken into consideration for all the other buildings on the campus master plan.

5.5.9.5. Discussion

Our research team has demonstrated that the gardens will benefit the school, its population and the community that the campus is surrounded by. The inclusion of rooftop gardens on the building will make it an example for future builders. After our research, we decided that that since the building is so big it could have two Roof Top Gardens, to help the building keep cooler. As a group we decided that it would be more economical that the one of the gardens be more of a hang out area where the other would be more of a place where students could work; both would have moveable furniture, so that it could provide space for students to conduct sunrise and sunset yoga.

It is much more convenient to utilize what the environment gives us rather than trying to preserve something that does not belong here. Even though grassy areas create a very pleasing environment, they require much more maintenance. In order to maintain a green yard a lot of water and fertilizer is required, which can be difficult due to the dry and very hot seasons in Florida. Mulch can also be used to replace the grass since it needs less maintenance. But we would also mulch around the native plants; mulch by itself is not that interesting. However, It protects the soil that it covers by preventing moisture evaporation and maintaining the temperature. Mulch provides an abundance of nutrients to the plants. Ringling College of Art and Design already uses Mulch, but they use the one made out of wood that could contain and feed termites. This would be a problem for the furniture and the patio on the roof. It is recommended that a different type of mulch would be used like for example pebbles, grave, and or recycled old tires. These types of mulch are inorganic and they do not decompose or attract pests.

Ringling College has to address the problems that its current fitness center, and realize the importance of health and fitness for its students. An article by Leigh Goessi discusses the fitness problems that college students face and the importance of fitness and exercise as a daily part of a student's routine. Due to stress and irregular eating schedules, it is easy for college students to gain weight and get out of shape, and fall into a lifestyle of poor eating, little exercise, and as a result, bad health. Not only is exercising good for health, but it is also a natural source of energy for students. With an overwhelming workload and many things occupying one's time, it is difficult for students to find the incentives to make the trip to the gym and take the time to improve their fitness. It is part of Ringling's responsibility to create an environment that students can see as an incentive to go exercise.

Our general layout for this building solves many of these problems. It gives the fitness center its own, separate, freestanding building. Its location is ideal because of its surrounding buildings. The Ulla Searing Student Center and deck, in front of it, is already a hub for students, where they go to eat, study, hang out, and live. Next to the recreational center is North Hall, now Goldstein Hall, a residence hall that houses most of the freshmen and also offices, the Fishbowl work/hangout and television area, ping-pong and billiard tables, and the Mailroom. The area around these northernmost buildings is already high in traffic, so adding a recreational facility would make this area even more of a hub for students to congregate, whether to grab a bite to eat or to exercise. It is large and spacious, taking up most of the space from the Tamiami Circle fence to Goldstein Hall. It is also more efficient in how it is organized. The new facility delegates separate floors and wings to different aspects of the gym. The sides of the building are primarily glass, providing large windows and natural light for the facility. The expansive, floor-to-ceiling glass walls and structures on each floor of the building are also environmentally friendly. They add to the sustainability of the design of the building, because they allow for natural lighting as opposed to electrical lighting. The structure of the floors create staggered terraces, providing not only patios for students but also outdoor green space.

5.5.9.6. Conclusion for the Recreation Center

The virtual design model is complete as a proposal for a center of a proposed FSB. Although we have tested its efficacy as a thought experiment, the uncertainty of nature and human institutions means that it may not function as smoothly as a physical object. But, we are confident that we have addressed the problems of other traditional campuses with this design. In conclusion we designed these gardens so that they will help the building to save costs on heating and cooling for the building. We chose all native plants to Florida so that the building will benefit from adapted plants.

The space is designed so that it will be a relaxing atmosphere for the student to work individually or collaboratively. As described earlier, one garden will be used for a space to relax and enjoy the Floridian atmosphere, the other will will use modular furniture so it can be an outdoor studio or a yoga studio as well.

The design should meet the objectives presented earlier. It should provide optimum access to the ecological body of the campus; it should minimize disruption of the activities of learning through bustle and noise; and, it should add an iconic structure that expresses the function of the building and fits in the style of the campus. To some extent the success of the design depends on the actual size and configuration of the new buildings, paths, and open and wild areas. But, the openness of the design lends it a flexibility that should be useful in a variety of landscape changes. Constantly monitoring the design over time, as the campus develops, will contribute to its success. As the campus changes to a more natural campus, the center could be adapted for studio work or other functions relating to the maintenance of plantings.

The objectives of this building are to provide optimum access to a variety of physical fitness activities and equipment, while at the same time minimizing disruption of the activities of learning through bustle and noise, while adding an iconic structure that expresses the function of the building and fits in the style of the campus. This particular flexible, open design favors the fulfillment of the stated objectives.

To have a building like this is important to stimulate the minds of its students. This building could be the catalyst for the Ringling College to provide many more student wellness programs. This Center design could be a model for temporary or transitional building within the overall design of the campus. It provides the required space for keeping the campus healthy and productive. The fitness center will also provide open, flexible, customizable spaces for studios and team games such as Football, Basketball, or Quidditch. The new design addresses the needs of the identifiable groups of fitness center members, such as weight lifters, dancers, and runners.

Our proposal for expansion of the Fitness Center not only meets the requirements of the current Ringling College community, but also allows for further expansion as the school grows over time. Setting the location of the building in the middle of the campus allows it to be an easy place for everybody to reach, and by making it an environmental friendly building it will fulfill the needs of the campus master plan. It also provides everyone with more options regarding alleviation of stress in an environment that requires complete and total commitment and a high level of excellence and performance.

5.6. *Local Design Factors: Adaptive Patterns—Civilization & Industrialization*

By the end of the 1200s, the Mongols brought China into direct trade with Europe, and they developed paper money to make the trade easier. Their empire had its own transcontinental highway, as well as sea trade routes with the Chinese. At that time, the European cities were being changed by guilds, trade and gothic architecture. Colleges were beginning to replace monasteries as centers of knowledge; local languages were replacing Latin. By the mid-1300s, there was an economic downturn in Europe and China, which was related to plagues across Asia and then Europe. The regions were linked if not interdependent enough to influence each other. After a series of local disasters and political changes, China unplugged from the trade system. Did population growth prevent a Chinese industrial revolution? China had many advancements around 1000 BC: Papermaking, moveable type printing, paper-money, guns, gun powder, compasses, underwater mining, umbrellas, hot-air balloons, rockets, and laws of motion.

Then European commerce began to flow past local boundaries. But, the commerce had to be protected from pirates, so laws and agreements were needed. There was a slow transition to regional commerce. Specialization went beyond nations. The Dutch East India Company followed economic goals rather than political ones, although it was closely linked to political and may have become a tool for political objectives.

In the 1300s in Italy, most cities did not know how many people lived in them. With the plague, people began to know by counting dead bodies. How strong is order and morality when there is a plague or conquest? In the 1300s, Florence had a large industrial group of people. A third of the population was employed by the textile industry, as beaters, washers, carders, combers and laborers. Another third was classified as paupers. Companies in Italy started banks, so that there was capital for long-distance trade and development. Did changes in class and equity lead to first private gardens, then public gardens, to areas walled off from others? In the 1400s, the printing press (1455) was part of another transformation that included the Renaissance (1470), the formation of the Spanish nation (1492), and global exploration (1492-1550s).

The English encouraged trade to increase wealth. This led to Mercantilism, government regulation of the economy to ensure growth by granting monopolies. And, that led to the accumulation of capital. Capital required more energy and new technologies. Capitalism changed production (goods are privately owned yet there is separation of people from land and resources—England 1650 slave, sugar, cloth triangle). Other factors leading England over France or other countries: lower internal tariffs, weakened guilds, intercourse between aristocracy and middle class, relatively less conflict and war (the isolation of the island), and a geography conducive to commerce (access to the ocean).

The impulse for better sources of energy, and the challenges from using coal, led to many new inventions, such as the water pump and steam engine. To produce these things on a larger scale required capital investment, special designs, regulated labor, free materials, directional flow, and sufficient environmental services for renewal. These inventions also transformed society, along with the modern university in Berlin, the institution of science, and the American Revolution.

Early cultures obtained energy from food or from a few domestic animals. Cultures practicing intensive agriculture were also limited by energy, but were able to obtain more food by mixed crops on engineered terraces. With the advent of machines, more energy, from wood or coal, was required. And, with the change of scale in industrial production, more concentrated fossil fuels were found and consumed. Industrial societies used triple the energy of intensive agricultural societies. Another watershed of change occurred in the 1900s, with the ascendance of Japan and the United States, the invention of the computer, and the US GI Bill of Rights, which made a university education available to many more people. Some countries, such as the USA and Japan, were able to use double the energy of other nations and 50 times what typical hunter-gatherer societies used.

Table 560-1. Agroecological Sequences Pointing to Industrialization (Read down)

Fewer species	*Settlement*	Human labor	*Deforestation*
Control of land	*Population increase*	Tools/technology	*Erosion*
Competition	*Specialization*	Animal labor	*Water pollution/loss*
Conflict	*Big religion*	Machine labor	*Drought*
War against humans	*Big trade*	Slave labor	*Soil loss, wood scarcity*
War against nature	*Urbanization*	Energy slaves	*Species losses*

Industrialization changed many cultures. The culture of consumption has developed from the industrial large-scale production of commodities. It is the psychological switch from being to having. The packages and advertising become part of the commodity. Consumption has private and public aspects. As the production of art became commoditized, the mass production of entertainment by a culture industry, it also became a tool for pacification of a relatively poor population conditioned to 'having' the surplus products of capitalism dumped on them. People, however, regard consumption as an 'empowering' act. And, of course, they personalize things.

Humanity was calculated by Norman Myers and others to be using over 40% of the ecosystem productivity for the entire earth before 1990. Later calculations, by Stuart Pimm and others, indicate over 55 percent a decade later. Humanity influences virtually every ecosystem to some extent, destroying some, interfering directly with many, and exposing the rest to exotic chemicals and materials. Species normally use a percentage of system productivity without disrupting the processes of production. Humanity interferes with the processes.

Based on limited scientific and cultural perspectives, humanity fails to value those beings and communities for which no use is known. But, as Aldo Leopold (1949) notes, the majority of the beings in nature have no human uses. Even some ecologists cannot think of uses for many large birds and mammals. The real danger is genetic loss, which is grossly underestimated. As wild areas grow smaller, even wild species interbreed. As species are lost, the ecosystems become simpler or start to collapse. Our perspectives seem to be limited by metaphors, and metaphors can drive the direction of activities. The new possible post-industrial metaphor might be more useful in designing changes on a global scale.

Table 560-2. Changes in Metaphor by Societies

Social Type	***Metaphor***	***Psychological case***
Foragers/Gardeners/Chiefdoms	Animals	Otherness nonhuman
Pastoralists	Father	competition
Agriculturalists	Mother	Infantile (land=woman)
Industrialists	Machine	Take-over
Post-industrial?	Ecosystem?	Partnership?

5.6.1. *Historical Patterns of Industry*

Industry is a specialized approach to producing things by a division of labor combined with a division of time and the use of special tools. The first industries of hunters and gatherers were woodworking, pottery, or other trade items, such as axes or toy cedar crest poles. Many industries were winter activities. The scale of industry increased with the advent of agriculture. Catholic monks used the ideas of industry to run monasteries and to produce publications. Industry as a process soon came to mean the use of energy from fossil fuels to increase the scale of production, its speed, and its form, as assembly lines became more formal. In fact, the byproducts of industrial mining—steam engines—became the basis for further industrialization. The quantity of energy increased, from human labor with slaves, to animal and machine labor with energy slaves, but the variety of energy resources decreased.

Fashion industries exploited a single resource, such as beaver hats. Art industries produce status and luxury. The function of art in industrial society is to train people's perception of the industrial environment.

Industry is a form of intensification of culture, of miniaturizing nature and focusing consciousness on industry. Industry increases goods and the rates of consumption. It requires more energy and nonrenewable resources.

The key machine of the industrial age is the clock, from mass production to computers. The clock was invented in Benedictine monasteries on the twelfth-century to make daily routines more regular. Thus a thing invented by religious people dedicated to devotion, the clock, became more useful to those devoted to the accumulation of money. The clock made capitalism possible. It made mass production possible. It made wage slavery possible. The clock was one of the first metaphors for the operation of the universe. They were part of the process of mechanization. The clock sets the same time for everyone. It allows the units to be the same. So that people will do the right thing at the right time (of course, biological clocks did the same for animals in a changing world, to set the organisms rhythm to the natural world, in terms of temperature, rain and other conditions). Culture and industry have become driven by clocks.

Industry required free materials and 'externalities' (ecosystem services), as well as regulated labor, capital investment, and special designs and tools. Industry imposed more costs on society, as people had to act like machines, had to be regulated by time and specialties; pollutions and health-related costs accumulated as environments were processed into flatscapes.

Industry processes resources and dumped the wastes back unprocessed. It forces one-way flows. It does so at an unnatural speed. Unlike a pioneer stage of succession, industry is, in Evan Eisenberg's words, at a "fetal" stage. It relies on the maternal biosphere, or the biospheric matrix, to feed it and lick its wastes. Alas, this fetus is very large and could kill the mother soon, unless the fetus matures or the mother reacts faster.

Industry has grown in a very linear, then exponential way. In the 1800 and 1900s, industry became 'heavier.' Human populations rely more on the industrial production of food, which requires fewer people. Industry has resulted in factory farms, which handle insane numbers of animals in smaller areas, where increasing production means treating animals as machines, which is a form of cruelty. Soils are depleted. Human health is compromised by animal stresses and diseases. The industrial system destroys plants and animals, poisons water and soil, as well as soils and human communities in its quest for size and efficiency.

Industrial methods have also dominated manufacturing and sales, also. Industry eats away at cultural images and values. It focuses on discovery and use, rather than need or recovery. Industrial practices are sold as producing 'better quality' and more volume. Its myth is 'bigger is better.' The other myths of industry are familiar: Industrial agriculture is necessary to feed the world, to provide us with safe, nutritious, cheap food, to produce food more efficiently, to offer us more choices, and, of all things, to save the environment. Yet, industry implicitly recognizes the myths and lies. In fact, it points to advances in biotechnology and nanotechnology to solve the negative impacts. Its claims are broadcast through every communication channels. Industry is related to habitat destruction and extinctions. Industrial society is constantly mobilized for emergencies, in the battles against, noneducation, poverty, diseases, terrorism. Industrial development has never been nonviolent or respectful to people.

The scale of industry increases the scale of cultures. Increases the vulnerability of culture, as there are higher incidences of starvation and homelessness. The industrial revolution decreased contact with the natural world and objectified what was left. As a result of drastic changes in the production of economic goods, other political, social and even psychological changes occurred. Other kinds of order were de-emphasized. Human relationships became based on economic allegiances instead of kinship, and were formed in societies, not communities. Money became a symbolic representation for the value of labor and land. Similarly, labor was seen as minimum value. For example, the idea that "labor is a resource" implies that, like any common resource defined by industrial society, labor is cheap and can be used up. The real costs of free goods and externalities have had to be accounted for, yet—this often influences the selection of corporate priorities and growth. Furthermore, the production and distribution system for most economies is linear (straight throughput) and not circular (complete recycling), although this is logical economically, given our frontier resource-use accounting. Why is everything an industry now? The industrial revolution restored humanity to a place of grandeur and importance on the planet.

Despite a few paths of plastics recycling, aluminum or steel, most industry is a one-way path from energy and materials to waste energy and materials. Industry has not yet matured to fit ecosystems and recycle elements back into the systems at a proper scale.

5.6.1.1. Industrial Growth

Mesarovic and Pestel assume that further industrial growth will continue, that economic growth is good, and that this growth solves human problems as long as it is organic. Exponential growth is said to be bad, and organic growth is said to be good. In fact, although organic growth is better, there is little difference during a world crisis; both reach asymptotes of suffering. One need only regard the population crashes of lemmings and others to see how organic growth can go wrong.

Economics became enamored of growth during a critical time in history. Rapid European expansion occurred at rates rarely exceeding a growth of one percent per year, and with unparalleled opportunities for expansion into sparsely settled areas, such as North America, Australia, South America, and South Africa. Many cultures now do not have these opportunities; the continents are claimed, and violent population growth may have wrecked their hope for development by ravaging every resource.

The economy has been growing almost constantly since it has been studied. Demand for better industrial products has been an important factor. But, we have been trying to force it to grow, rather than let it stabilize or contract, when demand did subside. Even if it stopped growing, the economy could still develop. Mesarovic and Pestel, as well as many others, confuse growth with development. J.S. Mill did not. In the organic world, growth is healthy only when the rate of change is decelerative in the long run; cancer and population are constant or accelerative. Mesarovic and Pestle fail to realize that continued economic growth in any form is a threat to the stability of the biosphere.

5.6.1.2. Industrial Intensification

There has been an intensification of tool-making in the past 3000 years. Population increased and new areas were exploited. The agricultural revolution was a technological revolution. The industrial revolution, by definition, was a technological revolution, which resulted ultimately in men being replaced by machines. Only the Luddites faced this limitation, unsuccessfully. Human labor is increasingly dispensable. Industrial culture confuses mechanical with personal power. According to W. I. Thompson, industrialization is an intensification of civilization.

Table 5612-1. Important Cultural Revolutions

Date	*Development*	*Effect*
9000-8000 BC	Domestication	Animal things & labor, weaving, animal diseases
7000-4000 BC	Agriculturization	Sedentization specialization, accumulation
3000-0 BC	Urbanization	Cities, architecture, trade, metallurgy, writing, armies, calendars, disease concentration
500 BC-600 AD	Cosmologization Thought systems	Religion, ethics
500-1500 AD	Mechanization Science / Banking	Machines, wind/water power, literacy, banking, capital, corporations
1700-1800 AD	Industrialization	Steam power, assembly rules

Industrialization is really an intensification of civilization, which is still an ektropic process. In each case of cultural absorption, there was an attendant process of miniaturization. The forest was miniaturized in clumps of trees; animals were miniaturized in artistic image; time on a lunar tally stick; plants in a garden; women in a household; nature by culture in 1800, under the glass roof of the Crystal Palace; and now by the new consciousness surrounding the old. What is intensity?

Intensification brings cultures together faster. Conversion increases, technology and industrialization increase. Intensification is a gigatrend that could lead to violence. For instance, intensification leads to urban living, which increases creativity, as well as some kinds of illness, which leads to physical weakness, which leads to changes in population, which leads to intensification of resource use, which leads to the potential for conflict, which can lead to dislocation and violence.

Urbanization concentrates people in a smaller area. Just squeezing in does not mean better conditions. There has to be enough energy, sanitation, water and other things. In cities, industrialization, in the form of increased wealth, can bring about a demographic transition. As health and wealth increase, people have fewer children. What is the actual trigger? The desire or opportunity for self-actualization after reproducing heirs?

The industrialization process has led to a dramatic extension of cities and buildings, as well as growing extents of machines and increases in energy use. Furthermore, people, property and machines are much more mobile, which requires more pathways and more energy. This has increased the impacts and pressures on ecosystem productivities. Design has not been able to effectively deal with this kind of runaway process.

5.6.1.3. Problems of Industrial Civilization

Our modern problems reflect an unbalanced and immature image of the earth, the earth as a machine, for instance. People sometimes constructed their worlds from preconceived notions, and many of these worlds did not survive, because they could not adapt to the environment. Our modern cultures are defective for this reason. The modern attitude toward nature as a resource has resulted in pollution and depletion of resources. It has allowed humans to overpopulate their habitats. Recent productivity studies indicate that the optimum sustainable human population is far below the current world population.

Even worse, decisions regarding resources are still made exclusively on short-term economic rationalizations and lead to material shortages and environmental degradation. The crises of environmental degradations are crises of cultures. Monocultures of the industrial kind lead to 'dedifferentiation,' that is, the decomposition and destabilization of complex structures. A species or culture that destabilizes its ecosystem through misbehavior risks its own extinction. Human beings make changes to ecosystems that endanger themselves.

Industrial society is constantly mobilized for emergencies, in the battles against, non-education, poverty, diseases, and terrorism. Industrial development has never been nonviolent or respectful to people. Industrial production has its own unique style, shape, and scale.

Is the industrial city a jungle? Herbert Spencer saw the world as a jungle, where life was nasty, brutish and short. Spencer coined the phrase 'survival of the fitter'. He based it on the competition in industry, where entrepreneurs fought for money and power. Spencer thought the weak should be eliminated, so he opposed poor laws, charity, sanitation, education, clean water, and pure food, among other things. Rioting is lashing out at the cage, when people cannot leave cities that do not meet their needs.

One problem in industrial culture is the production of flatscapes. Our attempts at social improvements have proceeded without order, without sufficient insight and perspective, without sufficient confidence, without a comprehensive plan, and without a great dream. Our politics has been corrupted by special interests. The structure of our civilization comes from anonymous builders and mediocre designers, minimal engineers and rapacious financiers. We work within the rules as they have been for decades, rejecting any alternatives as too utopian. The rules themselves have been shaped by centuries of social metaphors and utopian ideals. They do not exist in place, either a human place or an ultrahuman place. They are designed to be no-place, without weeds, storms, or hard ground. Because they are nowhere, flatscapes, like demented unplanned utopias, lack any reference point.

Speed, so beloved by industrial cultures, can be a problem in archaic cultures. The Kelantese people in the Malay consider haste a breach of etiquette and ethics; slowness is important. George Beard, in *American Nervousness,* coined neurasthenia, to describe mental illness caused by increased tempo of life.

Information pervades society, but it is for an information market. Between uncoordinated information and the acceleration of activity, the social fabric gets fragmented. Projects are fragments of work. Industrial information work is bad for physical and psychological health, from bad physical conditions, high pressure, and low control. The information economy can lead to disconnection, loss of identity, and loneliness.

Physical laws create patterns in space, as well as in human history. There are simple kinds of patterns. A linear pattern tends to be interpreted as progress or regress. This is the dominant concept of modern history, unending progress. Despite the chaos of individual events, there does seem to be a direction of gradual improvement. Marquis de Condorcet suggested that civilization will always move in a desirable direction (1795). People become frustrated when it does not, and there have been collapses.

5.6.14. Possibilities for Industrial Civilization

Perception is a large part of patterns. And, we perceive the direction as being towards more complexity and more integration until we have a global society, coordinated on several levels, within a more complex biosphere. The local should maintain its diversity, and the local will be integrated into new global forms. Most approaches to design and the global are dualistic (wilderness-industry) or triune (wilderness-design-industry). A better approach would show how these interweave so extensively it is hard to just use boxes or circles. The same is true for humanity and nature or science and action ethics.

The cosmologies of archaic cultures have been limited to historical places and by human perception, tradition, and technology. Modern technological cosmology, beyond being another kind of order, more linear and abstract, is wrongly considered the evolutionary successor to traditional cosmologies, and is displacing them rapidly—although we cannot afford to suppress the diversity of thought necessary for adaptation to the diversity of environments or to eliminate ecosystems and the societies adapted to them.

Small cultures have built-in checks; furthermore, their cultural definition of good helps to maintain balance between other species and the use of ecosystem productivities. Local areas are limited in size, to avoid problems of scale. Historical smallness, even lacking natural resources, has not been an obstacle to wealth for many countries, for instance, the sovereign German states of Hamburg or Bavaria. The merits of urbanization do not require a large population. Local concentrations of artists, philosophers, and scientists are capable of creating a distinct civilization. Cities fifty times as large as classical Athens or Florence have not been fifty times as creative.

5.6.1.5. *Creative Civilization: Soul Science & Wild Art (Technology & Design)*

What is science? Knowledge? A method of knowing? What is art? Is it a skill, a craft, an artifice, or a creative work, a product of some kind? A profession? A branch of learning? Is it something bigger? What is design? The ability to make many things? Is design larger than art, encompassing technology and science?

Or, is art the opposite of science? Art makes the invisible visible by presenting the unseen; science makes the visible invisible by going beneath appearances. Art displays the unique individual moment; science displays patterns of samenesses. Unlike science, art uses the rare, unique, individual instance for its lesson. Science uses numbers to relate samenesses and forms. As quantum mechanics showed that participation in the field was not an option, so art requires participation for its consumers to recreate the subject themselves. The two are different, of course, as art focuses on the unique in everything, what is different in the pattern or flesh, while science focuses on what is common, on what can be measured and compared. That is why art is metacentric and science is numerocentric.

Maybe that is the problem. They should not be centric at all. Art should be metaperipheral, science should be numeroperipheral. Does art not focus? Is there a way of not focusing? What about the periphery? Could we approach it sideways. crab-like? Can art do that? Or do we need something new?

Art is an individual nonadditive expression; science is collective additive knowledge. Science is centripetal, art is centrifugal. Science is the art of the common, art is the science of the unique. Science is reflective; art is nonreflective. Science is appreciative, art is creative. The constant separation distorts both. As human enterprises they differ mostly in their focus on unique events or similar events. Art by practice is doing separately, therefore art is the opposite of ethics, which means 'doing together.' Now science is doing together, a cumulative group effort, even as it pretends to be morally neutral. Science is domesticated, art is wild.

How else is art different from science? "Art is a window with a garden behind it: one may focus on the garden or on the window," said Jose Ortega y Gassett. The anthropologist Robert Redfield distinguished between two types of perception: iconic, where the garden is the focus and the window is frame, and aesthetic, where the window is the focus and garden is the frame; he claims that a double perception is impossible, in principle. Every work of art therefore is a window frame—the aesthetic form, with a garden behind it. Is there a holometaphor possible in art?

Primitive art grew out of, and framed, a complex garden, which has grown over and changed. With their art in our cultural world, can we see through it? Is the content, once private, now public or heuristic? How faithfully does the window translate the view? If the only way we have of seeing gardens is through windows, can we ever know things themselves? Perhaps iconic and aesthetic perceptions are the same. Can art only be window? Modern nonobjective painting seems all window. Is focus the problem? Can art address the periphery and not the figure in the center? Can it look sideways at the frame?

Is science like a window on a garden? Like science, each new medium undercuts the old paradigm. Like quantum mechanics, which was the death of objective reality, which is what it was supposed to prove, art undermines its parent idea. Something new flourishes, then it is old. Then the revolution is over, and art is part of the new environment that will require further art to see. The media become the field of the new creative ecosystem.

Artistic images and symbols are aesthetic and equivocal; signs are linguistic and univocal; since images have such poor semiotic value, it is dangerous to reduce them to cognitive terms. When art works become cognitively generalized, their aesthetic specificity is lost, and they become poor vehicles of knowledge. An aesthetic object should not offer a reassuring vision, which interprets or identifies nature, but a naive vision, which surprises, shocks, fascinates or seduces the senses, which awakens desire and stirs the imagination, and which furnishes a feeling of the invisible.

Should art be limited, in terms of subject or responsibility or environment? It should not be limited to educational and moral purposes and situations. It is a process for perceiving things that may be at odds with a culture, yet may be of importance to a culture. In that sense, the basic responsibility of art is to show what it sees. If art is limited, that is, domesticated by money or rules, then it should obey codes of ethics and accept some responsibilities.

Should art look at everything, regardless of what a cultural definition of health, good or responsibility is? Art in this sense should not be restricted to one place or to one set of rules or limits. Wild art has no responsibilities or ethical obligations. Can art enlarge or alter the perceptions of all human beings on earth with the selection and presentation of relevant information to form an ecological consciousness? The survival of society now depends on a consciousness of the global system in its complexity and connectedness. The spirit of humanity depends on a consciousness of its proper relation to the wild places of the earth. Such an art, combined with an ecological science and politics, could be adequate to deal with the creation and maintenance of good places on earth.

Should art be wild? That is, should it be allowed to reproduce on its own? Without being chosen for its "useful" characteristics? Should it be responsible for stating what is wrong? For questioning a bad direction or poor decisions? Without regard to consequences?

Art can be defined through its functions: As human perception; as a physical expression of existence; as imitation of nature; as a tool for the symbolic expression of the processes of nature and the limits of itself as art; as a dialectic communication; as play; as meaning; and, as survival technique. As play and as survival technique, art is especially critical in local designs.

5.6.1.5.1. *Art as Play*. Art plays with symbols and forms, recombining them in new contexts. The artist releases ideas from the unconscious, or unexpressed and conscious, for creative purposes. This creativity is a kind of play: Put the idea in a new context and play with it, to see it in a new way. Play is an activity for itself, although playing may allow learning as well as enjoyment. This is how a metaphor works. Artists are considered dangerous because they play with ideas, because they question ordinary ways, and because they play with serious subjects. Oddly, however, the artist needs a safe place and security to allow the vision to emerge to a new context. Art also creates an explanatory context by allowing the viewer to think or perceive several things at once. In this kind of illuminating moment the viewer can see many things at once, sometimes the entire whole thing (perhaps mirrored). Should we use other metaphors of art to understand art? Art is a mirror? Maybe more like a circus mirror. Otherwise art would just reinforce the current environment and become part of it. Art distorts things, then presents the distortion for attention. But, does art mirror dangerous subjects like starvation, rape, dismemberment, extinction, or environmental destruction? If not why not? These may be the most critical issues affecting life on the planet.

5.6.1.5.2. *Art as Survival.* Art may have other advantages. Is Frederich Schiller right about art? That it could achieve what violence and law could not? Education through a peaceful process? By enlarging people's perceptions? By broadening their mental worlds and encouraging tolerance and wonder? By embracing his three concepts of liberation, play and community? Liberation is freedom from contemporary limits of identity. Play is imaginative experience, natural learning entered into freely. Community provides order, meaning and justification. Is Gary Snyder right about poetry as an ecological survival technique? What is required for survival? Order, diversity, cooperation, knowledge of biogeography? Poetry teaches that these things are valuable. Jonas Salk concluded that only wisdom will ensure human survival. Perhaps art is a form of preadaptation or adaptation to a changing environment, and is required for wisdom.

These functions make art different than science, but they also indicate how art is related to science. Is art the same as science? Both use technology. Both expand consciousness (Or entertain). Both use metaphor to make models of the world. The interpenetration of metaphorical meanings is a dialectic, where opposites are unified in a synthesis that transcends the initial contradictory conjunction of the two systems. Thus, concept formation in art and science is a working out of contradictions.

Functioning well in a technological culture requires good design, and Higgs says good design depends on a fusion of science and art. As John Dewey said, science is an art and art is practice; the distinction between science and art is between their modes of practice. In this sense, design is a frame. Ecological design fuses art and ecology from the work on forests and rivers to agriculture and buildings.

5.6.1.6. *The Role of Music in Ecological Design*

By Connie Foss More

Music has shaped human development in a multitude of ways, and it continues to be a powerful vehicle for expression and change that is often underestimated or ignored. The prevalence of music in every culture clearly indicates its necessity to human experience and communication. Music influences human development from infancy to adulthood, as well as from pre-history to modern times. Music helps us to be human—it dispenses joy, soothes, energizes, and creates compassion and cooperation. Music helps us to live full and rewarding lives as individuals and as a species.

Philosopher and music educator Zoltán Kodály noted that children's singing games offer a profound insight into the primeval age of folk music, since singing connected with movements is a much more ancient and complex phenomenon than a simple song. He also believed that a child's development repeats in brief the evolution of mankind, and a child's forms of music represent a history of music—indeed they afford a glimpse into the prehistoric period of music.[5616-1]

Kodály was convinced that folksongs represent a high quality of expression, resulting from repeated human need. "To write a folksong is as much beyond the bounds of possibility as to write a proverb. Just as proverbs condense centuries of popular wisdom and observation, so, in traditional songs, the emotions of centuries are immortalized in a form polished to perfection."[5616-2]

Music is far more than a noisy decoration; it is basic dimension of human experience. The eminent psychologist and neuroscientist Daniel J. Levitin contends in his book, *The World in Six Songs: How the Musical Brain Created Human Nature*, that "Music … is a core element of our identity as a species, an activity that paved the way for more complex behaviors such as language, large-scale cooperative undertakings, and the passing down of important information from one generation to the next."[5616-3] That is, music pre-adapts the brain for complex thought, and sophisticated communication emerges from those forms of thought. He also states that the diversity of music demonstrates our adaptability as a species—these many forms of music make us who we are.[5616-4] "Early musicians … may have been able to encode important survival information in songs, an easily memorable format. Those of our ancestors who just happened to feel good during musical activities are the ones who survived to pass on the gene that gave rise to these feelings."[5616-5] Thus, music is a survival technique that we have used for thousands of years and which is still relevant to our survival in challenging times.

A relatively contemporary example of survival information in song is the historical genre of sea chantey (aka shanty). Not only do these songs coordinate the actions of sailors dealing with the sails and other equipment essential for "smooth sailing," especially in dangerous weather, the texts teach essential nautical vocabulary and activities, such as naming of pieces of the ship's equipment, recognizing points of reference on land and star constellations, and gaining information about sea life and birds. Performance of the songs also reinforces social interactions and group membership.

Music is widely acknowledged as a powerful force, which is one reason that the important rituals, public occasions and social events of every culture consistently include music. Because it affects brain chemistry, behavior, and mood, music can shape changes both in individuals and in groups. It is also a powerful drive, so much so that we create music even under great hardships. Examples of this drive are found in concentration camp poets, artists and musicians. Levitin notes that "many artists, absorbed in their work, temporarily forget all about eating and sleeping."[5616-6] *Shared* music-making is also a significant force, unifying thoughts, perceptions and actions simultaneously in many people, especially noticeable during peaceful protests, marches and meetings. The power of many *feels* like more than a simple multiplication of the number of participants.

Because of music's power, educators often agree with Kodály: "A child is the most susceptible and the most enthusiastic audience for pure art; for in every great artist the child is alive—and this is something felt by youth's congenial spirit. Conversely, only art of intrinsic value is suitable for children! Everything else is harmful. After all, food is more carefully chosen for an infant than for an adult. Musical nourishment which is 'rich in vitamins' is essential for children."[5616-7]

Agreement on what constitutes "musical nourishment" is akin to reaching consensus on a definition of art, but suffice it to say that the power of music requires us to consider that its effects can be "negative" as well as "positive." While we may "know what we like," we must realize that "we like what we know," so that exposing ourselves and our children to a variety of musical forms, that we can "know" them, is a good idea. Because music education in North America is often disparaged and even discarded as a "frill," many adults have little idea how artistically-inspired types of music can help them to become better human beings; we can only hope that they support a deeper and broader exposure for their children.

Indeed, the notion of improving the lives of children, especially one's own offspring, can motivate all kinds of changes in people. It can cause people to act responsibly in the long term. Gary Snyder emphasizes the importance of seeing the big picture: "Human beings themselves are at risk—not just on some survival-of-civilization level, but more basically on the level of heart and soul. We are ignorant of our own nature and confused about what it is to be a human being."[5616-8]

Kodály expressed a similar insight during the Great Depression in 1929: "The economic crisis is the cause of everything? Everything will be set right as soon as the economy is in order? I do not think so. Penury may hamper development but wealth does not always promote it either. Money does not produce ideas. Anyhow, there would be sufficient money here if only it were always spent on what is needed. However, the most valuable things cannot be bought with money. The greatest trouble is not the emptiness of the purse but the emptiness of the soul. And of this we have got more than our share."[5616-9]

The only way that entire cultures can experience and embrace artistically-valid music, and reap the benefit of more complete lives, is via education. Cultures that still have strong elder-to-young musical transmission are fortunate; most of us need to turn to schools. If government fails to supply the musical necessities of life through schools, then other organizations must step into the breach, taking care to strengthen equal access for the masses rather than simply to catering to the wealthy and already-enlightened. One of the most amazing current examples of this process is found in Venezuela under the guidance of José Antonio Abreu, and it has fledgling imitations in many other countries, including Canada and the USA. In 1975 Abreu founded "Social Action for Music" to establish children's orchestras all over the country, as a way to improve people's lives and Venezuelan society, and to subvert crime through discipline and wholesome teamwork. By 1977 the government took over the funding of what has now become "El Sistema," with more than 160 orchestras for approximately 100,000 children and youth, most of whom live in poor and sometimes violent barrios. Music and its social function occupy a prominent position in the *daily* after-school life of these young citizens, and the government plans to extend this program to the entire country (with 500,000 students), this time in schools, by 2015. El Sistema has even been established in the penal system as a way to "humanize" jails. The goals focus on social responsibility and self-esteem rather than on musical careers, but El Sistema has graduated many internationally-renowned artists, including the current Conductor of the Los Angeles Philharmonic, Gustavo Dudamel.[5616-10] As a result of his vision and actions, Abreu has been engaged as a special international representative by UNESCO's "World Movement of Youth and Children Orchestras and Choirs."

It is tragic that the North American focus on the "3 Rs," now matched with enthusiasm for technology as exemplified by the centrality of computers in education, has often resulted in the demotion or even removal of the arts in education. Music in particular has been shown to have many attributes that contribute to overall scholastic success, reaching far beyond its own content to enhance aptitude and skill in other subjects. Studies have shown that everything from specifics like dealing with numbers, to general abilities like concentration, are improved by having a significant amount of music in the curriculum.[5616-11] Students who are deprived of music thus lose many opportunities to develop better generally.

The motivational power of music should not be underestimated, either. People in discouraging or even despairing situations have often been helped to survive by music. A clear example is the central role that music played among slaves in the southern USA, who sang not only to coordinate their work actions, but also to learn about "Negro" history and to encourage social cohesion through shared musical experiences, which sometimes reached an emotional catharsis. Repetitive call-response song forms coordinated with rhythmic clapping and creative improvisation—in church, at home, or in the fields—were frequent vehicles for this, with no need for musical instruments beyond their own bodies. Hope for freedom was also bolstered by song, and many familiar titles had a double-usage to communicate information about the Underground Railway to Canada: "Follow the Drinking Gourd" (the big dipper, directing viewers to the North Star) and "Get On Board, L'il Children" are obvious examples.

We have only begun to study the role of music in the design and construction of ecological and cultural patterns. We need to continue this important topic by framing questions about music, such as: Can the loss of music be related to the loss of spirit or of practical knowledge, as may have happened with the Ik in Africa or the Polynesians on the Pacific island of Rapa Nui (Easter Island)? Did the loss of city-sponsored art and music precede the collapse of the Southern Mayans? How is diplomacy or patriotism related to music? We need to have knowledge of these interactions, which we can acquire by expanding studies of and experiences with music.

If music can be harnessed to reinforce ideas about ecology using its memorable qualities, then the process could and probably should go far beyond the text and incorporate emotionally-charged melody, harmony and rhythm that is artistically significant, regardless of the musical style and culture that is chosen as the vehicle. The music can be humorous, epic, solemn, sparse, or be described with many other adjectives, but it must have integrity. This is the best way to create a lasting personal and group meaning that is positive instead of inconsequential or even negative. All the participants, makers or listeners, would be pulled to *think* and *feel*. Then, they will be motivated to solve the challenges and problems of our complex civilization with zeal and commitment.

5.6.2. *Connections*

(Being edited)

Paths create connections. Human life is linked in an intricate web of connections. There are always unintended consequences. Humans have the ability to recognize or make connections, although often we do not pay sufficient attention to them. Analytic science and the compartmentalization of scientific fields has exposed the complex connections of the subjects. Philosophy has to be positive and constructive, to ask the questions that highlight patterns and rules for living, to contribute to healthier images and myths, to rethink the terms of debates, for instance, of tree farms versus wilderness, so that as many connections as possible are made visible and meaningful, and to provide good metaphors. Ecological metaphors, such as gardening or tending a forest, are more fruitful than images of machines or war.

Cultures and ecosystems can have too many connections. Overconnection functions like a trap. The process occurs too close to limit and it cannot expand away. In an ecosystem, individuals and species are connected to some degree, in terms of quality and quantity of connections. The connectivity of a component of a system is a measure of the number of direct connections between it and the rest of the system. Connectance is a percentage of the number of connections through predation or exploitation as a percentage of the total number of possible interconnections. A system is more connected if the absolute number increases and the percentage, and the strength, increases.

Agricultural fields are good examples of overconnectedness. This is even more true with corn than with wheat due to the changes from domestication. Overconnection causes greater lag times. But, in a city, feed bins damp food variations so the lag is less important. By being overconnected a system can lose stability. Overconnectedness creates a lag in signals. This can lead to system collapse.

Underconnection can also create instability. Parts go their own way and there is no communication between them. If a system is underconnected, it may become unstable or lose resilience, because there is no pathway to allow a signal between significant parts.

5.6.3. *Living Synergy*

(Being edited)

In a network with a number of nodes, links increase faster than the number of nodes. As networks expand, potential synergy expands. Introducing new tools, such as a stirrup for horses, results in other changes, such as changes in warfare and trade. And, we conclude that in larger communities, technological advance expands. Not only does that expand but the rate of new knowledge accelerates.

Metaphors create synergy, which is an emergent effect of any system. Metaphors extend the network of possibilities in thought. They extend thought into the external world. An open historical order creates emergence and surprise, in fact synergy.

5.7. *Local Problems: Ecosystem & Cultural Collapse*

Ecosystems and cultures share many properties, perhaps since cultures emerged from being in place in ecosystems or perhaps because they are both complex systems. They also share stages of development, which always end in collapse.

5.7.1. *Collapse*

Collapse is the rapid, significant loss of an established level of complexity after some catastrophic event. By this definition, ecosystems can collapse during climate changes, and cultures can collapse after social or environmental changes. For an ecosystem, collapse can mean less complex food webs, fewer species and decreased diversity. Ecosystem collapse is a regular process, often precipitated by environmental change. For a culture, collapse can entail the loss of centralized control and regulation by elites, decreased flow of information between center and periphery, less trading and redistribution of resources, losses of complexity in organization and stratification, drops in economic specialization, and reduced investment in the complex physical structures. Many cultures have collapsed and disappeared, often without being remembered or documented. The known collapses range from the Old Kingdom of Egypt (2181 BCE) and the Harappan in the Indus Valley (1750 BCE) to Rome (476 CE) and the Khmer in Cambodia (1431 CE). Recent collapses include the Kachin of Burma (1950 CE) and the Ik in Uganda (1970 CE).

5.7.1.1. Kinds of Ecosystem Collapse

An ecosystem can mature through a series of stages, described as succession, to old-age and dissolution. Pierre Dansereau delineated four general stages of succession (modified here): pioneer, consolidation, mature (Dansereau's subclimax), and closed (Dansereau's climax). A fifth unmentioned stage is collapse, where the system reacts to a disturbance by dropping to an earlier stage or by completely collapsing. Eugene Odum characterized the pioneer stage as having a linear food chain. A typical pioneer stage might have lichens, mosses, and annuals. The consolidation phase may have perennial forbs, grasses, mixed herbaceous plants, shrubs, and a few shade-intolerant trees. The mature stage might have shade-tolerant trees. The closed stage would have emergent trees and a mixture of plants and animals that resist exotic species, in effect closing the system to further colonization or invasion. In the mature and closed stages, complex food webs are dominated by decomposers. For animals, body sizes increase and life-cycles and strategies become more complex. At this stage, the system has learned the cycles of the environment. Throughout this process of maturity, according to R. Margalef, there are changes in productivity, efficiency and nutrient cycles. Diversity increases and trophic structure becomes more complex, with added numbers of consumers and decomposers, and more specialized niches. During a collapse the networks and webs fall apart, the system can drop to any earlier stage, and individuals and species disappear or disperse to another system.

Catastrophes (used in the mathematical sense meaning a down-turning), such as storms, fires, glaciers, and clearcuts, can set back stages of succession or change its direction. Stages do not necessarily begin in order or progress uniformly; they can begin anywhere and overlap. Nor are they exclusive, as life forms in one can occur in another, for instance, when lichens appear in all stages in a coniferous forest.

A mature ecosystem can collapse when internal overconnections between species make it fragile or incapable of being flexible enough to respond to environmental change, either large changes or new patterns. Climate change, especially drought, long or short-term, has caused the collapse of many natural ecosystems. For instance, the change in temperatures and moisture patterns at the end of the last ice age replaced many forests with grasslands, and many species could not adjust to the change and were extinguished.

5.7.1.1.1. Local Ecosystem Collapse: Mt. St. Helens

During the eruption of Mt. St. Helens in Western Washington State in May 1980, thousands of animals (at least 5000 deer and 1500 elk) and millions of fish (probably 12 million Chinook and Coho salmon) were killed; over a hundred square kilometers of forests were destroyed by a super-heated wall of gas and ash. In the direct blast zone, everything was obliterated. In an intermediate zone the blast was channeled by the hills, and trees were flattened. In the outer zone, the trees were seared and killed, but left standing. Mudslides flowed down creeks and rivers. The landscape was described as 'scorched and lifeless.' Although natural disturbances, such as fire and drought, drive the direction of many forest ecosystems, this large-scale disturbance destroyed many systems, sterilizing a plain north of the crater and leaving a 'forest' of dead snags to the east.

Ecosystem recovery started within months after the eruption, in different stages at different rates. Communities of plants and animals under the remaining snowpack were little affected. Many burrowing animals and insects survived in the intermediate and outer zones, as did numbers of ground dwelling insects and spiders. The rate of recovery depended on proximity to remaining original forest, that is, the biological legacy. Areas close to surviving forests experienced faster recovery. In the blast zone pumice plain, as seeds blew in, willow and alder shrubs have rooted and other tree species are evident. Along the blast zone, seeds have created an alder forest with some conifers. Birds and mammals have returned to many areas, followed by their predators, although the species mixes are unusual. Along some streams, coniferous forests have been replaced by a deciduous woodland, with alder, cottonwood, and willows, inhabited by neotropical migrant bird species. Other coniferous ecosystems are reestablishing themselves. Salvage crews took out over a billion board feet of downed trees and planted stands of Douglas-fir, which should also be subject to succession.

5.7.1.1.2. Regional & Local Ecosystem Collapse: Mesopotamia

By the end of the last ice age, the storm tracks had shifted north from Africa to Mesopotamia, and brought moist air masses. The ecosystems switched from being boreal to being temperate. Grasslands and deciduous woodlands expanded.

Around 8200 BP, there was a sudden cooling that may have been caused by the collapse of Lake Agassiz, which had formed over 4000 years of melting, after the ice wall collapsed and the lake suddenly discharged through Hudson's Bay or the St. Lawrence Seaway (and may have changed the salinity of the north Atlantic and caused the thermohaline circulation to alter or shut down). Temperatures and snow accumulation dropped dramatically. It affected North America, Greenland, and Europe, as well as western Asia. The regional climate adjusted, and things became colder, drier, and windier. Lakes in Africa dried up, including a large one in the Sahara, which never reformed. In western Asia and Mesopotamia, ecosystems dried up and were replaced by desert ecosystems on desert soils. Some systems in Turkey and the Zagros mountains survived.

There were subsequent coolings in 5200 BP and 4200 BP. The first event caused a drought that coincided with cultural collapses in southern Mesopotamia along the Euphrates and Tigris rivers. Although irrigation canals brought water to fields, a weakened river flow would have reduced irrigation and yields, so people may have had to switch to drier crops or abandon the effort entirely. Settlements in the interior of Arabia were abandoned around this time. In the second event, the westerly winds bringing moisture to the Mediterranean and Mesopotamia failed. Precipitation fell 30 percent. Hot winds contributed to drought. Some of the cities, such as Tell Leilan, were deserted; many villages were abandoned. Between 4200 and 4100 BP, Mohenjo-Daro and Harappa, around the Indus River, declined suddenly.

5.7.1.1.3. Discussion

If a catastrophic event is total but localized, plants and animals can recolonize the ecosystem. If it is total and regional, ecosystems may disappear. If it is partial and regional, many ecosystems can recover over ecological time. Certainly the subtropical ecosystems on the northern Yucatan peninsula disappeared immediately at impact, which not only changed the rock substrate, but also dramatically altered the soils and topography.

5.7.1.2. Kinds of Cultural Collapse

Cultures seem to mirror human growth, development and aging. A fragile or old culture may collapse at the end of its cycle. The stages of a culture could be described as: Origin or Renewal, growth, maturity, collapse, and dispersal; this might be a rough parallel to the stages of an ecosystem: pioneer, consolidation, maturity, closure, and collapse. After closure, the ecosystem either collapses or is bumped to a lower stage by some disturbance or interference. Lance Gunderson and C.S. Holling, in their book *Panarchy* (2002) present a stylized representation of ecosystem functions—exploitation, conservation, release, and reorganization—that they use also as a four-phase heuristic model of institutional dynamics and other applications. This representation will be related in a different section.

Joseph Tainter uses several models to describe cultures: In the Runaway train model, a culture is impelled on a certain path without the ability to change directions; although it is dynamic, its course is fixed, as when the Aztec continued to ensure the rising of the sun with sacrificial blood. The House-of-cards model stresses that a culture is inherently fragile, with little ability to respond to stress; perhaps the dramatic decline of Rapa Nui is an example. The Dinosaur model suggests that a culture is a lumbering colossus with a big investment in one environment, but too static and maladaptive to adapt to any change. One might suggest other models that still might result in collapse. The Fungus model presents culture as an adaptive, problem-solving, intensive social structure that, although it can respond to many environmental challenges, can still fall apart with scale or be overwhelmed by large events.

Cultural collapse can entail any set of many factors. The rapid loss of an established level of sociocultural complexity may be first expressed as a breakdown of central authority. Provincial provinces or villages may break away. Revenues to government may decline. There may be foreign challenges over territory or resources. The upper hierarchy may start to claim resources for themselves. Ordinary people may become disaffected. The military may be ineffective. Continued central direction may not possible. The center may lose power. Distribution of goods may suffer. Trade may decline. The city center may be ransacked and abandoned. Small states may start to emerge in the same territory. People may lose the protection of the law. Public art and monument construction may cease. Literacy may be lost. The small remaining urban populations may reuse the architecture and subdivide rooms. Palaces, government buildings, churches, and storage facilities may be abandoned. Technology may revert to simpler forms. There may be a great reduction in population size and density. Peripheral ecosystems and animals may recover, although not always.

Generally four concepts leading to collapse can be identified (J. Tainter 1989 and J. Diamond 2003): Cultural systems need energy to be maintained; increased social complexity results in increased costs per person; the investment in complexity reaches a point of diminishing returns; and, the cultural system fails to react to very large, slow or invisible catastrophes. Of course the culture could respond to those challenges. At some point, all energy income is used for maintenance and none is left for other problems, such as starvation of classes of people. Cultures often know how to deal with resource uncertainties, but do not know how to reduce populations to reduce pressures on scarce resources (although they allow disease and war to lower populations for a time). Cultures also seem to know how to deal with regular catastrophes, but do not seem to know how to minimize them or avoid them; catastrophic fires or floods could be minimized by relocating buildings or replanting native trees—perhaps the people grew tired of the increased costs. Cultures also seem to know how to provide and control labor, but they cannot reduce management levels (and this applies to royal classes as well).

Table 5712-2. Internal Kinds of Cultural Collapse

Social dysfunction	Class conflict	Militarism, over-taxation, degradation	Mayan lowland
	Peasant revolt		Huari, Peru
	Group Conflict	Agricultural collapse deforestation	Rapa Nui
Economic inefficiency	By-passed by trade routes. Agrarian system unproductive	Spanish gold ruined economy. Expansion of government/ army	Ottoman 1500s
	Increase scale for control	No support for surplus population. Contrast rulers	Chinese dynasties
Political dysfunction	Loss of provinces	Increased taxation	Babylon
	Roman Withdrawal	Regional tribalism	England 411
	Maladaptive ideology		Aztecs Rapa Nui
	No inheritance from old rulers	Continued conquest to enrich new ruler	Inca
	Bad management	Lack of economic development	Spain 1700s
	High taxation		Netherlands 1700s

Collapse can occur as a result of other reasons or combinations of circumstances, from invasion to social dysfunction. Such reasons include: Resource depletion, establishing new resources, catastrophe, insufficient response to environment or change, intruders, conflict mismanagement by class, social dysfunction, religious or mystical factors, chance series of events, and economic failure. An example of social dysfunction is class conflict. In the Mayan lowlands, class conflict was complicated by militarism, overtaxation, and land degradation. These contributing factors may have been solved, except that three long droughts weakened the Mayan cities further until they collapsed. Group conflict, deforestation, isolation, and population increase contributed to the collapse of Rapa Nui.

Economic inefficiency was a contributing factor to the collapse of the Ottoman Empire, which had to support an expanding population and an expanding government and military. Their agrarian system was unproductive, the influx of Spanish gold hurt the economy, and the economy was also by-passed by new oceanic trade routes.

Bad luck was a critical factor in the fall of Rome. Weak emperors and their mismanagement of the Huns and Visigoths contributed. Other, mystical factors may have been important; perhaps the final challenge was a loss of virtue or a spiritual or physical exhaustion. Other cultures also have been ruined by bad luck or chance events. Byzantium was unsuccessful in its competition with Venice for sea-lanes and trading, and they also suffered the loss of many agricultural lands. More recently, the Ik people of Africa lost their territory after European conquest and had to switch to farming, which they did not like.

Political dysfunction was a major factor in the collapse of Babylon; the loss of provinces and high taxation made things worse. Political dysfunction was also contributing factor to the collapse the Inca and the Aztecs, who also had a very maladaptive cosmology (the constant thirst of the sun for blood; see Table 5712-2).

5.7.1.2.1. Local: City Taxes and Collapse in Mesopotamia

City-states on the Tigris and Euphrates flourished around 2800 BCE. Irrigation systems and arts developed. The Akkadian empire formed. Two hundred years later, the city-states rebelled and became independent again. Shortly afterwards, the Third Dynasty of Ur set up a larger bureaucracy to collect taxes and tribute. They rapidly expanded the irrigation system, settlements and the population. This led to a more rapid and more complete collapse. In the following hundreds of years there was a 40 percent reduction in settlements and a 77 percent reduction in area. Political power shifted north to Babylon and Hammurabi. But that empire only lasted 80 years to the death of Samsuiluna in 1712 BCE. Succeeding kings ruled smaller realms. The last resurgence of Babylon was ended by Cyrus the Great. Mesopotamia was incorporated into successive empires. Under these empires, agriculture and city-building was expanded. Then after the 7th century CE the river systems changed courses and alluvial deposits. By 1100 CE the total area was only 6 percent of what it was 500 years earlier. Population was at its lowest point. Tax revenue was down 90 percent. People rebelled. The only remaining irrigation weirs were in the vicinity of Baghdad. The region was claimed by nomads until modern times.

5.7.1.2.2. Regional & Local Collapse: Diseases in North & South America

When European people started to explore and colonize North and South America, they came in contact with large native populations, many of which welcomed and helped them. Almost immediately, native people started dying. Entire villages and tribes were wiped out. Survivors often moved in with neighboring tribes, mixing belongings and cultures. Epidemics spread from tribe to tribe, often well in advance of the Europeans themselves. European explorers commented on how empty the land was. Some disease-devastated or abandoned villages were overgrown by vegetation; a few were noticed by the explorers. The pre-Columbian native populations were reduced to 5-10 percent of their original levels by the epidemics. In North America the original population may have been 10 million; in Central America, over 17 million; and, in South America 25 million—even these estimates are being revised by research.

Insects, diseases, and animals, more than being simply agents of mortality, are native components of complex food webs in ecosystems, and they contribute to the selection of species. The domestication of animals from Mesopotamia to Asia and Europe exposed people to animal diseases, which transferred to the human populations. Epidemic diseases originated in domesticated animals. Measles, smallpox and tuberculosis came to humans from cattle, flu came from pigs and ducks, and whooping cough came from pigs and dogs.

In North and South America, only the dog and lama were domesticated, with less disease transfer. American peoples did not have epidemic diseases or immunities because they did not have the domesticated animals that gave rise to the diseases. Europeans, however, were exposed to syphilis for the first time.

Disease was even more important than horses or guns in the European subjugation of the Americas, according to Jared Diamond. Disease not only reduced the numbers of native peoples, but it wrecked havoc on their cultures, so that the enormous competitive advantages enjoyed by societies with horses and guns were more effective when they were used. Diamond recounts how Spanish conquistador Francisco Pizarro used 62 horsemen and 106 foot-soldiers to destroy thousands of Inca soldiers on one day, November 16th, in 1532. In hours, Pizarro's small band captured the Inca emperor Atahualpa, leader of South America's largest and most advanced state, by panicking the emperor's 80,000 guards.

5.7.1.2.3. Discussion of Cultural Collapse

In the Sahel and Mesopotamia, the argument was that overgrazing and human population caused the droughts. Exposed soil contributed to a changed albedo and hot air, which did not permit rain-forming clouds. Recent research indicates that, for the Sahel, a single variable made most of the difference—rising sea surface temperatures of the Indian Ocean, from greenhouse gases, was responsible for most rainfall decline. Despite the fact that we often focus on political and behavior causes, environmental changes are critical factors.

5.7.1.3. Coterminal Ecosystem & Culture Collapse

Cultures and ecosystems produce co-effects on each other. In some areas, such as Mesopotamia and Central America, the synchronization of plants used for crops can increase conflicts over food. The simplification of complex ecosystems for agriculture usually causes the collapse of the native system. Overuse of a wild ecosystem can cause it to collapse. Even targeted removal of keystone species can cause the system to collapse into a simpler system. English forests, for instance, changed after large predators, such as wolves and lions, were eliminated; deer and goats reduced the germination of trees, so grass or scrub lands expanded.

Table 5713-1. Kinds of Environment-driven Collapse

Reason	*Main factor*	*Related factors*	*Examples*
Catastrophe	Maize mosaic virus	Overpopulation Droughts, lack of flexibility	Maya lowlands
	Earthquakes, plagues		Teotihuacan
	Eruption of Thera	Competition with Mycenaea	Minoan Crete
	Malaria	Lead poisoning, exhaustion, political corruption	Roman state
	Climate change, drought	Salinization	Hohokam
	Climate change	Agriculture-base	Hopewell
	Nile flood failure	Destruction, elite rule, over-taxation, parasites	Egypt
	Flooding	Collapse of trade	Harappan, Indus
	Climate, drought	Famine, migration	Mycenaean
	Climate change	Agricultural collapse, erosion, Deforestation, invasion	Roman

5.7.1.3.1. Local: Maya

The Lowland Maya formed around 1100 BCE. By 200 BCE, massive public architecture was rising. Temples and palaces were built. Vast public works, such as aqueducts, were undertaken. The arts flourished. The entire landscape was modified for planting. The zenith of organization and population occurred between 700 and 900 AD. Perhaps 75 percent of the region had been cleared for agriculture at that time. The Maya had a high density, stressed population, with intensive agriculture, complex hydraulic systems, in large centers, with an elite class, calendars and rituals. Population growth triggered competition and conflict, which lead to positive feedback that caused more stress on populations, which led to disease and stress on the surrounding ecosystems.

Drought was a major consideration for the Mayans, who had built so far from water. Maybe the southern centers were sited for water. Much of the culture was devoted to collecting and distributing water. The water lily had iconographic significance because it was indicated good water quality. Between 810 and 910, Mayans had three droughts of three, six, and nine years, in 810, 860, and 910. They entered the drought with a maximum population and limited flexibility.

People suffered from the stress. Analysis of skeletons shows that in the Late Classic they became more fragile. Although people became 7 centimeters taller by the Early Classic, by the Late Classic the stature of men had declined markedly; they also exhibited degenerative bone conditions, bad teeth, scurvy and other pathologies. There was a collapse and depopulation, from 3,000,000 to 450,000, which never completely recovered. The current population is 1,250,000.

Collapse probably improved things for the Mayan peasants, without the burden of rulers, elite, priests, and artists. In the long run, however, even the peasants were decimated, perhaps due to environmental deterioration, stress, and in-fighting. By the time of the Spanish, the area seemed to be unbroken forest. The Spanish introduced malaria and hookworm, which made the forest worse to live in. In some cases, such as Maya, environmental degradation did play a role in collapse of the civilization, either as a contributing cause or effect. Complex societies put harsher demands on local environments when political regimes set production demands too high.

5.7.1.3.2. Regional & Local Collapse: Mediterranean

In the Minoan civilization of Crete, the earliest palaces were built after 2000 BCE. Although they were regularly ruined or destroyed by earthquakes, each was rebuilt more splendidly, with a sophisticated knowledge of architecture, engineering, hydraulics, and drainage. The Palace of Knossos was more luxurious than anything in Egypt, especially with water-flushing latrines.

The palaces were administrative and trade centers, but also warehouses. Knossos for instance had the capacity to hold 240,000 gallons of olive oil. There were craft production rooms for potters, weavers, and metal workers. Written records show how goods were directed to the palaces and redistributed from there. Scenes on widespread frescoes on the walls were generally peaceful. The palaces were not fortified.

In 1500 BCE, a powerful earthquake precipitated major destruction and widespread changes. Knossos started to dominate the other palaces. The Mycenaean Greeks competed with Crete for sea trade. They introduced new kinds of warfare, with new weapons and horses. About 1380 BCE the palaces were all destroyed, and the civilization collapsed. Parts of Knossos were rebuilt and a reduced administration carried on for a while but even that ended by 1200 BCE. The early script Linear A was replaced with Linear B, which was Greek.

The Mycenaean Greeks themselves inhabited a hilly topography with good forests, rugged semi-arid regions with small alluvial valleys. Villages dependent on domesticated plants and animals appeared about 6000 BCE. The core of Greek subsistence was small scale farming. Agrarian success led to increased soil erosion. This civilization began to develop around 1650 BC. It reached its height about 1400, around the Minoan collapse. Central and southern Greece was divided into independent city-states. Mycenae seemed to be the most powerful. It had 16 administrative districts, each controlled by a governor. Each was an economic center for distributing goods and foods. Aqueducts were built to carry water and roads to carry people and goods. The cities had massive walls with major structures. Palaces had frescoes and bathrooms. Under supervision of palace authorities artisans cut gems, worked metals, and threw pots.

After 1200 BCE, palace after palace was destroyed. The artisans seem to have vanished. Writing disappeared, and art became much simpler. Cities became more fortified and dug into their rock bases for water. The number of settlements dropped from 320 to 40. Athens survived but suffered a political collapse. Overall population declined from 75-90 percent. Some people migrated to the southwest Peloponnesus. Elsewhere, around the same time, after 1200 BCE, the Hittites in Anatolia, and the Vera basin people in the southeast Iberian peninsula collapsed—deforestation of uplands, and a shift to barley monocropping, were made worse by the desiccation and many Vera basin villages were abandoned. Egypt experienced troubles. There were also local collapses in the western Pacific, for instance Kangaroo island off Australia.

A shift in westerly winds brought long droughts to the entire eastern Mediterranean. Some hypothesize that this abrupt climate change may be related to a supernova, bolide activity, comet or asteroid impact, volcanic activity, El Nino event, or earthquakes. Cities were not able to survive on reduced crops. Populations dropped; people returned to herding or foraging when possible.

5.7.2. *Discussion of Collapse*

Combined cultural-ecological collapses are probably the most common kind of collapse. That is, every cultural collapse seems to have an ecological component, and every recent ecological collapse seems to have a cultural component. This should not be surprising, as people are embedded in ecosystems and tend to use them and transform them. Combined with the human propensity to multiply to fill in every niche, the sum of human activities puts strong pressures on ecosystems.

There seem to be two basic problems in living in ecosystems: Perceptual and managerial. Often, we do not perceive the system in its complexity. We depend on initial observations and ignore a wealth of details. We tend to make general responses to complex, detailed challenges. We may make general models of the environment for thinking about it. We also tend to transfer generalities from one ecosystem to another, without being attentive to critical differences. Assumptions by immigrants on entering new ecological zones shape their perception. The earliest aborigines must have though the herds of diprotodons stretched forever. The first Americans may have thought mammoths were numberless. The Maori may have thought the moa were limitless. Hunting would have been easy and successful. Deception is also a problem. Europeans thought that America and Australia were *terra nullus*, empty lands, or under-utilized ones. Deception can turn to disillusion as resources disappear.

Managerial problems can arise from difficulties with communications and assignment for responsibilities. With more than one level of management, the response to a challenge might be delayed or entirely inappropriate. Furthermore, with each level of management, there is a degree of detachment from the participant. These two problems can lead to poor recognition of challenges and to poor, untimely responses.

Of course, our perception of challenges is improving with advancing science and increased communications. Climate change is only one of the challenges to ecosystem or cultural health. Other threats can be summarized briefly as global or local problems. The local problems include such things as the removal of key elements, the addition of novel elements, and the losses of species and habitats. The global problems include such global things as global warming, ozone depletion, wide-spread contamination, and the disruption of global cycles. Any one of these threats, or some combination, can cause ecosystem collapse. Ecosystem breakdown happens as a result of stresses, singly or grouped, that relate to interference patterns in the system, most of which are caused by the human species now, although the potential for asteroids, volcanic eruptions or prolonged droughts remains.

Collapse is often part of physical, biological and cultural cycles. Collapse can happen when a culture is too static in a changing environment. It can happen a culture selects growth to try to overcome certain environmental obstacles. Sometimes the collapse is thought to be the result of internal moral or technological failings, as well as conquest or some other external influence. Cultures are adaptive systems that have to integrate a number of challenges, opportunities and pressures, from drought to invasion, and then reconcile them to changing economic and political situations. Collapse can happen by bad luck, chance that is, or just a coincidence of bad leadership, bad images, cultural problems, external social pressures, and environmental degradation.

5.7.3. *Patterns of Collapse: Recovery & Renewal*

There are many ranges of collapse. In some cases, the population collapses, but there is not much loss of cultural complexity. Ireland, for instance, lost half of its population, during and after the potato famine, because of its reliance on that one crop; due to English rule, the government continued. The population stabilized at a new lower level, under three million. After 1960, with the development of industry and then membership in the European Union, the population has been increasing to six million (still less than the eight million in the 1800s).

In other cases, there has been a tremendous population loss, along with a political crash and complete loss of organization. The Maya collapse eventually led to the complete abandonment of the cities and the urban way of life. The population dropped dramatically. Some parts of a culture may collapse, such as the Southern lowland Maya, while the Northern upland culture continued to survive for several generations before collapsing. As part of a cycle, after people disperse to return to older styles of living, the local ecosystems can regenerate, without the pressure of use or overuse, and recover.

In still other cases, local city states may collapse for a generation or two, and then be rebuilt in place, as the local ecosystems have experienced some level of renewal, perhaps at a lower level of complexity themselves, where the forests and woodlands may be gone, but the grasslands have recovered. Mesopotamia civilizations recovered numerous times, as new states were able to benefit from the natural process of desalinization of soils after the hundred years of rest for the soils.

Of course, some of culture may survive and be used by new or other cultures. The ideas produced by a culture may spread and reproduce. The culture of ideas continues through people leaping to other places. Lower levels may survive with many of the ideas of the larger complex. So, the Roman Empire collapsed but not parts of Italy or France. The Germans were able to return to chiefdoms.

5.7.4. Potential Collapse

Elman Service uses a biological analogy, where social organizations are modeled as plant or animal species that are initially successful because they are adapted to niche, but later become overadapted and less flexible. In this model collapse is part of an unalterable natural cycle. Adaptation denotes a systemic homeorhesis in which a range of variability is activated in response to various environmental and social perturbations. Service believed that complex systems were profoundly maladaptive since their responses to stress became less flexible.

This argument does not consider weed species or the maturity of the system. In a systems model, collapse is part of stochastic process, which implies that civilizations will die, but not necessarily within a definite time frame or for specific reasons, such as overconnection. Perhaps one reason for cultural collapse is due to overconnections, between trading groups and social classes. This could be a problem with modern globalization, in the 1990s, as well as with simpler regional connections, such as in the 1300s in Asia and Europe. In the general system model, complex systems are hierarchically composed of many stable lower and intermediate orders, strongly connected horizontally, but less so vertically. The problem may be more one of scale than complexity.

Human cultures tend to fill all available space, carrying capacity space, even though some of the spaces are occupied by other species or other cultures. This makes them prone to crash after sudden changes. They have adapted to marginal environments with behavior and technology, such as that for water storage and grain storage, to buffer themselves against the known changes of the environment, but when an unknown change happens, such as a nine-year drought, they fall apart. Few people have the luxury of moving to an open area.

Global climate change has been established by many scientists as a real threat to the public health and safety of cultures. Examination of Paleolithic records establishes that climate, far from being benign and uneventful, has been dramatically unstable for local or regional patterns. Droughts can start abruptly and continue for tens or hundreds of years, far beyond the ability of the adaptations to them, such as urban living, to cope; agriculture is disrupted and the technological innovations, such as immense grain storage buildings, cannot continue for the duration or amplitude of change.

Now, global warming is related to human activities. Human contributions of carbon dioxide, methane, and water vapor contribute to a much faster temperature rise. Natural factors, such as the eruption of Mt. Pinatubo, may temporarily mask the effect of global warming, as may technological factors, like jet contrails. Still, if the trend continues, global atmospheric temperature increase could develop deserts where croplands exist, dramatic sea-level changes would flood low-lying areas, and shifting rainfall patterns would affect crops and fisheries. Global warming could lead to reversal of ocean currents, unpredictable redistribution of rainfall, and other unpleasant, chaotic, deadly effects.

Any one strategy, such as reducing the human populations—without making changes in distribution, flexibility, ecosystem health, complexity a many other factors—might not let us avoid collapse, but merely postpone it. Reducing the population would relieve stress of ecosystems and reduce the destruction of species and systems. But, if we continued growing economically and connecting tightly globally, then the catastrophe of a single key resource, such as cheap oil, could set off cascading pulses of contraction and collapse. Developing and relying on relatively limitless resources, such as solar power, would reduce pollutions and the energy disruption of systems. But if we keep enforcing historical inequities while relying on a lifeboat approach to saving civilization, that could set off havoc and warfare that would lead to collapse. Reducing and refitting our massive appropriation of ecosystem productivities and services would allow those systems to recover and diversify again. But, if we continue to rely on externalities for free services, without restoring and setting side a majority of the planet for wild systems, the support system may break down and trigger ecological collapses. By becoming less complex and connected, by deciding on a satisfactory level of sophisticated culture, we might have the flexibility to recover from a collapse if we could not avoid it.

Lewis Mumford noted that each civilization began with a living urban core, but ended in a common graveyard of bones and broken pottery. Every complex culture so far has failed, although some like the Romans or Chinese, were able to renew and rebuild subsequent cultures. Collapse has been history, but it is not necessarily fate. Cultures do not choose to collapse, despite what Jared Diamond says; they choose to continue successful behavior in inappropriate circumstances, in spite of the unsustainable costs—the Greeks called this the operation of tragedy. We believe that we can avoid collapse by growing and expanding, even to the point of stealing and destroying natural capital—that just postpones the inevitable.

We can learn to understand the interdependency and scales of nature. We can change our strategies by reducing our size and impact, by decomplexifying our societies and governments. We can accept that our labors will be more intensive and that our luxuries will be smaller. We can balance our global push with a greater isolation and insulation, with self-reliance and self-control.

Because people live in groups having unique cultures, they react differentially to diseases and stresses, even war. In crisis, people tend to pull back to smaller groups. Smaller populations can adapt faster to smaller resources. This was an appropriate response to local catastrophes, but it may not be the best way to deal with global ecological threats or coterminal collapses. Dispersal to other healthier ecosystems is no longer an option for most cultures. The problem is scale and it has to be addressed on a larger scale.

Science can create models that can be used to anticipate future changes—not exactly or definitely, but in terms of probability and eventuality. Models of climate change can map climate change and perhaps even accommodate unexpected nonlinearities. And, models can provide the information to design strategies to give cultures more flexibility in responding to change and challenges. With international cooperation, the risks can be shared and vulnerable cultures can be helped with minimal disruptions.

Figure 450-1 Wild lupine, foxtail & bachelor buttons in west nursery at Altazor 2000

5.8. *Local Problems: Culture & Bad Images*

No culture has developed a perfect balance of human and situational needs. Some do better than others, but all cultures change and age. As a culture ages, it may become abstract, indifferent, self-centered, and forgetful, suffering rigid rituals and cultural amnesia. If the contradictions become too great and maladaptive, however, then the culture dies.

5.8.1. *Cultural Transformations*

Cultures emerge from groups of human beings living in places. The variables of the environment influence cultures in a number of ways. For instance, A high Net Community Productivity (NCP) can allow larger annual crops, or, a low number of sunny days can contribute to psychological depression. Cultures have been unique programs, using local materials and ingenuity, for satisfying basic human material and spiritual needs.

Cultures develop over time as the groups change and always seem to grow larger. Cultures are influenced by climate, resources, and of course by human ideas about their places and themselves. There may also be larger patterns in human culture. For instance, reproductive success and overshoot of resources may always occur in the development of a culture. The asymmetry of sex and violence, ecosystem conversion, and limited time horizons are also things that seem to develop.

How does this happen? Culture does not fit together into a perfectly integrated whole. A culture is a loose-fitting patchwork of ideas, relationships and things. In that sense it is parallel to species adaptation to an environment. There are discontinuities and contradictions. Humans can tolerate inconsistency and operate with contradictory beliefs. If the contradictions become too great and maladaptive, then the culture disappears.

According to most theories of cultural adaptation (or integration or evolution), resistance to change is normal as a cultural process. Groups like the pygmies have specialized to fit the requirements of the environment, successfully. This makes it difficult to adopt other cultural arrangements. (Thought experiment: If we found a way to live in the forest, using solar power and eating only farmed algae in small arcologies, would the pygmies adjust to that?)

On the other hand, resistance to change itself is an adaptive mechanism. According to Betty Meggers, it works as a successful "cultural isolating mechanism." Isolation remember is what allows a culture to develop in the first place. But, then does it force a culture to become stagnant?

Stability is a characteristic of cultures. We can even state it in Newtonian terms: A culture at rest tends to remain at rest. According to Harding (1960), when forced to act on changes, a culture will only accommodate those changes that preserve its fundamental character. Since cultures have been traditionally self-reliant, resistance is a positive act.

As place changes, a culture changes. As people change, under the influence of each other and other cultures, a culture changes. Culture does not fit together into a perfectly integrated whole; it is a loose-fitting patchwork of ideas, relationships and things. It is parallel to species adaptation to an environment. There are discontinuities and contradictions.

The mode of operation of nature consists of a rhythm of dissolution and reformation. Often the elements of a culture will simply be rearranged by a succeeding culture. A new culture can only be made from the heritage of the old. The International Workers of the World urged its members to make the new world in shell of old one (cf. genetic recombination) Our survival depends on the capacity to remake the image of the world from within, phoenix-like. The planet is wild beyond our imagining, and we need a wild image that can capture that wildness. The photograph, from the Moon, of the earth in space, became the symbol of change. The image contributed to the idea that the planet was an organism, that it could maintain itself in the environment of the solar system, and that it could balance its atmosphere with living communities.

5.8.1.1. Patterns & Renewal

Nature consists of moving patterns whose movement is essential to their being. As a rope makes the knot visible, so the body is a pattern made visible. The body is a movement that maintains a topologically stable pattern; it is a vortex but not the water. The thing, the pattern, is a cross section cut through the movement. The mind is an invisible knot that is capable of recognizing both visible and invisible patterns, that is to say, a rope is not always necessary for the demonstration of a knot. Culture is also this kind of pattern. Culture can be analyzed into smaller blocks; the pattern of the whole organization is reflected at every division in differences of organization on either side of boundary. The wholeness of the character of a culture is reflected at every level. Patterning relates symbolic meanings in the context of a cultural system as a whole. The patterns form another level of meaning that has to be addressed in understanding a culture.

There are patterns of interactions of cultures, which arise out of several possibilities: Indifference, trade, competition, cooperation, conquest, or respect. Some archaic cultures seemed to be limited to indifference, that is, they ignored one another, and to trade. Competition and conquest may have accelerated with the acquisition of territory for agriculture. Cooperation and respect seem to have occurred under some circumstances of trade or unification.

The mode of operation of nature consists of a rhythm of dissolution and reformation. Perhaps this process applies to cultures. Often the elements of a culture will simply be rearranged by a succeeding culture. A new culture can only be made from the heritage of the old. The International Workers of the World urged its members to make the new world in shell of old one (in a way similar to genetic recombination perhaps). Our survival depends on the capacity to remake the image of the world from within, phoenix-like.

5.8.1.2. Weaknesses of Culture

No culture has developed a perfect balance of human and situational needs. Some do better than others. But all cultures change and age. As a culture ages, it may become abstract, indifferent, self-centered, and forgetful, suffering rigid rituals and cultural amnesia. Even a culture that fits its adherents and place changes and may become unfit even as the adherents and place also change. Cultures seem to have no limitations of size or kind, although declining mental health may be indicative of some limit exceeded in industrial culture; a culture can grow beyond ecological limits.

5.8.1.2.1. Holding Arbitrary ideas

People sometimes construct their worlds from preconceived notions. Success in one area may become associated with a chance happening, an event that is repeated to continue the success. In this way a maladaptive image of nature can be built. The culture on Easter Island developed over a dozen centuries, but extinguished itself before contact with Europeans. The people devoted enormous amounts of energy and materials to building heroic statues; other spectacular public works projects included a road network and agricultural terraces. Their culture allowed them to exceed the carrying capacity of the island. Even converting almost all land to human use was not enough, and the population dropped from about 12 thousand to 111. Some primary traditions may work against the conservation of a place; for instance, the Algonquian notion that game animals spontaneously regenerate after death means that there is no reason not to over hunt. A powerful arbitrary idea, such as the Christian principle of plenitude, can influence many cultures over centuries. The principle states that an intelligent creator gave an earth of unlimited bounty to humanity for their use; this seemed to be confirmed in the Renaissance with the discovery of the richness of stars, microscopic life, and unexplored continents. Modern ideologies have even been shaped by the principle of endless wealth; the economist Adam Smith believed that the real price of anything was just the toil spent acquiring it. Many European cultures would have vanished if they had not been able to leave their exhausted fields for new lands.

5.8.1.2.2. Remaining Indifferent

Industrial cultures desacralize nature. Since the advent of the machine image, the concept of the sacred has been reversed. In the primary view, the familiar was sacred. When modern cultures made the familiar trivial, it became profane. The quality of sacredness was bestowed on the unknown, wilderness, or children. Modern cultures show reverence toward that which cannot be dominated. So, reverence for nature diminishes as control escalates. In industrial culture, all aspects of life become interchangeable artificial units, including soil, water, and land. This view impoverishes humans by claiming all consciousness for humanity. It claims that nature offers no joy, love, peace, or certitude. Emphasis on the emptiness of nature creates a gap between humans and their environment; there is no room for the intrinsic worth of nature. By granting human sovereignty over the entire earth, industrial culture justifies usurping the habitats of plants and animals for coffee plantations and recreational boating. Many different peoples have deforested their lands and poisoned their waters, regardless of their religious ideals as Buddhists, Taoists, Moslems, or Christians. Industrial cultures are indifferent to the limits of a natural carrying capacity. Cultures may also be indifferent to long-term catastrophes, such as species extinctions, or to short-term hazards, such as volcanic eruptions or flooding; people always resettle floodplains and volcanic lowlands.

5.8.1.2.3. Overexploiting Nature

All peoples want some power over the natural order. Primary peoples rely on ritual acts instead of machinery. As technology supplies power to primary peoples, rituals decline. Power increases exploitation and interference. Exploitation can become pathological, when it interferes with the natural processes that maintain an ecosystem. The intrinsic worth of beings can become supplanted by monetary value. For example, some North American Indians were seduced into the fur trade by the lure of manufactured materials. The spread of power has two other effects. The natural order becomes simplified, the human world becomes increasingly complex—and both orders become unstable. Human society acts from ignorance of the bonds of living and nonliving beings. Applying culture beyond a small scale gives rise to behaviors that are nonecological and unsustainable. Distinctions may not be made that could encourage survival in a long-term context. For example, modern cultures have not learned to distinguish between renewable and nonrenewable resources, or between the temporary and permanent carrying capacity of a habitat.

5.8.1.2.4. Being Incomplete

The very circumstance that makes each culture unique—being in a unique place—ensures that each culture is limited. All cultures produce destruction and waste, all of them produce at least some of the opposite of the good intended. A culture rarely meshes perfectly with the natural order or even its own social order. That a culture includes so many patterns and dimensions makes its fitness less. To the degree that it is effective, any ideology can fit the order of nature. But the total mix of ideologies makes the overall fit very sloppy. Cultures rarely have long-range plans; they do not concern themselves with global problems. They rarely consider any cultures other than their immediate neighbors; they do not have policies to help them. They are rarely conscious of their activities. Many cultures have little interest in gaining new knowledge on how to exploit their areas more effectively and efficiently. Many cultures have no way to cope with their own expansion or contraction.

5.8.1.2.5. Staying Inflexible

It was thought that cultures could vary infinitely and change rapidly. This is an exaggeration. Change is not always easy or adaptive. The inertia of cultural practices makes change painful. People may become fixed in permanent roles and personalities. Even if cultural attitudes are appropriate, they can trap a people if there are no longer functional reasons for the practices. The Nembi of Papua New Guinea may be trapped in their system; making stone axes is difficult when thousands of steel ones are available, although the ritual of making axes can bond people together. Cultures can determine inappropriate attitudes towards nature. The Ik had a string of misfortunes after their hunting ground was turned into a national park. The difficulty of farming and adverse social conditions made their situation worse. The Ik acquired an attitude as victims, characterized by a cluster of new beliefs, including: Nature as alien, unjust, violent, or vengeful; things being better in the past; humans beings are out of place. By contrast, the English treated tropical lands as enemies to be defeated, then enslaved them in plantations. Their cultural attitude as conqueror of nature led them to treat biogeochemical cycles and soil requirements as temporary obstacles in a world where everything had its price. This is the prevailing mode in institutions dealing with land use today: Nature is a beast to be tamed, controlled, and exploited. Despite proof of the importance of tropical forests and knowledge of their destruction, corporations still mine them for short-term profits.

5.8.1.2.6. Keeping Exclusive

When the largest social unit was the tribe or nation, it was possible for the local mythology to represent other people outside its bounds as inferior, and the local inflection of human mythology as the one true mythology. The young were trained to respond positively to tribal members, to love their home, and to project hatred outward. But, there is no outward.

5.8.1.2.7. Being Aggressive

Are humans innately aggressive, or does the nature of the culture of civilizations promote aggression? Cultures allow more aggression against people outside the home culture. The size of a local population increased the likelihood of its success. For cultures, size was important. More important cultures were larger and more aggressive. Aggression may be encourage to protect a culture trapped in low food outputs or scarce resources. Aggression would be important to protect a culture, but it can become a prime way of relating to other cultures, especially very different culture, or neighboring cultures that may hinder the expansion of the home culture. Cultures need not be limited to aggression. They can also divert aggression from violence and war into propaganda and art.

5.8.1.2.8. Ignoring the Limits of Culture
A culture will often develop without concern for limits of complexity or scale. How large or small can a culture be? How simple or complex? There are human cultural limits in numbers. For instance, a minimum might be genetic, at only 2000 people; but for ideomass, the minimum might be one million. A maximum, based on wilderness, might be ten million, or there might be a social maximum of forty million. Each limit must be worked out, depending on place and the structure of the culture, but they should not be ignored.

5.8.2. *Challenges & Traps*
Sometimes, rearrangement leads to a position of not being able to rearrange further. In many cases it is hard to tell if the destructive use of land preceded ecological problems or followed from efforts to maintain production after an ecological challenge. Cause and effect are hard to separate. The same environment that challenges a culture with some kind of change, also offers opportunities with the change. New resources can stimulate economic activity and increase the level of living.

Cycles that do not operate with the right kind of feedback function as traps. Thus, on an elemental level, phosphorus becomes trapped in an ocean sink, and can only be recycled by long geological processes or by specific harvests through human activity.

Karl Marx contended that humans live in cages, partly natural and partly of their own making. However, human actions can modify the situation. The word cage is a metaphor; it implies being trapped. It is however, a metaphor that can be expanded with a description of space as a four-dimensional box. Perhaps the trap is a better metaphor, since we depend on nature and society as a foundation for life.

Traps function in different ways. The use of resources by a people, where the replenishment rate is constant and the rate of use exceeds it, is a serial trap. This trap results in ecosystem degradation that is less reversible. The industrial age mistakes the rate of discovery for the rate of recovery.

Agriculture is an energy trap, because it allows a higher concentration of energy, that is, higher yields, but then it requires more energy be put into the system to maintain it. The system has to produce more energy than it uses to be sustainable, with a surplus for trade.

Sedentism is a trap. As the population of sedentary communities increased, the wildlife numbers decreased. The productivity and narrowness of food increased. Thus, there was less possibility of returning to the foraging lifestyle. People became committed to the new lifestyle. Intensity was no longer an option either; it had to be pursued. Habits were set. One problem of sedentism is that the individual cannot simply move away to avoid conflict. People are tied to a particular place and have to communicate to adjust to sharing places.

The city is a different kind of trap, that offers intensity and opportunity, but requires massive imports of supplies to survive. The size and scale of cities create the dual centers of attraction and despair.

The cultural trap is that: One cannot transcend culture unless one knows the hidden structure, axioms and unstated assumptions about how life is lived, viewed, analyzed or changed. Cultures are systematic wholes composed of dynamic interrelated wholes. They are more easily described from outside with comparison to another culture, although transmitting culture to youth and watching the culture collapse expose hidden structures.

Language and art are also traps. Language because one is limited by words. Art because one is limited by styles or demand. Even if cultural attitudes are appropriate, they can trap a people if there are no longer functional reasons for the practices. The Nembi of Papua New Guinea may be trapped in their system, making stone axes with difficulty when thousands of steel ones are available.

Global capitalism can lead to a consumption trap. Capitalism claims to serve the wants of the people, but it spends half its income creating more wants in people. Not many of those wants are real, or as real as cereal and roofs. Few of the soft services satisfy real psychological needs. Markets advance individual desires and not social goals, by offering running shoes, not inner city restoration. Instead of being free from economic want to develop their potential as creative human beings, people are trapped in a consumer cycle. Self-actualization is postponed for self-gratification. Furthermore, capitalism can undermine traditional cultures by offering consumerism in the place of guides for behavior. Social roles seem irrelevant by comparison, if the good life can be bought without effort.

Being in a trap means much-reduced flexibility and fewer choices. Climate can drown whatever is in the trap. That is, being in a trap makes one vulnerable to many other changes that could be avoided if you were not in a trap. When the weather got colder, then hunters and gatherers could move south. Cities could not. Civilizations are more fragile and more vulnerable to smaller climactic changes.

Addictions, such as those to foods or oil or money, make it difficult to escape from a trap, a trap being a kind of energy well or gravity well. Addictions can amplify some emotions, such as fear or hate, especially as they relate to the possible end of the addiction or the threat of that end. Addictions can justify illegal behavior, especially those that seem necessary to continue the addiction. Of course, many cultures are addicted to the illusion of control and power. The U.S. is trapped in the belief that only it, among nations, can bring prosperity and peace to other nations, with trade or violence. Eventually the trap is escaped, or more likely destroyed or collapses with its victims. Paul Shepard suggests that the entire Neolithic revolution has trapped us in behaviors that only end in madness. The feedback is inevitable.

Paul Shepard considered that the direction of our development led to madness. Now we have to ask, what happens after madness? Do we die? Do we change and get better? Do we stay the same and destroy everything. How would we act if we were mad? Better than consumers? Can we analyze our way out of the trap?

Table 582-1. Agriculture & Population Feedback Sequences

Direction	of	Progress	——>	——>	|||
Concentration	Intensification	Disease	Stress	Decline	Madness
Simplification	Instability	Famine	Drawdown	Destruction	Madness
Territory	Defense	Male dominance	Military	Take-over	Madness
Surplus	Specialization	Technology	Novelty	Stress	Madness
Distribution	Taxation	Inequality	Insecurity	Slavery	Madness
Human order	Abstraction	Isolation	Stress	Drift	Madness
Knowledge	Habit/tradition	Manipulation	Control	Laziness	Madness

The cultural trap: One cannot transcend culture unless one knows the hidden structure, axioms and unstated assumptions about how life is lived, viewed analyzed or changed. Cultures are systematic wholes composed of dynamic interrelated parts or wholes. They are more easily described from outside with comparison to another culture. Although transmitting culture to the young or watching the culture collapse can expose the hidden structures.

5.8.3. *Problems Facing Individual Cultures*

Problems of individual cultures include: Lack of Resources; environmental change; conflict and violent relations; environmental degradation; species habitat diversity loss; introduction of exotics species and artificial elements; cultural exhaustion; human limits; and human inequity. Many of these problems arise from other activities, such as: Competition; take-over; cooperation; trade; exchange; clash of images and metaphors; differing ethos or ethics; trends or gigatrends; and random changes or changes in luck. And these activities and problems can result in the problems of overshoot, reproductive success, ecosystem conversion, stupidity, violence, or stagnation.

In Mesopotamia by 3000 BCE, for instance, a stratified class society had developed. Slaves at the bottom. Peasant farmers, craftsmen, then the elites of administrators, religious and military. As problems developed, temporary military leaders became permanent hereditary kings. Palaces were built and staffs numbered thousands. But, the fields could not keep producing wheat and barley. Many of these problems like salinization are long-term problems and do not become evident for several generations. They are also very difficult to reverse. For a society than needs surpluses to continue, with growing dependents and growing people, there is little flexibility to change. The only way to avoid the problems was to let the land be fallow for long periods until the water table fell. This was impossible due to food demands. So, the land and the society collapsed.

Cultures fail for many reasons. Early cultures had little understanding of their impact on ecosystems. Mesopotamians silted their water supplies and salted their soils; the Greeks overcut and overgrazed the Mediterranean hills. Other cultures were not able to adjust to a qualitative change in size. The Mayan culture probably became too large to grow and distribute food. The Marajo Island culture probably collapsed due to population pressure. Some cultures, stagnant or senile like Rome, only avoided failure by expansion into new areas—for instance, the European expansion into Africa and America. Industrial culture, depending on its expanding market system, is becoming unstable—worse, it is attempting to become a global system at the same time. We know that cultures can destroy their ecological basis, but we do not know how to extend their existence. Often the elements of a culture will simply be rearranged by a succeeding culture into a new pattern.

Our cultural images, our worlds, do not have a close match to the organization and complexity of nature. Our image of the world has failed; our myths, from progress to science, are no longer effective in dealing with regional or local changes. There is no formal global culture. No global image has been formed.

A regional culture would have emergent problems far more complex than any one individual culture. It could be crippled by hyperadaptivity (success and overshoot), since humans can adapt to poverty, bad diets, crowding, stress, and other unhealthy practices. There might be homogeneity of forms, from a loss of diversity, which could make the global culture more fragile. A global culture might exhibit a lack of flexibility, which could lead to stagnation and collapse. Other possible problems of a global culture include: Hyperpersistence of error (stupidity or violence); lack of consciousness and planning (ecosystem destruction); the limits of capitalism, or any single system, as a global economic strategy; the acceleration of interactions beyond the human social or political ability to keep up with them; and, a breakdown of boundaries and limits, especially ones that control productivity.

5.9. *Designing Cultural Units Based on Primary Cultures*

Our dream of civilization, in modern industrial culture, is the dream of order and beauty. But, as Aldous Huxley notes, the dream of order begets growth and tyranny, and the dream of beauty ends in monsters and violence. Striving for the good life for many has left us with crowded roads and regimented jobs; trying to build beautiful cities has given us gigantic boxes and neighborhood violence. Trying to fulfill our dreams of comfort and security has provoked global threats and local nightmares.

There is a way to dream consciously so that the nightmares are diminished. The solution is to permit a political anarchy, based on traditional cultures, coordinated by a global 'regulating' body, based on the United Nations. There are 500 million indigenous peoples in 15 thousand distinct groups, such as the Uighur in China or the Kuna in Panama; and, there are over 2 billion people in hidden nations within massive political structures, such as the Azerbaijanis in the Soviet Union or the Tibetans in China. Furthermore, there are regions in some countries, such as the Pacific Northwest in the United States or Wales in Britain, that may prefer independence to forced membership in a confederation. Any indigenous people with a traditional culture could become an independent nation without fear of conquest or compromise by existing political states. The benefits would outnumber those of a global monoculture and the negative aspects would be more manageable.

5.9.1. *Begetting Problems & Erasing Cultures*

To ensure the success of our species, we have appropriated the places of other species. To extend our families, we have increased our numbers and our rate of increase exponentially. Our overpopulation has led to aggression against other cultures and species, then to indifference at their suffering. Even low levels of food and fulfillment can be maintained only through theft from other species, from future human generations, and through the degradation of billions of humans, as well as the ecosystems on which they depend.

To provide for the needs of many and the extravagant luxuries of some, we have produced waste and pollution on a geological scale, from islands of garbage to acid rain. Manufacturing processes result in the production of new dangers, such as recombined genes, and new substances, which are not easily incorporated into natural cycles. The overuse of ecosystems results in deforestation, devegetation, and desertification, then in depletion of raw materials and depletion of agricultural land. Economic and political pressures, derived ultimately from population pressures, force farmers to intensify their efforts to increase crop production, instigating a dismal cycle of population expansion, environmental deterioration, and poverty.

To provide efficiently, we have increased the scale of our activities. But we have decreased the diversity of habitats by filling in wetlands, felling forests, plowing grasslands, and irrigating deserts. Agribusiness has caused widespread landlessness; people who try to grow their own food are forced onto marginal lands. Acquiring fossil fuels also creates landlessness; coal mining in the Black Mesa mountains of the United States, for instance, may force the resettlement of 20 thousand Hopi and Navajo people. Without land, and the economic independence it allows, cultures are more likely to disintegrate.

To achieve even greater efficiency, we have increased the speed of our activities, converting materials and cultures without consideration of the meaning of or need for efficiency. The speed of our economy is too great for many cultures to adjust to; and the thoughtless transformation of cultures may result in great mistakes. The speed of our conversion of wild habitats to domesticated lands is too great for many species to adapt.

To increase trade and claim resources, states worked with business corporations to enclose entire areas and stabilize them with physical force. Now, every piece of land on earth is enclosed and claimed by major states. States have also incorporated traditional tribal territories into their artificial boundaries with little regard for representation. The Oromo in Ethiopia, for instance, comprise half the nation's population, but do not have a voice in government or even title to their lands. In sub-Saharan Africa alone, 450 million people speaking 1800 dialects have been compressed into 50 states.

To increase our economic wealth, we have created a 'global marketplace' in a 'global village.' We have tied together people with millions of telephones, hundreds of millions of televisions and billions of radios. More and more people eat the same foods, wear the same style clothing, and read, watch, and listen to the same entertainment. People are pressured to give up their ethnic identity and kinship for the 'global unity' of humanity. This global culture suffocates local cultures; unique dialects and ways of life are diminished.

Population pressures, resource shortages, and manufacturing "side-effects" cause instability in many societies; militarism, intolerance, crimes, and health problems are symptoms of that instability. Confusion and misinformation contribute further to the destruction of cultures. The instability of cultures, as well as stress, insecurity, and insufficient diets, results in psychological problems for people. Individual powerlessness and disillusion provokes the further disintegration of cultures.

Progress is erasing archaic cultures. There have been great cultural transformations over the past 20 thousand years. Primary cultures, previously called 'primitive or archaic,' regard the relationship of human beings to nature as one of kinship; all neighboring beings fall within moral consideration. These cultures observe the synchronicity between their bodies and nature and understand their culture through mythical explanations. They employ hunting, gathering, and shifting agriculture.

Secondary cultures analyze and deduce the operations of nature; rituals become more stylized. Cultural innovations permit larger human populations; ecological limits are raised by agriculture, although they are not eliminated. Moral consideration is reserved for human beings and sometimes other conscious beings.

Tertiary cultures (in fact, the real meaning of a third world: twice removed from nature), are based on mechanical images that objectify nature. Drastic changes in the production of goods forces other psychological and social changes; human relationships are based on economic allegiances instead of kinship and exist in societies instead of communities. Money becomes a symbolic representation for the value of labor and land, which are considered mere commodities. Social stratification and the specialization of labor become fundamental characteristics. Orders are rearranged during the process of urbanization. Moral order, for example, becomes subordinate to technical order.

This last transformation of culture is not the only one in existence, however. There are hundreds of others, although around 1900 there were over one thousand unique cultures and 3000 languages (roughly equivalent to the number of natural biogeographical provinces, subprovinces, and habitats on earth).

The images and diseases of secondary and tertiary cultures had immense repercussions on primary cultures. American cultures had no resistance to diseases bred in European cities. Many cultures could not compete with more aggressive groups. Many primary cultures have lost 60 to 99 percent of their populations. The Tasmanians, for instance, lost over 98 percent of their population; this much stress on a culture usually results in extinction, as happened to the Ona and Yahgan in Tierra del Fuego. About one third of the known groups in Brazil were gone by 1957.

Some cultures are simply wiped out. The Herero people in southwest Africa were exterminated as a culture by German forces. The Yanomami and others in Brazil are facing threats from prospectors and ranchers, now. Other cultures subside or intermarry out of existence. The Birale people in southwest Ethiopia have only 89 remaining members—and only 19 of them speak the tribal language, Ongota.

Industrial culture is wrongly considered to be the evolutionary successor to primary cultures and is displacing them rapidly. Scholars once plotted an evolutionary trend of cultural types, from primitive through historic, modernizing, and modern; they speculated that later developments were more adaptive than earlier ones and should replace them. It was assumed that the modern view culminated from earlier ages; thus, the 'superior' modern cultures were justified in exploiting or removing 'primitive' cultures.

There is no evolutionary trend of cultural types from the primitive to modern. Later developments have not proven to be more adaptive than earlier ones; nor do they necessarily replace them. Ethnic groups are not anachronistic stages that point to Switzerland or Japan; they are equally valid ways of living. Any culture is only one of many possibilities, one way of living in a unique place—there is no single correct way.

5.9.2. *Redefining Culture*

Much is known about the dimensions of cultures. Culture is everything created by a group, society, or nation, physical or ideal, past or present. Thus, culture embraces cookware, arrows, and turbines; art, books, and legal codes; images, values, and social structures.

Culture is a codification of reality, a symbolic system that transforms physical reality into experienced reality, which can be preserved and transmitted through many generations by language. The uniqueness of the place of a culture is exhibited through language. The Inuit may have over 17 different words for snow, while the Taureg may have 11 words distinguishing the kinds of blown sand—and Americans recognize 94 shades of lipstick and 22 kinds of road surfaces. Language is not only a medium to express thought, it is a major element in the formation of thought. Different languages recognize events differently, therefore no culture can be considered apart from language or entirely apart from place.

The difference between cultures is not due to the number of phenomena taken into account; it is due to a difference in the basic postulates of thought. Nor is the difference really a matter of truth or falsity. Truth and falsity are less important than relevance. Primordial water is no less true than six-dimensional phase space or primordial *ylem*. Each group views and reconstructs the world through their experiences and values. Codifications are true to reality; they represent different facets, not exhaustive catalogues. The inconvenient truths of one culture, like the germ theory of sickness or the vengeance of Coyote, are usually disregarded when they conflict with the direct beliefs of another culture.

Culture is an active way of living for a group of people in a unique place, a set of behaviors that allow survival in one place. Culture is not simply a matter of territory or human ancestry or names; it is a living organ, like human skin, that allows the interpenetration between the human and the natural. Every culture has strengths and weaknesses, however, that may color or distort human perception, or limit or expand human adaptation to the environment.

6.0. Designing Domiture

The early discoveries of science seemed to confirm that there was a real dualism between humanity and nature. New scientific research in quantum physics, psychology and ecology, focusing on anthropogenic effects on nature, suggest that the perceived dualism is erroneous. Nature is no longer a separate realm that we can look at from outside. Although the old dualism is a common misconception, human actions are embedded within human-dominated matrices, which are embedded with massive biogeochemical cycles and wild matrices.

Our level of interactions in many places suggests that human processes are significant drivers that affect the function, organization, and composition of many ecosystems (Turner et al. 1990). As the degree of our influence on the entire biosphere increases, especially interference with global cycles, we need to work to fit our actions into the limits of those cycles and systems, or risk having them collapse and require human restoration and control.

6.0.1. *Nature Itself.* G. Spencer Brown understands a much wider concept of the self. In describing the conception of form, Brown notes that the self constructed boundaries in order "to see itself'. But, in order to do so, it must divide into one state that sees and another that is seen—it must become distinct from itself. In this sense, the world has divided and subdivided itself. Whenever another division is made, a self—Brown says a "universe"—comes into being. The skin of an organism only cuts off an inside from an outside. But, the skin is permeable.

The earth has innumerable modes of being that are not human modes. Our direct intuitions of nature tell us that the earth is infinitely strange; it is alien, even when gentle and beautiful. It seems often mysteriously impersonal, unconscious, immoral, hostile, and awesome. J.B.S. Haldane recognized the strangeness of nature. "I have no doubt that in reality the future will be vastly more surprising than anything I can imagine. Now my own suspicion is that the universe is not only queerer than we suppose, but queerer than we can suppose." Perhaps the queerness results from sheer complexity. George Perkins Marsh believed that the equation of animal and vegetable life was "too complicated a problem for human intelligence to solve, and we can never know how wide a circle of disturbance we produce in the harmonies of nature ..." Barry Commoner echoes them both: "not only is nature more complex than we think, but perhaps more complex than we can ever think." In its immense complexity, nature seems wholly other, nonhuman, or ultrahuman. Nature consists of moving patterns whose movement is essential to their being. The holomovement enfolds and unfolds in a multidimensional order that is undefinable. Nature seems distant and unknowable, so it is feared as unfathomable and uncontrollable. Nature seems contradictory and sinister, shaped by death, which we fear. We fear to understand, to be compassionate. So, we try to dominate and control nature, to overwhelm it before it can overwhelm us.

6.0.2. *Culture Itself.* Culture as a filter to keep the details of nature from overwhelming us. Culture feeds back into what nature is, as ecosystems and species. As people learn a language, and as they learn from the collective store of memories and experiences, they contribute to their own change and the historical change of a culture. People, like termites, beavers and birds, modify the environment to improve their chances of survival. The modifications and changes become cumulative, so that houses change, ways of generating energy change, without having to be reinvented. Our general cultural ability, rather than specific biological improvements or specific adaptations, give us a greater survival potential. The accumulated cultural knowledge and their meanings as they are transmitted, is a semantic environment. The limits of this environment limits how we can design future environments. This environment needs to be redesigned before the overall environment can be redesigned. When experience is distilled in norms or laws, these secretions, as Anatol Rapoport calls them, change the semantic environment, in a way parallel to toxins or nutrients in the biological environment, encouraging or inhibiting actions.

Culture forms an integrated design. Elements are fit into the design and related. A traditional culture integrates these relationships in a coherent whole, according to cultural values. By virtue of its integrative potential, culture provides an ideal framework for public and private decision-making. Cultural order is necessary to deal with the redistribution of wealth and power. Order provides stability and security. Furthermore, justice, ethics, freedom, and truth are based in culture. Our minds are not only nature dependent, but culture dependent as well. As the wind, trees, and birds are sources of signals and symbols, so are gestures and words. A community is a place where a group of experiencers share ways of experiencing or the same experiences. This enables an individual to go beyond a finite view, to see the embedded culture as one of many ways of relating the self to the universe. Culture evolves from the interactions of humans with nature; both are in a constant state of flux. The development of cultures may be thought of as parallel to the development of species, where memes or ideas in a culture have the similar function of genes in a body.

Nature needs a place to play, without being controlled or converted. Culture needs a place to play, without being forced by nature. Nature is an extension of the field, Culture is an extension of nature through human existence.

Even where the culture may be good, the scale of the culture results in conversion of wild ecosystems into limited human ecosystems. This is part of a large-scale problem of interference, not just in artificial systems, but also in wild ones. Stewart Brand thinks that the levels of a healthy society move at different rates. Each operates at its own pace, with the lowest and slowest sustaining the others. Culture moves at the pace of the "long now," according to Brand, at the pace of language and religion. Nature moves slower than culture. Culture is the work of whole peoples.

Landscape change is about intertwining ecological and cultural processes. Because we are humans and have cultural ideas and images, and because we have impacted ecological systems for ten thousand years, culture is part of any restoration. Environment is the natural; the landscape is cultural. But, it's the same thing. It is not environment or landscape—It is something that includes all agriculture, cities, geospheres, and wilderness.

Figure 450-2. Mountain bluebird on 11-box bluebird trail at Altazor 1981

6.1. *Domiture: The Coevolution of Nature & Culture*

Domiture is the entire field of extensions as a unit of study, rather than the reification of something new, perhaps divided among the studies of natural history, ecology, human ecology, and cultural ecology. Domiture, a neologism made from the Greek word fragments for 'home' and 'again,' could do that. The system of culture is embedded in nature; domiture is a larger term to enclose the previous nature/culture dualism. It has to include human reason and human emotion, rather than simply putting them on opposite columns, as with order and chaos, higher and lower, linear and cyclic, as well as agriculture and wilderness. Nature and culture need places to play. Domiture envelops both concepts, giving them room to play.

Nature and Culture are systems. Domiture is the combination of those two systems. Culture was once called a "Second Nature," but human culture has expanded so dramatically that the two systems are better identified as one hybrid wild/developed system, now. The fitness of human systems are intimately related to the fitness of species and natural ecosystems. The human attachment to place is critical to understanding why people live where they do.

Domiture is the system of culture embedded in nature; it has to be a larger term to enclose the previous nature-culture dualism. It has to include human reason and human emotion, rather than simply putting them on opposite columns, as with order and chaos, higher and lower, linear and cyclic, as well as agriculture and wilderness.

Table 610-1. Changes between Culture & Nature over Time (Read to right)

Humans as part of environment	Second nature is equal	Second nature exceeds natural
Wild ecosystems	Agroecosystems	Urban ecosystems
Natural environments	Cultural landscapes	Built environment
Dependency on natural environment	Modification of the environment	Major impact on and control of environment

The study of domiture requires a 'Pan Ecology,' human ecology combined with ecosystem ecology. Design has to consider the rates of change of culture and nature, as well as those of emotion and technology. Nature evokes feelings of beauty and terror, joy and sadness—we can observe the wild or feel rewarded by the experience of nature. Nature is fun. It invites play. Ecology can be fun. It invites play. No matter how tiresome or frustrating ecology as a science can become, there is always the potential to enjoy it. Who cares if nature is not natural anymore? It is only human words and ideas. Nature is healthy, and that is what makes us healthy. Who cares if culture is claims dominance? Hurricanes, tsunamis and other events are agents of cultural humility.

Nature becomes more complex through filtering, combining, dividing, and mixing. B. Mandelbrot suggests that nature is not made of three simple dimensions. Things can have 1.63 or 2.17 dimensions. Regular simple dimensions are imposed on nature by culture, which has its own odd dimensions of complexity. Euclidian nature is a fantasy. But, nature has gotten more playful with fractals. But, fractals too are necessary fictions. Thus, every form of knowledge becomes a human fiction. Still, that fiction is based on the 'wisdom' of the wild planet, and we are compelled to ask questions: Does nature exist? What is the role of humanity in the destiny of the planet? Who knows? Let's play.

6.2. *Practicing Ecosystem Medicine*

Medicine has made great progress in the past hundred years, especially with the invention of machines that allow noninvasive examination of virtually every part of the body and the discovery of drugs that can control moods or modify diseases. It is possible to transplant malfunctioning organs or sets of organs. Some diseases seem to have been extinguished; others have been controlled. The understanding of diseases has been extended to psychological dimensions and to social contexts. Some medical practitioners and researchers even talk about removing death—as if it were a disease—or cloning healthy replacement body parts or whole bodies. Medicine, in combination with advances in hygiene and food technology, has consistently extended the average life span.

But, medicine is not perfect. Some diseases are making a comeback, and new diseases are starting to appear regularly. Some of the new diseases transfer from wild animals to humans, and a few from humanity to the planet, such as greenhouse fever or ozone loss. Some cures, such as chemotherapy, seem to cause more damage in the long run than no cure at all. Some medicines, or at least their effects, including packaging, chemicals, and testing cycles, are degrading human and wild environments; medical toxins, such as mercury, are killing plants and animals. Some treatments drain individuals and entire insurance companies with their costs—and some of the extreme costs are passed on to all individuals, healthy or sick. Some procedures, especially many kinds of elective plastic surgery, have no medical purpose at all. The distribution some medical procedures is centered on those rich enough to pay the recognized costs. Modern medicine has seemed to reach some invisible limit.

Alternative kinds of health care are attempting to address these problems and limitations, but they also seem to be limited to the exclusively human dimension. Public health emphasizes prevention for individual and communities. Other crisis environmental sciences, such as conservation biology and ecoforestry, try to address the unwanted effects of the medicine, but are unable to influence the causes.

A new field of inquiry is needed to focus on the health of the entire system, and to reconcile the care and health of ecosystems, populations, communities, and individuals. Using the term first used by D. J. Rapport, this field can be designated Ecosystem Medicine. This field will be contrasted with traditional medicine in the following pages.

6.2.1. *Medicine and Its Brief History*

The Greek physician Hippocrates theorized that illness was a natural biological event and that the body could heal itself naturally, in time. The Hippocratic corpus focused on prognosis rather than diagnosis, but, it insisted on observation and reason as the basis for any actions. Hippocrates suggested that there was a relationship between the occurrence of disease and the physical environment. Hippocrates' insight was that health can be produced and maintained by natural elements, such as hygiene, diet, mental balance, physical conditioning, and a supportive home. Health depended on being in harmony with these things.

Greek medicine was typified by the notion of well-being. The goal of medicine, like Greek philosophy, was to establish well-being (*eukrasia*) or happiness (*sophrosyne*). Happiness was conceived as harmony with nature and self. Democritus wrote that by using the principle of harmony (balance) we can attain calm of body (health) and calm of soul (happiness).

Over the thousands of years since then, medicine has changed and developed. The entire history of medicine can be compressed into six stages.

1. Traditional medicine, which is common-sense and faith-based. Things have to be bal-

anced in nature. Sickness results when things get out of balance. A shaman or physician can return the balance with actions and medicines. People are expected to limit themselves as the shaman or physician tells them.

2. Rational medicine, as the result of observation. The Egyptians noticed that brain swelling could be reduced with trepanning. The Romans noted that people living near swamps got sick, so they drained swamps. The reason for the engineering was common sense, without medical or ecological knowledge of the cycle of mosquitoes and microbes (and with the belief that the environment is something outside that can attack the body).
3. Scientific medicine (from the 1860s), where the body as a machine can be fixed with surgery, amputation, pressure release, balanced with medication, stopped with radiation, or modified with other tools of the trade. It is based on the chemistry and anatomy of the body.
4. Psychological medicine. The body can be harmed by bad thoughts and improved by good thoughts, that is, the mind shapes the body as they both age. Some diseases are psychosomatic and some cures are psychological, based on the functioning of the brain within the body.
5. Social medicine. The body can be harmed or helped by the thoughts of other people. Shunning can kill, as peoples as diverse as the Inupiat and Amish have found. The love of family and friends can heal. But, of course, prayers can help, that is the thoughts of others can help individuals recover, sometimes, regardless if the individuals even know about the prayers. The effectiveness of this is based on the functioning of human consciousness, e.g., the use of the brains, in groups. There are scientific hospital studies that show the efficacy of prayer on distinct groups of patients.
6. Ecological medicine. These first five areas are defined by different levels of human consciousness or understanding. The environment is still considered an outer thing that fires its insults in towards innocent humans. The environment is not outside, however; we are embedded in the environment, which can direct feedback into physical, mental, and social dimensions. But, our consciousness of the earth still can manifest itself in our modified and artificial ecosystems, and through the degradation and destruction of wild ecosystems. Our love or hate for specific places can influence the state of those places. This is what many call spiritual growth, where the consciousness transcends its limits. People can create ways to avoid painful personal or ecological experiences. People can create a harmony that unites living with the living of every other being in the network. People can cooperate with other people and flow with natural processes.

Despite the history of medical thought, many forms of medicine still exist together and still work simultaneously within a culture. General medicine, as per Hippocrates, addresses the healthy person. Reactive, or scientific, medicine addresses diseases and illnesses. Preventative or alternative medicine is concerned with environmental causes that can unbalance a healthy person. Holistic medicine considers the spiritual and community effects on disease and health. And, ecosystem medicine recognizes that human health ultimately depends on the health of the environment.

Medicine exists because people become ill. Illness is a subjective state where a person detects a change in harmony, and suffers an altered state of existence. There may or may not be demonstrable pathology. In medicine, a disease is identified through a syndrome of patterns. Medicine has a long history of trial and error in identifying patterns, but it has built a foundation of science (hierarchical knowledge), now, with advances in cellular and molecular biology.

Medicine, as what doctors do, has been called a science, humanely practiced. It has also been called an art. Yet, it is neither an art nor science, but an intermediate discipline that combines theory and practice; the theoretical knowledge of science and symbols, as well as the practice of individual experience, is combined with an altruistic commitment to the patient.

According to Pellegrino and Thomasma, medicine is the cognitive art applying science and persuasion through a complex interaction in which a mutually satisfactory state of well being is sought, and in which the uniqueness of values and disease, in the institution in which care is delivered, determine the judgments made.

Clinical judgment is the central element of a theory of medicine. The clinical event is a key feature showing why medicine is neither science nor art. Medicine is a discipline of practical experience arising from clinical interactions, e.g., interhuman events. The ingredients of a medical event include: etiology, responsibility, trust, and decision. Medicine bridges the scientific study of symptoms and diseases as well as human values. It creates a tension between the abstract and the concrete.

Ivan Illich pointed out that people assume something is wrong inside them when they respond to a difficult, intolerable environment. Self-care and modern technology can be mutually supporting. But, people have to work to resolve their problems in the whole network and not just give themselves over to machines. Illich suggested that convivial institutions are better than manipulative ones for education and healthcare.

6.2.2. *Extensions to Medicine*

By 1997 almost half of adult Americans had visited practitioners of alternative medicine at least once, if not regularly. This social trend is occurring because alternative practitioners are willing to acknowledge the necessity of treating illness within a larger context, one of meaning and spirituality, and not just the symptoms.

Alternative medicines seem to be better at managing disease prevention. C. Everett Koop, in the 1988 Report on Nutrition and Health concludes that dietary imbalances, which are preventable, are the leading contributors to premature death in the US. The Center for Disease Control calculates that 54% of heart disease, 49% of atherosclerosis, 37% of cancer, and 50% of cerebrovascular disease could be eliminated by lifestyle modification.

Alternative medicine recognizes an intuitive dimension for healing systems and people. Everyone who is good in their field works sometimes by intuition, which is the integration of knowledge at a subconscious level, involving more than just senses and technical expertise.

6.2.2.1. Definitions of Health

Human health has been studied for thousands of years. Our first clue to a lack of health in a person is abnormal behavior—not moving or breathing, for instance. The first thing a doctor does is to classify the symptoms and measure vital signs: heart, blood pressure, temperature, and maybe blood chemistry. Then she makes a diagnosis and verifies it with more measurements. Doctors, who often rely on their long experience and learning, then discuss a prognosis and prescribe a treatment. So, a first definition of health is the continuity of normal behavior, of living.

There are problems with definitions, however. The problem with health is that it is such a general concept—it is a judgment without an operational definition. Since the human body is complex, it is hard to determine its health. Stress and pathology are normal parts of living systems, as are their agents, such as bacteria or viruses. Furthermore, not enough data exists about what levels of stress or pathology threaten the health of individuals. Since extremely sick individuals display continuity, for extended periods of time, further consideration is necessary to define health.

Health can be redefined as the absence of disease. Health has an exact scientific definition in medical science—it is defined as the absence of disease. In this traditional way, *via negativa*, health is not having cancer, infections, high blood pressure, diabetes, or other ailments. The opposite of health is disease. But, what is a disease? Many diseases, at some stage or concentration, obviously compromise health. But some human diseases, such as sickle cell anemia, make one healthier in the sense of being able to resist another worse disease, G-6-PD deficiency (glucose-6-phosphate dehydrogenase), a genetic disease that causes red blood cells to dissolve.

There are problems with redefinitions, also. Absence of disease is not adequate as a definition, unless we can measure every kind of pathogen. People who seem not to have diseases are termed healthy, yet, there are some people who do not seem healthy, although no disease can be found. The definition of health, according to the World Health Organization (WHO), is "a state of complete physical, mental, and social well-being and not merely the absence of disease and infirmity." This definition of health is the condition of being sound in body or being well. The human body is a dynamically changing being. Human medicine itself is changing from being disease-driven to wellness oriented, from focusing on symptoms to describing the properties of health, such as interconnectedness and self-realization. We could define health as the potential for recovery after collapse or attack.

Health can be redefined again in terms of vigor and resilience. Too much stress, for example, leads to unsustainable patterns of behavior; continuous stress leads to a breakdown of processes that becomes irreversible—the system dies. The imbalance is a form of stress. There is a direct link between the reactions to stress and the body's ability to regain balance. Hans Selye identified three stages of stress: Alarm, resistance, and exhaustion. Each stage causes a different response in the body.

The basic medical definition of health used to be freedom from disease. Part of a new definition of health is resilience to stress—of course, not all stress is harmful; there is good stress (eustress) as well as bad stress. A system may require a certain amount of eustress to be healthy (athletic competition, lovemaking, and childbearing all can cause eustress for instance). Stress may be related to the rate of change for the system, in addition to loss or gain of components or changes in structure.

After Illich and Dubos, the British Medical Journal redefined good health as "the autonomous personal capacity to master one's conditions of life, to adapt one's self to the accidental modifications of one's surroundings, and to refuse if necessary environments that are not tolerable." To be considered healthy, a body has to be stable, to maintain its structure and metabolism (rate of energy use) despite occasional stresses. Health is a dynamic measure of system organization, vigor, and resilience. Organization is described by diversity and connectivity; vigor is related to the amount and speed of productivity; and resilience is a measure of reaction to stress. Since resilience is only one form of stability, that component should be an additive function.

There are further reconsiderations of redefinitions: Until we understand how people change and move around their physical and imaginary landscapes, we will not know which changes are important and inevitable and which are the unhealthy result of human imbalance. Until we understand the changes, we will not be able to adjust our needs to the limits of supporting ecosystems.

Health can be redefined again as harmony and wholeness. The body reacts to as well as shapes its world. The living body selects harmony, that is, health, as a goal. Health is a value of living bodies. Health is the coherence of the pattern of living in other words. If the pattern is disrupted, the local entity dies. Many local patterns flow together through time interdependently, sharing materials. The death of one pattern sometimes leads to the death of other patterns. The body of a human or any entity is a dynamic pattern supported by dynamic processes that include other entities.

The disease event throws one's perception of health out of balance or harmony. The physician helps to restore the whole. In Chinese medical tradition, the highest good is harmony, especially social harmony, or good relations. A good person is one who creates and maintains harmony. Perhaps this is a good working definition of health. But, it requires inclusion of a healthy environment.

Health can be further qualified as harmony in a whole context. Health is a quality that is grounded in the total order of the environment—or implicate order. Health is a dynamic quality of the entire movement of the environment (holoverse) as it flows. As organisms sometimes interfere with others or with the flow of change, the harmony breaks down—we call that disease. Health is the dance of bodies that interpenetrate (in Paul Shepard's image). None of the bodies are completely independent or completely bounded; they are interdependent and open systems. A body is only maintained by a flow of energy and materials from its environment—much of this flow is in the form of other entities, usually much smaller, such as prey, insects, bacteria, and viruses. Harmony is a constraint of the whole system.

Human health has been the focus for many thousands of years. The concept of health has been applied to domestic and wild animals more recently, and now to any complex system, such as a forest or ocean, or even to the planet according to James Lovelock). Applied to large whole systems, health is an integrative concept that can address the well being and functioning of life forms and environments. It also highlights the dependence and intertwining of living beings at home in living ecosystems.

Signs of system health include the homeorhesis of the system (a similarity of flow, rather than the stable state of homeostasis, after Conrad Waddington), the stability of the system (that is, its resilience after stress, such as infections), the diversity of its components, the continuous recycling of elements, and flourishing. Health is the overall ability of a system to maintain itself under a normal range of environmental conditions, which may include extreme temperatures or lack of water.

The relationship between environment and health is integral. The environment is a critical factor in human health and disease. Health, being a complex harmony of the environment, society and individuals, requires that the ethic of medicine must consider individual, social, and environmental good—all are rooted in living bodies.

6.2.2.2. Extensions of Medicine to the Community

Medicine already has to consider the whole spectrum. In disease, the harmony of the body is disrupted by some event through the environment. The disruption causes a symptom, of some kind, which becomes objectified as it, the disease. But, the disease is a conceptualization of the disharmony of the patient's world, that is the self-image and human image, and that image is partially defined by the human community and the larger environmental community, that includes movements of animals, plants, and microorganisms. Medicine has to consider multiple etiologies of disease, from environmental causes, to human social, genetic, somatic, and psychological aspects.

Modern medicine already considers epidemiology (or population medicine) "the study of the distribution and determinants of disease and injuries." The goal of epidemiology is to limit disease through early intervention, controls and treatments. These actions are performed through a community—a group of people with a shared location, environment, and fate. Community health is the private and public efforts of individuals, groups, and organizations to preserve the health of those in the community.

Community health education emphasizes the importance of preventative health care at the community level. Their basic function is to give people facts about health, causes of disease, and methods of prevention, so that they can act for their own well being (and for that of their families). There are established strategies for community health: Establish a board of health, collect statistics, perform research, implement sanitary measures, then preventive services, health protection, and health promotion.

There are shifts in roles and continuity. Physicians offer advice for individual patients in an office. Community medical doctors are advocates for individual patients by communicating with employers, public health agencies or other agencies; they may advise and educate citizens, colleagues and leaders about environmental health.

6.2.2.3. Extension to Environment: Environmental & Conservation Medicine
Environmental medicine usually refers to—for instance, in the 1988 Institute of Medicine report—the diagnosing of and caring for people exposed to chemical and physical hazards in their homes and workplaces through media such as contaminated soil, water and air. This definition emphasizes nonlife-style environmental factors, but does not omit traditional lifestyle factors such as diet, smoking and drinking alcohol. Environmental medicine has been considered as dealing with the impacts of air, water, or food contamination on the well being of people and not much more (see Table 6233-1).

Emerging infectious diseases cause novel complex problems, especially if diverse organisms are perceived as threats to humans. Emerging diseases are either infections newly expanding their territories or new creations. Viruses can exist as latent or persistent sources of infection in a population.

Table 6223-1. Possible hazards to the whole system

Site	Earthquake, flood, wind, drought
Physical	Radiation, vibration, forces, abrasion, humidity
Chemical	Toxins, poisons, allergens, irritants
Biological	Microbiological, vegetative, insect, animal
Psychological	Stress, discomfort, depression
Sociological	Overcrowding, isolation

To some extent human disease has always been the result of the reaction to environmental stress, certainly from microbes and other things, but also from the failures of agriculture, sanitation in cities, deforestation, and the use of exotic chemicals. Population size and structure are also critical factors in infection susceptibility. Medicine is more sophisticated and accomplished, but environmental degradation and the decrease in biological diversity—and the stresses from them—are increasing rapidly, resulting in new diseases and new problems, that is, new stress on individuals and populations.

There are already in place city, county, state, and federal laws regarding sanitary standards (also for the disposal of hazardous materials). These laws are responsible for five human resources: air, water, food, shelter, and waste. Human sanitarians are responsible for controlling, preserving or improving environmental conditions so that human health, safety and well being are maintained. Environmental medicine is an anthropocentric medicine to help people overcome problems from environment. It has a bias for human welfare without regard for cost to other species.

There are examples of relationships of environmental conditions to human health (and the discovery or classification of diseases that probably existed previously but were misdiagnosed). Health has started to take account of the health patterns that result from ecosystem changes. New infectious diseases and cancers occur. For example:

6.2.3.3.1. *Lyme disease*. The white-tailed deer and white-footed mouse thrive in an impoverished landscape where large predators no longer select out sick animals. The disease gets magnified when the vectors, ticks, hitch up the spirochete to humans.

6.2.3.3.2. *West Nile Virus* (WNV). WNV is a virus that is maintained in nature through biological transmission between susceptible vertebrate hosts by blood-feeding arthropods, such as mosquitoes or ticks. The virus is maintained in a complex life cycles involving a non-human primary vertebrate host and a primary arthropod vector. These cycles typically remain unknown to humans until humans interact with the natural focus or the virus chooses human hosts as the result of some ecological change.

WNV was first isolated in the West Nile District of Uganda in 1937. The ecology was characterized in Egypt in the 1950s; it was first noted in Egypt and France in the early 1960s, and it first appeared in North America in 1999.

Humans and domestic animals can develop clinical illness. The most serious manifestation of WNV infection is fatal encephalitis (inflammation of the spinal cord and brain) or severe meningitis in humans and horses, as well as mortality in some domestic and wild birds. WNV has been a significant cause of human illness in the United States in 2002 and 2003.

6.2.3.3.3. *HIV/AIDS*. Human Immunodeficiency Virus (HIV infection) causes an Acquired Immune Deficiency Syndrome (AIDS) in monkeys and human beings. The virus appeared to be resident in wild African monkeys. Possibly after decades of forest cutting, the virus was able to use humans as hosts. The first attested date for AIDS was 1959. In order to trick the human immune system, HIV can evolve new molecular pieces of the microbe, called antigens, within an individual patient.

6.2.3.3.4. *Hantavirus*. Several people died during the Hantavirus pulmonary syndrome outbreak in 1993 in the southwestern United States. The summer of 1992 was rainy, leading to an increase in the crop of pinon nuts, which lead to an increase in the rodent population. Various species of rodents have carried (presumably for a long time) this strain of Hantavirus; cases may have occurred previously but been unrecognized medically. The larger reservoir population of rodents led to closer contact with human populations and the emergence of the Hantavirus in 1993 in the Southwest.

Subtle environmental changes, after a delay, affect the spread of disease in humans. This spread may be accelerated not only by exploration and destruction of tropical rainforests (where HIV may have emerged), but also by the increase in the amount and speed of travel and commerce (which aided the Asian tiger mosquito, a recurrence of cholera, and others). Also, large human populations allow a disease to shift to another local area and to avoid dying out.

Culture is intimately intertwined with health. Culture provides the mode for pain and suffering. It provides rules for sickness and death, as well as compassion for others suffering. African customs of polygamy and extended families provide a larger pool for HIV and hastens its spread.

The health of ecosystems is also intertwined with human health. Since 1996 a group of Canadian and Peruvian researchers has been developing an adaptive ecosystem approach to human health. They used two phases: A conceptual framework that combined ecosystems as complex systems with secondary data and fieldwork, and an application to understanding and improving a problematic situation in the Peruvian Amazon. The goal, however, seems focused on human health. They included natural resource use.

The term "conservation medicine" was introduced by Koch to describe the broad context of human health. Tabor says that conservation medicine "studies the multiple two-way interactions between pathogens and disease on the one hand, and between species and ecosystems on the other." He says it combines human health, animal health, and ecosystem health (shown as 3 intersecting circles equally). But, the application seems to narrow to human health. Michael Soule says "conservation medicine is the right medicine." It has more expertise, more knowledge, more research, and more cures—and possibly more understanding and prevention.

6.2.4. *Ecosystem Medicine*

Medicine has gradually extended its attention to wider domains, from the personal health of individuals to the health of human communities and the health of those communities in an ecological matrix. It will be concerned eventually with the health of environment (ecosystems).

The next step is to integrate ecosystem medicine with environmental medicine and ecosystem science. This means starting by creating a body of cases, then, evaluating the responses to the cases, and finally using that body of experience as a predictive for future treatments. A short discussion of ecosystems is necessary first.

6.2.4.1. What is an Ecosystem? Characteristics and Definitions

An ecosystem is a set of communities of species, using the flux of energy and matter in the same place and time, that is the smallest unit capable of recycling the elements of its membership. An ecosystem is also a topographic unit, a volume of land, occupied by organic beings, extended over an area and through an extended time, with connections to larger mineral, chemical, water and air cycles.

The new paradigm in ecology is the "flux of nature," which replaced the balance of nature, a homeostatic balance, with a homeorhetic balance, the flux. The ecosystems, in general are: open to external forces, do not maintain stable point equilibrium, have directional change as a result of stochastic forces and partial intention by itself, are influenced by both history and current composition, are adapted to natural disturbances, and have adjusted to small scale human influences for thousands of years.

6.2.4.2. Ecosystem Health

Concepts of health applied to organisms can also be extended to communities and ecosystems. Both are complex whole systems with parts and functions. Of course, ecosystems are more complex than humans, which is also why we have trouble measuring social or cultural health (there is no standard society or standard ecosystem as there is a "standard human"). That complexity means we that should be measuring a large number of variables, starting with soil depth (richness, compaction), then annual nitrogen uptake (often related to leaf litter), trophic flows, species counts, and patterns of activity.

Norms for humans and animals are more definable due to the large numbers and the long history of observation. Ecosystems often have only one sample, if they are very unique. This means that there is no population and no possibility for replication. Therefore, the use of analogy for individual systems may not be very productive.

Life energy, according to the physicist David Bohm, belongs to the implicate order, the unseen totality that underlies our reality. Health is the harmonious interaction of every pattern/flow that is part of the implicate order. But, since flow and order (in the holomovement) are imperfect and uncertain, perfect harmony or perfect health is not possible. Breaks in harmony appear as disease. Blockages of flow or stagnant flow result in disease. C. S. Holling considers that local pockets of chaos keep ecosystems stable by forcing the evolution of new forms to create new niches. Ecosystems reach their fitness near the edge of chaos. So crashes and explosions occur. In human medicine, that chaos seems to be a feature of ill health.

Health is not a final state, as modern medicine often regards it. Furthermore, the flow has channels or limits. The harmony of motion is more than just parts. Health is a description of the kind of harmony, not the opposite of disease.

The health of any wildlife species in a system is tied to the entire system, as well as to changes at the boundaries. This is especially true of preserved places. Gray wolves in parks have been shown to carry antibodies to canine distemper, canine parvovirus, and infectious canine hepatitis. It is likely that coyotes and fox in the same range also have been exposed to these diseases.

Ecosystem health must become a scientific discipline, addressing losses of biodiversity, habitat degradation, and disease explosions. With an understanding of ecosystem health, patterns of mortality in species may be more be able to be predicted and interdicted.

It is possible to examine ecological health from various perspectives: The emergence and resurgence of infectious diseases of humans and others; the effects of hazardous substances; the health effects of unwise actions, such as fragmentation or other alterations of systems; and, the interdependence of species and the connection of health, also. There was a link between natural history (descriptive ecology) and medicine in Thales and others. Ecosystem medicine reexplores the connections, which have never disappeared.

Aldo Leopold started to describe a science of land health: “Health is the capacity of the land for self-renewal. ... A science of land health needs, first of all, a base datum of normality, a picture of how healthy land maintains itself as an organism.” Notice that Leopold anchored this concept in a theory of organism rather than an ecological theory of community. Ecosystem medicine uses the broader concept of community to explore ecosystem health.

6.2.4.3. Local or Global Threats to Ecosystem Health

Threats to ecosystem health are well known. They can be summarized briefly as local or global problems. The local problems include: Removal of key elements, species, resources, and productivity; the disruption of natural cycles; the introduction of novel elements, as the result of inappropriate technologies; human take-over of habitats for human purposes, often the result of simple population pressures, but also of greed and sloppiness; and, extinction spasms in general, but specifically, for example, the decline of amphibians worldwide, due to habitat loss, pollution, and fungal infections (exacerbated by global warming). The global problems include global warming, ozone depletion (chemical causes), the disruption of global cycles, and contaminations (e.g., nitrates, mercury). These threats can cause ecosystem collapse. Ecosystem breakdown happens as a result of stresses, singly or grouped, that relate to interference patterns in the system, most of which are caused by the human species now, although the potential for asteroids or volcanic eruptions remains.

As with people, health is related primarily to lifestyle (or life habits) and not to intervention by a doctor. Alas, the lifestyle of an ecosystem is often determined by its keystone species, and in most cases now humans are that species. There are specific issues in ecosystem health: Biomagnification of pollutants; diseases crossing species boundaries (and boundaries in general); the relationship between biodiversity and ecosystem health; between habitat destruction and health; and, plants or animals that cross boundaries (requiring us to track health in several ecosystems). There are also specific pathways for infection of ecosystems: Any kind of simplification, from monoculture to habitat degradation or simplification can allow disease to spread faster and farther; the decline in predators; a lack of competitors (to which pathogens are not as adjusted); and, dominance by generalists or specialists, which allows higher pathogen levels. This is not a comprehensive list of threats to ecosystems. But, it might be adequate to use to develop the concept of ecosystem medicine.

6.2.4.4. What is Ecosystem Medicine?

Traditional medicine has developed traditional medical specialties, including: Anesthesiology; Immunology (allergy, reaction to foreign substances); Dermatology; Family; Gynecology/Obstetrics; Internal medicine (further divided into specialties: cardiovascular, metabolism/endocrinology, gastroenterology, hematology, infectious disease, nephrology, pulmonary, rheumatology); Neurology; Pathology (chemical, neurological, derma); Pediatrics; Physical/Rehabilitation; Preventive (Public Health, occupational health, and aerospace health); Psychiatry; Radiology; and Surgery (which deals with diseases that require operative procedures to restore or preserve function or to cure the disease). There are rough parallels with ecosystem care. For instance, ecosystem medicine might include:

- Examination by infrared or other parts of the spectrum (the equivalent to radiology)
- Study of boundaries, or ecotones (similar to dermatology)
- Immunology (reaction to exotic species or foreign substances)
- Pathology (chemical, virology)
- Internal functioning (metabolism, element cycles, infection)
- Surgery (from the French word for "hand-work;" in this case, the removal of exotics from invaded ecosystems)
- Rehabilitation (restoration of structure or function); and
- Preventive efforts (ecosystem health).

Ecosystem medicine covers the spectrum from human organs to the complete ecosystems of the planet and maybe the planet itself. Everything could be considered nested ecosystems, from a body to the planet. Ecosystem medicine is not exactly humanitarian or ecocentric. Although it addresses ethical concerns and the focus is on ecosystems, it is more ecoperipheral; it approaches its subject sideways, cautiously and slightly out of focus, and aware of the frame.

Ecosystem medicine asks a much larger question that is integrative and contextually sensitive: Is the physiology of the base system healthy enough for self-renewal? Focus is shifted from the symptoms of a disease to the entire functioning process of existence within ecological limits. Health is embedded in the context of the system, with all of its constraints, limits, and opportunities for development.

Our knowledge of the world is returning again to a unified image, so it seems every field is converging. Alas, every field is also diverging and looks fragmented—perhaps because we are using the wrong lens.

6.2.4.4.1. Organic Metaphor

What we have learned from physics and psychology is that the body is a pattern in dynamic relationship with its surroundings. Health is an extension into the relationships of bodies.

The breakdown occurs in the larger pattern, the body in context with other bodies. Health and disease, harmony and motion, are all connected, so none of them is negative or positive as local events in context. In most cases the causes of disease, bacteria and viruses, are only competing in the life base. A metaphor needs to reflect the reality. Machine metaphors or war metaphors are not adequate.

Lovelock used the human body as an analogy for the self-regulating planet. After all, the planet has recovered from several major traumas, such as oxygen wastes and strikes by planetesimals (up to 10 miles in diameter). Each time, although the time may have been a million years, life bounced back. The biota of the planet appear to regulate the surface temperature, atmospheric composition, and ocean chemistry, for a start (perhaps like the human body regulates its temperature, blood chemistry, and other vital signs).

But, the organism is only a metaphor. With scientific study, the earth appears more regulated. Organisms, however, seem less regulated, considering symbiosis and neural competition and selection. Nevertheless, organisms are more a functional whole than the planet, which is whole more because of limits. Most organisms are limited by their original designs, that is, the body cannot replace the heart and liver with one purifying pump. The planet is not limited to one set of designs for its composition (biologically anyway).

The central metaphor of the Gaia hypothesis is that the earth is an organism. But, we consider that it is more loosely organized and less integrated than organisms. But, then we find that organisms are less integrated than we thought. Organisms seem like the ultimate bricoleurs, which gather up patterns, only some of which are then selected in living. Still, organisms are more functional wholes, with genetic programs that orchestrate growth and development.

The organism might not be adequate as a metaphor. As a metaphor, the web offers connection. Perhaps a nested set of boxes would be more fruitful. As the nested series of embedded centers, it is the largest center, the environment, that is the most crucial. Without a healthy environment, community and individual health with only be a temporary situation. Healthy ecosystems are the foundation of healthy communities, which are the foundation for healthy individuals.

6.2.4.4.2. Ecological Perspective

A germ tries to live well and to reproduce. If it is quick, and spreads to more than one new victim, then it does not matter if the first host (often human) dies. If it is too fast, the host dies before the germ can spread. Human beings and germs all evolve tricks and counter-tricks to stay alive. Medicine is one of our tricks.

The many breakdowns happening—in government, in education, in health care, in the family, and in business—may be negative or positive forms of rearrangement. In the larger, evolutionary context in which these social changes are taking place, the disintegration of our social structures may be a positive phenomenon. Without understanding the larger context, it is easy to mistake these breakdowns as pathologies. From an ecological perspective, most change is neutral.

Our planet is friendly, because it was a humaning world (or composed of “peopling rocks” as Gary Snyder put it). We have been afraid of the planet and depressed by it, and we have responded by degrading it. Human impact in the form of overuse and inappropriate technologies is rapidly degrading the environment. This syndrome creates new patterns of human and ecosystem disease and instability. But, we can be rejuvenated by understanding, and we can work to rejuvenate the systems we live in.

An ecological perspective recognizes humanity’s deep connection with our supporting ecosystems. Individuals cannot live healthy lives in unhealthy ecosystems. Due to the large human population, healthy communities and biological systems depend on human restraint and responsibility in technologies, population, production, and consumption.

This ecological perspective is a way of examining the whole context of medicine, to see how it might be redirected to examine its context within community and ecosystem health. The ecosystem approach requires a knowledge or list of actual and potential pathogens in the system. Consciousness is an important emergent property of physical health. The common goal is a healthy environment.

This means transforming our global and local economic and social structures, not totally, but within limits of the cultures that furnish with our identities and rules. Both can work. Current economic structures are locked into exploiting the maximum for the minimum, or for controlling scarce resources for a favored few. Profit with emotional and spiritual impoverishment is not healthy, but support with emotional commitment is. We need to develop a sense of enoughness within the real natural abundance, within the ecological limits. Security is found in working within the limits.

6.2.4.4.3. Ecosystem Medicine and Ecological Principles

In medicine a false positive diagnosis is an inconvenience; a false negative diagnosis can be catastrophic. This is true in ecology and conservation biology, as well. Making a diagnosis is a form of gambling, so it should be done on the side of caution.

The practical ecology of a scientist needs to be grounded in a theoretical formulation. The science of ecology provides principles that can guide actions. These include:

- The importance of scale cannot be ignored; things that work at a small scale do not always work at a large one; and, large scale rules can not be predicted from small ones.
- Patterns of interdependence (connection and embeddedness) are as real as bodies, and have to be considered.
- Resilience, the ability to recover from exploitation, disturbance or disruption, is a characteristic of a healthy ecosystem.
- Appropriate measure, the Greek ideal emphasizing minimal intervention, is a proper approach to less healthy systems.
- Diversity is crucial for stability and interest. Approaches must be matched to the type of ecosystem and culture.
- Cooperation is necessary. For patients, partnership. For communities, the interaction of patients and professionals. A cooperative framework for healing within the depths of communities and ecosystems.
- Reconciliation (equality of opportunity for treatment) is necessary.
- Conviviality, basically living together in harmony, according to Ivan Illich, is a necessary strategy.

These ecological principles, and many more not presented here, can guide our actions to make good, healthy places.

6.2.4.4.4. Actions and Treatments

Medicine can be destructive to individuals, land use can be destructive to landscapes, and ecology can be destructive to animals and ecosystems. The concept of ecosystem health, by bringing the pieces together into a conversation, could avoid much of the destructive behavior of semi-autonomous departments that are not questioned or contained as part of a larger holistic picture.

There are limitations for our treatment of ecosystems. We do not have a list of diseases for ecosystems. It is difficult to see the effects of ecosystem change or disease from the air or from a distance. Ecosystem illness is similar to chronic illness in humans. The appearance of symptoms indicate that the disease began long before the symptoms became apparent. So, the exact date of onset cannot be pinpointed. If so, then prevention becomes more important. And that is related to genetics, lifestyles (of forest entities, for instance), stress, and environmental effects. Furthermore, prevention is not a short-term, one step solution.

Some patterns of resource use need to be understood on the landscape level (and now on the global level). Others need to be examined over a year, decade or life of the system (especially in the Amazonian forest). There has to be a landscape level mechanism (and also a global one now) for regulating common resources. Local diverse patterns are good, but they must be coordinated at the landscape or higher level. It is the normal range of variability that has to be defined. Models need to be created for a wide range of habitat ecosystems.

There must be an institutional framework, with legal and social mechanisms, for monitoring and managing common resources. This is necessary for the health of the system, as well as the long-term health of humans. That means all interest have to be represented, even global corporations trying to profit from disease or rareness (brought about by overuse).

Public health specialists and population biologists look at disease in populations, whereas, doctors and veterinarians consider disease in individuals. The latter intervene while the former observe. The ecosystem doctor has to intervene in ecosystems. Ecosystem doctors care for the basic systems and communities.

Surveys need to be made of every kind of ecosystem. We need to have an inventory of kinds of systems and kinds of changes. How is conserving terrestrial animals part of conserving ecosystem health? We do not know whether animal declines were caused by disease or some other factor (competition or predation). We need to find that out.

Monitoring is the key to understanding changes. Disease needs to be monitored as an important indicator of integrity. Other indicators are surveys of key species, habitat mapping and human impacts monitoring. Complex interactions have to be monitored, using a range of indicators at levels from behavioral to ecological. There may be limitations of the bioindicators of ecosystem health. Perhaps we need to find common and endangered indigenous species and monitor them, hoping that would reflect the health of the system.

Many systems that have been overused to collapse need to be restored. Especially in forests, many small changes have a cumulative effect. Climate change can lead to loss of forest biomass. Change of rainfall patterns lead to water stress in adapted species. Deforestation results in other patterns of change, especially in vectors. Reforestation is associated with rapid changes in vectors, which can adapt to nonindigenous species of vegetation. Restoration is a necessary part of reforestation. Maintenance of remnant populations may not be enough to prevent loss of key species on a landscape level.

6.2.4.4.5. New Goals for Human Medicine as Part of Ecosystem Medicine

Medicine can continue to advance and confer benefits to societies, but it has to have a larger perspective. The physician had traditional obligations to the patient, to herself, and to her society, but now there are obligations to the environment. All these are partial because all of them are inescapable and unavoidable.

Medicine needs to monitor disease and health, as well as the human use of the environment and its consequences. Medicine needs to improve research for the prevention and treatment of new diseases related to ecosystem changes or degradation.

The standard for our efforts should be health—of communities, ecosystems, and corporations—not profits, technological sophistication (although that is sometimes a good thing in use), or fame. The common goal is a healthy environment as a basic human right.

Medical advertising needs to change. Rather than promote the unquestioned use of drugs, advertising needs to promote awareness of consequences of wildlife diseases (and of course the causes, as a result of change or human intervention), as well as paths to human and ecosystem health.

6.2.4.5. *Summary: A New Category*

Less than 30 years ago, the environment was of little concern to most people. Now it is the primary issue for most people. Calvin Coolidge once said that the "business of America of business." The biggest single business in most of the world, now, is the environment. All farming, most pharmacology, most tourism, and many other "industries" have their basis in the health and beauty of the environment. The environment contributes to the largest share of most gross national products directly or indirectly.

Historically, we have used ecosystems without regard to their continuity or to their health. Partial knowledge and technology has allowed us to exploit our environment beyond what is desirable for us or for other species. While moderate exploitation is necessary to live, too much exploitation is unwise. A wise use of resources would not make the world less habitable. We are part of the system and must protect its health as a whole.

A new category of medical professional is needed: People who address the health of ecosystem themselves. Human physicians may need to be able to identify critical environmental conditions that affect human health, but others are needed to identify the health of those systems themselves. Human physicians need to know the basic principles of diseases related to environmental change or chemical exposure; others need to know the principles of ecosystem health and how that is related to human health.

Conventional medicine has great strengths, as do alternative medicine or traditional cultural medicines. Ecosystem medicine must develop such strengths. Ecosystem medicine incorporates all other kinds of medicine as special cases. It can use the best and most appropriate of any procedures. No single approach works best for every instance.

Using a model of ecosystem medicine offers a comprehensive framework for investigating the problems of health, from individuals to ecosystems, especially the interactions between individuals, social groups, place, and environmental change.

Ecosystem medicine is a medical discipline, aimed at restoring ecosystems to health. As with any medicine, the patient actually does most of the work to become healthy, although the doctor gets the credit and the payment. This leads to respect for the practitioners, but also to more responsibility and more rules. The first rule, which we might take to be basic, is identical to the first vow of the Hippocratic oath, "Do no harm." Noninterference is a basic ecological principle—do not interfere with the health and stability of the ecosystem—the health, diversity, and stability of the ecosystem are a first consideration.

Ecosystem medicine bases itself in a community context and limits the use of the ecosystem to that which the ecosystem can afford to provide and remain healthy over indefinite time. Ecosystem Medicine undertakes the responsibility to preserve the healthy functioning of the ecosystems under its domain. It also has a responsibility for the ecological production of goods from an ecosystem.

This is the local application of ideas for specific ecosystems, which may have a direct link to human health. The systems still have to be self-sustaining and self-renewing, Of course, the planet can also be linked directly to human health. In traditional medicine the organs are more integrated than in ecosystems, which are looser and more complex. James Lovelock has emphasized the health of the planet as a single system.

The health of ecosystems and human institutions should be measured with a holistic index. We have not developed qualitative indicators of ecological health or quantitative measures of social health, much less an ecocentric view that would value preserves of nature for themselves.

To address the health of ecosystems, ecosystem medicine would be a temporary medicine, not a constant intervention or even a continuous diet. We have already tried to gain complete control over ecosystems through scientific methods and technological applications. We have not been able to control them successfully. We regard modern medicine as a foolproof system that tried to eliminate weakness, disease, and mistakes. It has not. Ecosystem medicine must limit its goals.

One goal is the pursuit of the health of ecosystems and their inhabitants. Their goal is good health. Individual health is in the context of community health, which is in the context of ecosystem health.

Another goal is security. Symptoms of insecurity are poor human health, migrations, and conflicts (territorial or religious). Environmental security is more than the abundance of natural resources and having a stable social and economic situation. It is the health of the whole system resulting from balanced exploitation by all beings.

Rather than telling the ecosystems what to do, rather than controlling their growth, we need to watch ecosystems to see what they do (this used to be the function of natural history), and we need to let them do it (this requires patience and temperance), with a minimum of interference. Abraham Maslow regards this attitude as taoistic, and the way to ecosystem health is letting the ecosystem do most of the choosing and working.

Our response to the ecosystem, being concerned with its health (as ecosystem doctors or nurses perhaps), is not benign neglect or complete anticipatory stewardship, it is participation in the process of the ecosystem as a harmonious system, with mutually restrained conflicts and constrained influences.

The goodness of our lives reflects an imperfect balance of love and selfishness, reason and passion, sensuous materiality and spirituality. We have the responsibility to be healthy, to contribute to the health of our community, and to contribute to the health of natural ecosystem communities. Good intentions have to be combined with ecological knowledge and ethical behavior for the discipline to be meaningful. Aristotelian ethics emphasized justice and fairness; Epicurean ethics, gentleness and kindness; Stoics, duty; and the later Stoa, love, compassion, and mercy. Our rules for living together have to be a compassionate participation in the whole planetary process.

Figure 63-1. Panoramic view Of Mountain Grove Forest (looking west)

6.3. *Applying Ecological Design & Medicine to Mountain Grove Forest*

By Mike Barnes, Twila Jacobsen, David Parker, Dennis Martinez, Dean Apostel, Brett Dowell, Steve Radcliffe, Karen Walter, Paul Libby, & Alan Wittbecker

Many forests in the Pacific Northwest have been impoverished, but have the capacity for regeneration. As afforestation proceeds to reclaim wasted lands, as it has in England and Europe, more attention will be paid to the shape of the forest. Design principles can guide our decisions. Although design in Europe has primarily been concerned with artificial forests, many of the ideas can be applied to wild forests. A forest is an ecosystem characterized by trees—this definition is broad enough to include tree farms and plantations as special kinds of forests. Human design, until now, has been primarily visual. It has emphasized aesthetic reaction to a place, and also the uniqueness of a place. But, it is not enough to create ragged edged forests to satisfy human eyes; it is not enough to leave beauty strips of real forest to fool travelers. Design is needed to create natural spatial patterns and temporal phases across watersheds and entire landscapes. Ecological design considers the whole context.

The Mountain Grove Forest (MGC) occupies 420 acres of forest and meadows that occupy much of the valley floor and some of the hillsides in the Woodford Creek Watershed on the north of Buck Horn Mountain, which divides the Umpqua and Rogue River Watersheds. MGC is part of a mountainous landscape in southwest Oregon, in the center of the Klamath Mountain geologic province. MGC is bisected by Woodford Creek, which drains the Woodford Creek watershed, which lies with the Cow Creek Watershed (37,937 acres), in the Umpqua River drainage basin, which flows into the eastern Pacific.

This forest is a meeting place and transition zone between the drier Mediterranean-type climate to the south, characterized by the Pine/Oak/Incense Cedar ecosystem, and the moister temperate rainforest to the north, characterized by the Douglas Fir/Grand Fir/Western Hemlock ecosystem. Forest zones on Mountain Grove include a mixed evergreen zone and an interior valley zone. The area is environmentally and floristically diverse, including elements of California, north coast, and eastern Oregon floras with indigenous Klamath species. The floral and faunal communities that existed 500 years ago have been fragmented, removed, or altered. Many of the new associations are maintained only by human intervention, e.g., fire suppression or logging.

6.3.1. *The Setting*

The forest has a unique geology, topography and climate. It is located in the geologically complex and deeply broken Klamath (Siskiyou) mountain physiographic province of southwestern Oregon. The province is composed of four belts of island arc-related volcanic and sedimentary rock, intrusive rock, and ultramarine assemblages; the belts are primarily east-dipping, with older plates in the east thrust over younger plates to the west.

Mountain crests are comprised of steeply folded and faulted pre-Tertiary strata, which vary in elevation from 600 to 1200 meters. The region is set apart from the rest of Southern Oregon by a boundary separating its pre-Tertiary rocks, probably the oldest in Oregon, from rock formations outside the area. Most of the area is decomposed granite or schist. The basin is a highly erodible landscape. MGC is situated primarily in the valley floor at an elevation of about 1500 feet.

The Umpqua interior valley is a relatively warm, dry region with a Mediterranean climate. In the rain shadow of the Klamath Mountains, the Umpqua valley has hot, dry summers, and mild, wet winters, although potential evapotranspiration in the summer exceeds moisture buildup in winter. Average annual temperature is 12 degrees C. (Average January, 4.2, July 20.4). Average annual precipitation is 799 millimeters (US Weather Bureau, 1965).

Precipitation, as rain or snow, is intercepted by the forest canopy. Surface water is held by forest floor structure, including duff and debris, before entering the ground water stream. Some of the water may be held in an aquifer. Much of it is channeled into Woodford Creek, part of the Cow Creek watershed.

Soils in this Klamath Mountains belong in a widespread great group, Haplohumults (reddish brown lateritic soils). The soils are moderately deep (102 meters to bedrock) and possess a silty loam or silty clay loam A horizon underlain by a silty clay B horizon. Scattered upland areas of peridotite or serpentine bedrock have reddish-colored soils classed as Hapludalfs (gray-brown podzolic) or Xerochrepts (Regosols), which are considered unproductive, with very shallow and stony profiles.

6.3.1.1. Vegetation

The *Tsuga heterophylla* forest zone is considered to end its southern limit just north of MGC, at the North and South Umpqua River divide; it is regularly dominated by the fir subclimax. The oak woodland of the Umpqua valley has a well-developed canopy of firs and pines; this woodland ranges from open savannas with grass understories to dense forest stands with an abundance of conifer associates.

The vegetational mosaic can be characterized as 'Interior Valley' or typologically as a pine-oak-Douglas-fir zone, according to Franklin and Dyrness. The mosaic includes oak woodlands, coniferous forests, grasslands, chaparral (sclerophyllous shrub communities), and riparian forests—all considered semi-natural rather than mature communities, due to human activities. The 'mixed-evergreen' occurs usually above 800 feet elevation. Detling (1968) typified the vegetation of the Umpqua as chaparral, with a peripheral belt of pine-oak forest.

Mixed stands of deciduous oaks and evergreen Arbutus are conspicuous. Douglas-fir is common in the stands. Important shrubs are Ceanothus and Cercocarpus, especially on east and southeast slopes. Northeastern slopes and more mesic sites have open stands of Douglas-fir, Ponderosa pine, and incense-cedar, with a well-developed lower canopy of Oregon white oak. Typical understory species include Pacific poison oak, low dogbane, honeysuckle, balsamroot, fescues, lupines, brodiaea, and ground cone.

In coniferous forests, which tend to be in the uplands, Douglas-fir is considered most common, although Ponderosa pine and incense-cedar are conspicuous. Associated hardwoods include bigleaf maple, madrone, and oaks.

Some grassland or prairie communities may be mature sites on some soils or xeric sites. Others appear to be successional, maintained by fire and human activities. Some interior valley zones, dominated by soft brome, dogtail, and ryegrass, are invaded by sweetbriar rose and poison oak. Chaparral in interior valleys is dominated by buckbrush and manzanita, with other species present: Deerbrush, poison oak, dogwood, and tanoak. Riparian habitats have a typical hardwood component, such as black cottonwood, willow, bigleaf maple, and alder.

6.3.1.2. Animal Life

The Mountain Grove Forest is somewhat depauperate. High animal species diversity results from high forest structural and compositional diversity, and that depends, in turn, on species, community and age/size diversity in plants from ground to crown. Wildlife is a prime indicator of a healthy, fully functioning forest in their role as seed/spore dispersal agents, herbivory checks (from rodents to beetles), the health of soil fauna and flora, stream and aquatic habitat health and much more.

Only four of twelve arboreal mammals remain. Two species of woodrats, which are prime food for the northern spotted owl, are no longer seen. Woodrats abandon their stick houses when understory food plants disappear. Other arboreal mammals, including squirrels, porcupines, red tree voles, martens, fishers, chipmunks, forest deer mice, and woodrats, are a keystone species guild. They all depend on trees in some important ways, and they are either the main or supplemental food for forest predators, including most raptors.

Many tree-dependent mammals, with the sole exception of the red tree vole, depend even more on an adequate supply of quality understory plants for continuing survival. Porcupines depend more on understory herbs and shrubs than the inner bark of trees. The northern flying squirrel eats truffles (fruiting bodies of mycorrhizal fungi) and passes spores in their feces. Mycorrhizal fungi form a symbiotic relationship with trees by attaching themselves to the roots and greatly increase the uptake of nutrients and water, and by providing a large measure of resistance to disease. When the forest reaches the stem-exclusion stage, northern flying squirrels, like wood rats and owls, move on.

Of the fifty-eight shade-tolerant plant species at MGC, which remain at some population level, most are decreasing or have stopped flowering and fruiting. Many flying insect pollinators will not visit plants in the shade even if they are tolerant enough to flower.

Only twenty-four bird species have been counted so far. The BLM bird checklist for our region indicates that we should have over one hundred bird species as residents or winter/summer visitors. Few bat species remain of the thirteen species known in southwestern Oregon. Deer and elk are not usually seen because their prime browse plants have been shaded out of the forest. Some species of frogs and salamanders are locally extinct.

Finally, the endangered oak/ash wetland and oak/pine woodland are, along with riparian zones, principal habitats for the largest number of species, as well as the most endangered species, especially birds. At least fifty bird species are associated with mature or old growth pine woodland alone in southwestern Oregon. And, more animals live in a mixed hardwood/conifer forest than in one dominated only by conifers.

6.3.1.3. Cultural History

The valley served historically as the meeting ground of the Umpqua Indians. Prior to management by European settlers, fire was the dominant process affecting upslope and riparian vegetation (above the floodplain). Many sites burned, or were burned by tribal groups, as often as every 15 years and usually once every 100 years. A complex fire regime created complex vegetation patterns on the stand and landscape level. Fundamental ecosystem cycles—plant succession, nutrient cycling, individual life cycles—were driven by fire disturbance.

Through fire suppression, modern management has excluded fire as a disturbance process. Timber harvest practices, however, produced intense disturbances throughout much of the landscape, as have human house and travel patterns. These altered disturbances have fragmented the landscape; both early and late seral vegetation are often absent. The total species diversity is lower; tree density is higher. High tree density contributes to higher mortality among pines, from insect attacks. The accumulation of fuel loads increases wildfire hazards.

The forest of the Woodford Creek Watershed was initially high-graded in the early 1900s, when a railroad spur was constructed. The forest was then clearcut and burned between the late 1930s and 50s. The old growth timber was logged by later settlers in the early 1900s with the railroad taking wood to Glendale Junction. One tree, 66” in diameter, 280 years old, indicated that there were fires every 50-80 years in some parts of the valley. Partial logging occurred until the 1950s. The 1953-54 selective logging compacted much of the soils of the forest. It appears that the forest was cat-logged and that the tractors were not restricted to the skid roads. In 1985-86 a network of narrow roads, contoured with the land, was built. They were designed so that trees could be yarded to the roads by cable without compacting the forest soils.

A 420-acre parcel was purchased in 1969 by the New Education Foundation, with the intent of setting up a rural community school. Existing buildings at the time of purchase consisted of an old homestead and dairy with 320 acres of timber. Numerous houses and cabins were built in the 1960s and 1970s. Several have been refurbished for occupancy, while others are used for storage. A large Community building stands at the top of the lower meadow, about a mile from the property entrance. The remainder of the property was developed as agricultural land. The Foundation, on purchasing the property, established the conceptual policy of living with and appreciating the forest. This meant not cutting any trees. In 1982 residents first agreed to practice what they termed "ecological forestry" or "radical forestry." During the early 1980s they began commercial thinning using horses. The current condition of the forest is largely a consequence of past clearcutting, cattle grazing and fire suppression practices which resulted in an even-aged, simplified, overstocked forest with high fire hazard.

6.3.2. *Forest Management and Harvest History*

Community members, with the help of county Extension Service, cruised the timber in 1982, using tenth acre plots. The cruise resulted in projections of three million board feet (3 mmbf) of merchantable timber, without much detail as to the condition of the rest of the stand. The Extension Service forester wrote a management plan, recommending the clearcutting of large areas. With the timber prices low in 1982, the board enlisted a forester living on the property to commence a horse-logging operation. He cut 25 mbf before he became discouraged with the project and left. The board then asked another resident of the foundation's community, to take over the timber management project. All right of way timber and selected trees within 150-200' of roads were harvested either by cat or tractor winching.

Continued firewood collection from cleanup and some thinning in heavy areas was done by community residents in 1990. The writing of the management plan continued, with plots being assessed and new data collected. Decisions concerning selection thinning, correct tree spacing and economic necessity were weighed. Different microclimates and stand types were identified; permanent plots were established and cruise data collected. Precommercial and commercial thinning continued to be practiced through the late 1980s and early 90s, leaving the biggest and best trees. However, within five years following each thinning, forest growth again closed the canopy, leaving the forest in a stem-exclusion stage with tree growth slowing down and fuels continuing to accumulate.

Although research was intended to be a priority, the largest mistake was not to set up enough control plots. Plots that were set up provided some information; however, budget for research was not a priority. In the fall of 1994, following the first Ecoforestry Design Course, a new inventory and monitoring system was designed by Jerry and Sharon Becker. The survey, again, found that most stands were largely in a stem-exclusion stage and that fire hazard was high. Fire hazard reduction became a top priority.

6.3.2.1. Ecosystem Types

The Mountain Grove forest currently contains at least four (4) distinct ecosystem types: (1) Lower elevation, riparian areas with a predominance of Douglas-fir and Grand Fir, with Yew, Madrone, and Vine and Big Leaf Maples. In the absence of disturbance, i.e., fire, the number of Grand Fir is increasing as the stand becomes denser. (2) Mid-level mixed species forest with a predominance of Douglas-fir, Incense Cedar, Madrone, Chinquapin, and scattered

Sugar Pine. (3) Mid-level hot SW sites dominated by Chinquapin with nearly 100% canopy closure and little regeneration with some Douglas-fir and Madrone. And (4) Higher elevation, 1,700’ and higher, forest dominated by Douglas-fir, Incense Cedar, Madrone, Chinquapin, and a few Sugar pine. In the absence of disturbance, i.e., fire, the Sugar Pine are being crowded by the other species, particularly by the Douglas-fir, and there is little regeneration of Sugar Pine. As a result of historical processes and disturbances, the structure of the forest has four (4) distinct structural and size/age classes: (1) Old-growth Douglas-fir, Incense Cedar and Sugar Pine which predate the fires in the 1920s and the later clearcutting and burning; (2) Trees which regenerated since the fire are now 69 years old and younger; (3) Trees which regenerated since the 1953-54 selective logging and are now 42 years old and younger; (4) Middle-aged Hardwood groves, particularly Chinquapin.

6.3.2.2. Management Zones

Units were originally set up as harvest units rather than as to type and have since been changed to account for this. There were originally 9 units, but they were expanded in 1985 to 15 ecozones, including ponderosa pine, Pacific Madrone, Douglas-fir, and white fir. The 15 zones are characterized by size, slope, aspect, vegetation, diversity, fuel load, and special populations. MGC is considered to be located in a high Site 3 area, with a growth rate of 700+ mbf per acre per year. The results of the 1982 cruise indicated that MGC had 2.89 mmbf standing. The expected increase in volume, using the index, was 3.15 mmbf (700 bf/ac/yr 300 acres 15 years), resulting in 6.04 mmbf.

The total amount cut at MGC in its harvests between 1982 and 1997 has been 0.65 mmbf. Divided by 15 years, this means MGC is only cutting 43,333 bf per year. The results of assessment of permanent plots indicates that MGC has 6.20 mmbf of standing timber in 1997. The growth rate is calculated at 733 bf/ac/yr. The AAC is calculated at approximately 50 percent of the growth rate, to account for old growth that will not be cut. MGC does not consider timber the only product of the forest.

6.3.2.3. State of Forest & Health Assessment

The MGC forest is mostly second growth about fifty to seventy years old and entering the shady, densely-stocked ‘stem exclusion’ style of forest development. Because of complete or nearly complete canopy closure, with heavy shade and moisture retention, forest conditions favor regeneration of the more shade tolerant tree and shrub species—grand fir, incense cedar, western hemlock (we have little so far), bigleaf maple, vine maple, red huckleberry, oceanspray (iron wood), Indian plum, bane berry, hazelnut, western yew, salal, creeping snowberry, baldhip rose, longleaf Oregon grape, whipplevine (yerba de selva) and hairy honeysuckle. Seedlings of some species are also favored but usually begin to die in heavy shade before reaching maturity (Douglas fir, cascara, madrone, canyon liveoak) or remain suppressed for decades until released (tanoak, incense cedar).

There is a whole class of plants, constituting a major and—for wildlife and special forest products—critical part of biodiversity at MGC, which are present but are disappearing because of heavy shade. There are few seedlings in any stand interiors of black oak, white oak, sugar pine, Ponderosa pine, bitter cherry, choke cherry, Chinquapin, and mountain mahogany. Douglas fir in the lowland forest is losing ground to grand fir. Most native grass species exist in fragmented remnant stands on forest-meadow edges. Many other native grasses are locally extinct, but probably exist in the greater region in isolated remnant stands. Numerous flowering forbs are missing or exist here only as widely scattered solitary individuals—preventing genetic exchange which will quickly lead to local extirpation.

6.3.2.4. Wildlife Assessment

Nearly all of the sun-requiring or shade tolerant (but not maturing or producing fruit or seeds in heavy shade) plants mentioned above are important food plants for wildlife. A 1997 survey revealed fewer wildlife signs compared to other parts of Southwest Oregon. Even the woodrats—specialist feeders on hard-to-digest leaves of plants like manzanita and madrone—have abandoned their stick houses and moved away or are now residing in human cabins. Only twenty-four bird species have been counted so far, although more should appear as the seasons change. The Medford District BLM bird checklist notes around 150 birds, which should be Summer/Winter visitors or residents in this general area. Conservatively, there should be at least 100 bird species at MGC over all four seasons.

Deer and elk browse is in very short supply. Deer and elk do pass through here—although not in great numbers—and are rarely seen. There is evidence of an elk mud wallow up Woodford Creek (with scat and tracks). Dennis Martinez found only one or two corn lily plants—a favorite elk food—in the survey so far. There is little willow, deerbrush, or wedgeleaf buckbrush—the three most important food species for deer—and few nice, tasty succulent forbs or high protein native grasses (high protein browse, especially high after fires, assists deer in digesting the tannin in acorns and oak leaves, another favorite deer food now endangered).

Trees are linked to other cycled in the forest by species of arboreal mammals. There should be twelve species at MGC and vicinity: red tree vole, western gray squirrel, northern flying squirrel, Douglas' squirrel, dusky-footed woodrat, bushy-tailed woodrat, Townsends chipmunk, porcupine, marten, fisher, raccoon and possibly forest deer mouse. Except for the red tree vole which rarely comes down from trees, all of the above species, while depending more or less on trees for nests, depend on quality food plants usually found on the ground in at least partly sunny forest openings. Of the twelve arboreal mammals that should be at MGC, only four are noticeably and consistently here. Arboreal rodents are 'keystone species' in forest ecosystems; if they are largely missing, many other species will be impacted. An example is the endangered northern spotted owl, which feeds on the smaller arboreal mammals, such as woodrats, which in turn require food plants, which grow well only in sunnier forest openings. This food chain from avian predators like hawks and owls to arboreal rodents includes sun-requiring forest understory species also as keystone species. This translates into forest structure—gaps and edges between groups of trees—as serving a keystone role in forest ecosystems as well.

There are some porcupines here, but they eat more herbaceous plants in the forest understory than inner bark (cambium) and dwarf mistletoe (in short supply). There are Douglas' squirrel, which eats primarily Douglas fir cone seeds but will switch to hazelnut when fir crops fail, western gray squirrel and Townsends chipmunk here. Western gray squirrel needs lots of oak acorns and other native seeds and nuts, which typically grow in sunny forest openings or oak/pine woodland and tufted hairgrass wetlands. These ecotypes are endangered. An early survey did not record any sign of northern flying squirrel, which eats mainly fruiting bodies of mycorrhizal fungi (which are plentiful) and lichens, but depends on understory ericaceous shrubs, e.g. huckleberry, salal, manzanita, which form symbiotic mycorrhizal connections underground with the fungi, for cover while foraging on the ground for truffles.

Wildlife requires snags and large downed logs. Most of the arboreal mammals mentioned above are cavity nesters, as are bats, many bird species, and black bears. Bird species include pileated woodpecker, redbreasted sapsucker, acorn woodpecker, turkey vulture, owls and raptors, osprey, bald eagle, flycatchers and brown creeper. All of these classes of forest species use cavities or loose bark in at least eighteen different ways besides just nesting—everything from lookouts and drumming or singing stations to food sources.

Large down logs over 4 meters in diameter are great reservoirs of water in the dry seasons, nursing tree and shrub seedlings through nutrient and water release and inoculating these plants with fungi which hold out when its dry under or in logs. Reptiles also benefit from the moisture, especially salamanders. Invertebrate (insects) decomposers live there and provide food for birds, bears, bats, raccoons, and other species. Specialists will assist in identification of reptiles and invertebrates.

Part of this design is to assess the property for endangered species. Salamanders that should be present include western red-backed, Pacific giant, ensatina, clouded, northwestern, and Dunn's. The diurnal rough-skinned newt is very commonly seen. Frogs are common, but red-legged frog and western toad could be here—wetland restoration should favor both of these. Reptiles, including rubber boa, racer, ringneck, common kingsnake, and possibly mountain kingsnake, sharptail, gopher, and western rattlesnake have been noted; gopher, racer, northwestern garter, Pacific coast aquatic garter, common garter and western terrestrial garter snakes are in abundance.

6.3.3. *Design Objectives*

A number of general objectives has been agreed upon by the residents of and workers at MGC. These include:

- To protect, maintain and restore the Mountain Grove forest as a fully functioning forest ecosystem in perpetuity as a multi-species, multi-aged forest with old-growth characteristics within a landscape perspective.
- To recognize all forest values, including terrestrial and aquatic wildlife habitat, timber and other forest goods, e.g., mushrooms or medicinals, sources of clear water, fresh air, carbon sink, et al.
- To maintain and restore the natural habitat of Woodford Creek to encourage migration of indigenous aquatic species.
- To protect the forest against catastrophic fire.
- To practice, demonstrate and teach ecologically responsible forest use and restoration. To establish a Model Forest that can demonstrate to the public how to sustain and restore a fully functional forest, while harvesting a range of forest products.
- To provide a range of forest uses and forest goods on a long-term sustainable basis, and to provide employment for people in the local community who are sustained by the forest.
- To manage timber for quality wood for high-end uses, recognizing that precommercial and commercial thinning are also necessary in some situations to restore forest structure, composition and functioning.
- To establish a conservation easement on MGC land to ensure that MGC forestry management objectives will continue to be implemented for generations to come.

6.3.3.1. Landscape & Watershed Objectives

The bioregion has been altered tremendously by recent human impacts. Neighboring forest properties in the watershed have been overcut; this means that MGC cuts do not take place in a vacuum, but have to consider watershed and landscape processes. For example, if surrounding land has been overcut, it would not be wise for MGC to take as large a cut as it could if the surrounding lands were whole and functioning in a healthy way. So MGC forest objectives take place in a matrix of objectives that are being considered for the landscape.

Fire, Wind and Water are key natural disturbances in the valley. MGC foresters seek to intervene in the forest ecosystem in ways that protect, maintain and restore the whole system. By augmenting the abundance of the whole system we augment the well-being of all the beings who live in the watershed.

Since humans are part of the ecological equation—major players, in fact—it is critical that the Management Plan and subsequent activities take into account the environmental, social, economic and cultural aspects of reality, as we understand it. The MGC Management Plan is a component of a broader MGC Business Plan to develop an "Eco-village" of sustainable living, as well as an Educational Center for healing and restoring the watershed and ourselves.

Proper forest functioning requires understanding zones and corridors. MGC has as an important objective, the establishment of cross-valley corridors for wildlife and vegetation shifts. One possible corridor is in the 'waist' of MGC property, where it is bordered by relatively whole BLM properties; this would offer the shortest corridor with almost continuous forest cover. However, animals have traditionally used the wide lower field for transit; these fields connect with forest that has been cut heavily by private owners and offers a more dangerous crossing. The field is also a break in forest cover.

MGC has set up 15 management zones. It intends to manage these according to set prescriptions, depending on other objectives, historical use, and best potential use. The activities are restoration, thinning, planting, and prescribed burns. The idea of the design is to move towards a multi-age, multi-species forests with at least 3 general age-classes: (1) old-growth (age range to vary according to species); (2) mature second-growth with good canopy position; and (3) regeneration. Maintain most existing old-growth of every species. Emulate fire through management activities, i.e., thinning, some patch cuts, harvesting more heavily of shade-tolerant species, such as Grand fir. Consider use of controlled burns in a few selected small areas. Encourage regeneration

Goals are set for various groupings in the zones: To maintain habitat, including host species, structures, and food supplies for key old-growth species of birds. To provide artificial structures in the interim. To minimize disruptions to bird populations. To consider impacts for migrating birds. For Amphibians, Reptiles, Fish, to maintain specific moist habitat for amphibians, and, to minimize disruptions for amphibian and reptile populations. To create old-growth structure in each of the management zones (probably from 20-30%). To restore the major plant associations on appropriate sites. To maintain productive associations, such as Douglas-fir and incense-cedar, on appropriate sites, e.g., those that have 200-500 year-old trees. To allow natural regeneration as much as possible. Within these zones and their goals, we expect to accomplish several important things.

6.3.3.1.1. *Preserve the watershed*. Further landscape-level planning needs to be conducted over time and in cooperation with surrounding forest land owners/managers of both private and public forest lands. The owners and managers of the Mountain Grove forest will cooperate with adjoining landowners to plan and carry out forest use at a landscape level where opportunities present themselves. Some current ecosystem types will likely change over time, i.e., the Chinquapin grove is first successional on a hot SW slope, which over time will likely become a more heavily conifer dominated forest stand.

6.3.3.1.2. *Preserve the Forest*. In order to protect, maintain and restore the forest as a fully functioning ecosystem, the design addresses old growth, restoration and riparian areas. We work to maintain and restore (where necessary) an old-growth forest that is fully functioning, structurally diverse, and aesthetically-pleasing. We work to Restore several zones to an oak-pine woodland; that is, those zones that are drier, have many oak and pine individuals, and could support the association with a minimum of future intervention. Several zones will be restored to the Douglas Fir/Grand Fir/Western Hemlock association. Large Douglas-firs are already resident in these zones. Restore a small western redcedar zone on a north-slope above the riparian. We work to maintain and restore Woodford Creek to a condition where it could support anadromous fish, with an appropriate sinuosity, gradient, bed, and debris. Keep the canopy large and half-open (for ambient light levels enjoyed by fish and birds). Some minimal thinning may occur in riparian areas for restoration purposes. They need to meet the requirements of the Oregon State Forest Practices Act and be in accordance with landscape objectives and plans.

6.3.3.1.3. *Promote Regeneration*. MGC follows Jerry Franklin and others in expecting Douglas-fir to regenerate from single-tree and group selection cuts, as well as from shelter-wood or clearcuts. If periodically thinned, Douglas-fir can maintain good growth for 200 or more years; therefore, rotation times of 200 years are economically feasible. Pine and oak forests regenerate adequately after group selection cuts. MGC expects to regulate regeneration only to the extent of opening some areas to light and moisture. Many variables affect regeneration—soils, humus, canopy opening, episodic seeding, rainfall, animal predation and movements—but MGC only attempts to control canopy. Under certain conditions, e.g., restoration of species or replanting from roads, MGC may plant a limited number of trees.

6.3.3.1.4. *Keep Wildlife Trees.* The full spectrum of wildlife in a forest requires a full spectrum of habitat conditions. Each stage of decay hosts a variety of use, not only different species, but different parts of the life cycle of a species. House wrens for instance prefer small green trees, while woodpeckers use trees in the early phases of insect attack. For these reasons Mountain Grove will keep a full complement of wildlife trees in every stage of life and death. Wildlife trees are selected according to species (for target bird and insect populations), hardness (for longevity, as appropriate), size (to have a full range of sizes), location (to be well-distributed throughout the property), and quantity (MGC has an interim target of 5 per acre).

6.3.3.1.5. *Heritage Trees*. Old-Growth vestiges of an original, pre-management stand or forest are kept in numbers as heritage trees. Heritage trees provide important ecological functions in a stand, forest or landscape that has been converted to secondary forest. These trees perform a lifeboating function to animal and plant populations, especially forest interior-dwelling species, during the regrowth of the forest to a mature condition. Heritage trees are selected according to species (native forest), form (in general, trees with a large bole, thick bark, and flat top), vigor (continued horizontal growth, good crown), size (usually very large for the species, e.g., 1.1 meters (~42 inches) for Douglas-fir), and quantity (MGC has an interim target of 17 per hectare (7 per ac) or an occupancy of 30 percent of the canopy).

6.3.3.1.6. *Legacy Trees.* Healthy mature trees, either dominants or suppressed, are recruited to become old-growth members in the maturing forest. These trees will probably never be harvested, although depending on recruitment success and the longevity of heritage trees, a few may be cut. These trees are determined by a phenomenological inspection that addresses vigor, vitality, context, and species. Legacy trees are selected according to species (for a native mature forest), vigor (with good growth rate, needle color and density, and crown fullness), form (having a low taper, high branching habit, and few bole defects), and other factors.

6.3.3.1.7. *Restoration*. In restoration areas, absent native species, e.g. western redcedar, will be introduced through planting. Native seedlings will be ordered from seed zones appropriate for the site. The planted species will be calculated to comprise an appropriate percentage of the forest, e.g., western redcedar occurred in draws in the Douglas-fir, grand fir, hemlock zone and rarely comprised more than 30 percent of the stand. In old field conversion to forest, seedlings will be transplanted for equivalent sites from roads, other fields, or natural nursery areas. If seedlings are purchased, native seedlings will be ordered from seed zones appropriate for the site. The planted species will be calculated to comprise an appropriate percentage of the forest.

6.3.3.2. Mapping & Monitoring

Mapping is critical to understanding inventory. MGC has been reworking its maps, using a layer-cake model. Layers include topography, ownerships, roads and trails, habitat types, conservation areas, management zones, and harvest areas. These maps are being put together with computer program.

Monitoring at Mountain Grove is the systematic recording of soil, air, water, and vegetation numbers, to identify long-term trends in the forest ecosystem, that is, patterns of: primary productivity and tree growth rates, organic matter accumulation, inorganic inputs and movements through soils and water, disturbances, populations in trophic structure, and soil compaction.

Before monitoring is begun, the objectives and data collection methods are decided. The purpose of the monitoring program is stated and the objectives are identified, e.g., the health of the forest. Health is the first objective, followed by production and aesthetics. Health can be "defined" by a set of indicators of health, such as species numbers or presence, or by patterns of health, such as stability or productivity. None of the indices that are measured are really adequate to define the health of the forest because they cannot account for the complexity, richness, and cycling that goes on in the forest. For that reason health indices are data that need to be resolved on the ground by someone who knows the history of the forest.

The information needs to be credible, and gathered strategically and carefully. It needs to be entered into a data management system that is both relational and spatial, not for easy cures or the reduction of the forest into numbers, but as a way to gauge relationships and their patterns. The data essentially involves a complex series of relationships between the various events that are going on inside and outside its boundaries over large and small spatial and temporal scales. To understand the physiology of the forest requires that all view-points be considered together (top-down, bottom-up, or across the landscape).

6.3.3.2.1. *Physical/Chemical Dimension*. The structural integrity of forested ecosystems is vital to their continuance. Mechanical and chemical disturbances affect major changes in the structure and function of natural communities. This is an attempt to define a diagnostic procedure for reading the changing landscape. This procedure will need continual up-grading as workers fine-tune their ability to perceive and record the changes of structure, function, and the potential for response to disturbance. Measurements will be taken to monitor compaction, stream chemistry, landscape and stream morphology, and atmospheric effects. Forests have important biological characteristics that can be measured and monitored, including species habitat viability, plant associations, habitat linkages and fragmentation, historic range and variability of species, and soil organics.

6.3.3.2.2. *Human Dimension*. Human values ultimately determine what, where, and how we monitor forest management activities. Therefore, it is imperative that cultural values and natural processes be determined and monitored simultaneously. In this way, we can begin to understand which natural processes we use, favor or discourage in order to benefit our current value system (Re Martinez, 1993). Monitoring and evaluation of the indicators below provides necessary information in understanding the human dimension as it relates to ecosystem management. Social and economic data is often compiled by standard political boundaries, not on provinces, sub-provinces, landscapes or project sites. Thus, socioeconomic data is not strictly comparable or usable at the sub-province, landscape or project site levels.

6.3.3.3. Planning and Design

Natural processes—building up/breaking down, development, disturbance—animal movement, interelement flows, human interaction, and shifting mosaics, all operate in forests. The science of Conservation Biology suggests a number of rules for reserve design that are based on natural patterns: Large blocks of habitat are safer from species extinctions; blocks close together are better; contiguous blocks are better than fragmented; interconnected blocks are better than isolated; corridors can make large blocks functional; and, human disturbances similar to natural ones are less threatening or disruptive.

These rules are used to guide plans for restoration and preservation. In the short-term, staff at MGC continues to work on ecological plans for the forest. The long-term is also anticipated. Although it may not be possible to avoid ecological changes—nature is always shifting and changing—some changes such as the greenhouse effect can be taken into consideration with cutting and planting.

Some areas will be preserved. MGC intends to preserve old-growth Douglas-fir trees in areas where they are doing well. Because the forest itself has been so heavily altered, individual trees will be preserved. Two areas that are relatively healthy and functioning will be set aside as wilderness areas.

Other areas will be restored. MGC is probably the southernmost extension of southern Willamette wetland communities. The wetland and riparian species listed are native to both the southern Willamette Valley and the low elevation valleys of the Umpqua Basin. They include federally listed species like Bradshaw's Lomatium. Nelson's checkerspot, rough popcorn flower, Bensoniella, slender meadow foam, Oregon willow herb and red-root yampah probably occurred in Southern Douglas County, part of the Umpqua Basin, as well as in wetland communities as far south as Glendale and MGC in the Cow Creek drainage. We are considering restoring two wetland communities at MGC: wetland prairie and shrub swamp.

6.3.3.3.1. Design of Wetland Prairie

The historically dominant species—tufted hairgrass in the wetter places; perhaps co-dominant with slough and meadow barley; sedges and red fescue in the drier places—are nearly locally extinct. Only small remnant patches remain. Small remnant stands of more abundant grasses like wild blue-rye, oat grass, sheep's fescue, rough fescue, California fescue and Columbia brome have been located and flagged as future seed sources. Still other grasses and forbs will be collected on public or private lands off-site. Some herbaceous wet prairie plants exist on-site and have been flagged, e.g. grass widows, camas, buttercup, kneeling angelica, owl's clover, and field checker-mallow.

There are numerous benefits from restoring these communities: Support species diversity from relatively local seed sources, both on and off site within 50 miles; protect existing remnant wetlands from further degradation; expand wetland remnants through restoration techniques; expanded wetlands with greater native species richness may attract the threatened (although not necessarily listed) bird community associated with native grasslands and wet prairies; large logs placed in wet prairie may offer protection and habitat for some native amphibians and reptiles; federally listed wet prairie species like Bradshaw's Lomatium—if local seed is found and necessary permits obtained—could find a permanent protected refuge at MGC; exotic invaders like tall fescue will be contained and reduced.

6.3.3.3.2. Design of Shrub Swamp & Wooded Wetland Communities

Remnants of these once extensive communities exist at MGC. Present wetland remnants combine indicator species of wet prairie, shrub swamp and wooded wetland communities. Moreover, these communities inter-finger with drier oak/pine woodland, as well as riparian gallery forest. There is at present no neat line between all of these communities. Vegetation surveys at MGC have located and flagged the following native and exotic wetland indicator species. Native species include kneeling angelica, swamp lupine, meadow clumroot, nootka rose, Oregon ash, and Douglas spiraea.

6.3.3.3.3. Oak Woodland Restoration Management Plan

MGC's 420 acres consists of approximately 300 acres second growth Douglas Fir dominated forest (around 70 years old) and 100 acres meadow dominated by exotic tall fescue. Included are Woodford Creek riparian zone and remnant native ash\sporaea\slough sedge wetlands. Basically, the forest designated as oak-pine woodland (28 acres) is in the stem-exclusion phase of development with high stocking rates of younger trees (over 1,000 stems/acre) and high fuel loading/fuel ladders. Quality wildlife habitat is nearly gone, while wild fire is a threat.

We propose to thin (group and individual selection cuts) on a 5 year reentry schedule) for the next 10 years. Thinning goals are to generate revenue for restoring wildlife habitat, reduce fuel load to alleviate fire hazard, regenerate wildlife plants and habitat understory native shrubs/forbs/grasses/sedges; Ponderosa and sugar pine; black and white oak, canyon live oak and tan oak; incense cedar, madrone, Chinquapin, bitter cherry, maple and ash; red and white alder, vine maple, cottonwood, big leaf maple, ash, cascara, and red cedar in the riparian zone. Thinning will also be used to restore patchy forest structure and species-rich composition, restore underground mycorrhizal fungal-plant relationship, and restore wetlands. Target wildlife species for consideration include deer and elk, arboreal mammals, bats, passerine and game birds, raptors, and anadromous fish (we currently have only cutthroat trout) and eels/aquatic snails.

We also intend to reduce or eliminate exotic or weedy native pest flora and fauna, such as: spotted knapweed, tall fescue (convert meadows to native grasses/forbs/sedges with scattered pine, oak and incense cedar/maintain by fire), canary reedgrass, deer mice, and pine and fir beetle, and blackstain fungus.

To accomplish these goals we propose the following restoration tasks: Thinning with individual and group selection cuts/selling merchantable timber, prescription fire on rotational basis to maintain opens, and restoring native grasses/forbs/sedge to carry fire in opens when closed parts of forest are damp. Those areas not designated as preservation, restoration (which may, however, produce some timber or alternate materials through the restoration process), or riparian shall be covered under the silvicultural plan.

6.3.3.3.4. Old Growth Design

There is a separate age class for Old Growth. Approximately 30% of the forest shall be maintained in late-successional, old growth seral stage. Existing remnant old growth trees, which are scattered across the forest, need to be protected. Other dominant trees need to be identified as old-growth recruits. Old growth is defined differently for different species, based on how long such trees live. Douglas Fir can live to be 1,000 year or longer. Generally, a Douglas-fir does not reach maturity until it is about 125 years old. Old growth begins at about 150-200 years of age.

Since the forest is a growing, dying, dynamic community, today's old growth will become snags (for another 100+ years) and eventually fall to the forest ground to become woody debris (for another 100+ years, before finally becoming soil from which the forest of the future will grow. Snags can be considered as part of the 30% old growth structure in the forest. Accordingly, old growth recruitment is an on-going process. In one small experiment in the Altazor Forest in Idaho, we tried to accelerate old growth structure by changing the conditions surrounding middle-aged trees on 3 hectares and by modifying individual trees. For instance, one 60-year old tree was topped so its profile resembled an old growth tree, and it could be used by vultures and eagles. Two others were burned near the roots to mimic fire effects. Approximately 30 smaller trees were removed to simulate spacing in an old growth grove. The effects of that experiment have not been determined yet.

The old growth structure should be scattered across the forest, as well as in small stands along the creeks and riparian areas. In the balance of the forest, a minimum of approximately 30% of the forest shall be maintained in the 60 to 150 year age class, and maximum of approximately 30% of the forest can be maintained in the 1 to 60 year age class.

6.3.3.3.5. Wind Disturbance & Fire Plan

One important part of the design and plan is the response to disturbances. Many kinds of disturbances occur in a forest; many species are adapted to regular disturbances. Disturbances include fire, wind, and erosion (especially with local soils). However, it is difficult to manage disturbances in a human system.

Wind disturbances can be managed to some extend by not cutting edge trees, which protect interior trees. Because of the topography of the valley, wind should not be magnified or diminished as a result of cutting patterns on other properties.

Fire disturbance, however, is a threat. Because the MGC forest is largely a second-growth, even-aged forest, with 90-100% canopy cover over much of the forest, the fire danger is high. Cruise data, Permanent Plots and Photo Points indicate the same. Current data indicates that the Woodford Creek Watershed has experienced stand-replacement fires on an 80 year cycle. The last seems to have been over 70 years ago. Living in this forest, while studying it, we will experience first hand the dynamics of this fire cycle.

6.3.3.4. Specific Design Elements

All design elements are related psychologically by designers, as focus or frame, as contrast or uniformity, as dominant or recessive, or in a number of other pairs. Good ecosystem design means not violating any of the aforementioned principles or ideas.

Design can improve the results of bad practices. Bad harvesting practices in forests for instance often result in geometric wastelands. Good design can correct a misplaced reliance on straight lines, parallel lines, right angles, and perfect symmetry. In cutting or planting to improve natural appearance, a number of things have to be considered, including the age of the forest, windthrow, width of corridors, and minimum size of the habitat. Specific design elements include: Minimum sizes, shapes, completeness, diversity of elements, and standard design elements, such as foreground, margins, edges, boundaries, paths, water courses, openings, horizon, and character.

Many of these elements guide our work at MGC. Although the MGC forest is far too small to support viable populations of large predators, it can protect many smaller species, and some individuals of larger species, such as bears, mountain lions, and coyotes. The percentage of full sun and dappled shade recommended by the English Forest Authority guided the restoration of Woodford Creek. The forest at MGC is a great contrast to the sky and to the surrounding harvested forests, as these 'professionally' harvested hillsides look scalped.

6.3.4. *General Strategy for Actions*

We propose to thin each management area on a 5-year reentry schedule for the indefinite future. Thinning goals are to: Initiate regular rotational prescription fire following thinning, restore patchy forest structure and species-rich composition, and to restore underground mycorrhizal fungal-plant relationship.

Certain major plant species are targeted for reintroduction: Western hemlock on a small north slope area in the riparian upland, and western redcedar, which was extirpated by cutting, on north slopes and draws. Certain wildlife species or guilds are targeted for reintroduction: Arboreal mammals, bats, raptors, reptiles and amphibians, and invertebrates, especially pollinators and decomposers. Certain exotic or weedy native pest flora and fauna are targeted for reduction: Cut leaf blackberry, Himalaya blackberry, sweetbrier rose, deer mice, ticks, mistletoe (within limits), and pine and fir beetle/blackstain fungus.

These designs and plans are based on the current conditions of the forest, as modified by knowledge of how the forest has looked in the immediate and distant past. Special attention is to be given to the requirements of many species for specific habitats. In the interim, we may provide temporary structures, such as bat boxes, or create snags by girdling. Certain parts of the forest may need to be set aside to heal or develop. We intend to set boundaries and monitor those areas. Special attention also has to be given to minimum viable areas for vegetation (on the landscape level, areas for minimum viable populations of animals and birds can better be addressed). Where necessary, we will restore habitat through planting, cutting, and manipulation of species.

6.3.4.1. Creating Standards

The agenda of ecoforestry can be presented through a number of characteristics, principles, and standards. For example, one characteristic of a mature forest is its wildness. The corresponding principle is that the forest is self-ordering without human control and management. Our objective for the forest is to allow the foresting process to continue, whether we take resources from the forest or not (by also considering interference from acid rain, pollution, and other industrial effects). We can then set standards that are likely to keep mature forests wild: Limit annual biomass removal to 1 percent of the total forest; use appropriate techniques, e.g., single tree selection, with horse skidding; retain mature structure, e.g., 19 snags per hectare and 23 nurse logs per hectare in mature Ponderosa pine; and preserve surrounding landscape patterns. Standards for Oregon forests zones are still being developed.

6.3.4.2. Anticipating Future Use

MGC is planning for the quantity and quality of future harvests in the forests. To ensure the character of the forest, it has developed a protocol for legacy trees and natural regeneration. MGC contains scattered old growth or late successional forest fragments across the forest. Areas of late successional or old growth forests need to be included in a protected landscape/stand network. This is particularly the case because of the lack of old growth trees and forest in the surrounding landscape.

Old growth nodes should be located in ways that are connected to other parts of the protected landscape network, e.g., the riparian corridors. While old growth nodes need to be designated for each ecosystem type found in the landscape, it needs to be remembered that the forest is dynamic over time and what is old-growth today will be food for the forest floor in another 500 years. Accordingly, we design cutting patterns which allow for the occasional harvest of mature, old growth trees for high-end uses based on the following criteria: To thin more shade tolerant species at the interfaces of different ecosystem types, e.g., Grand Fir crowding out Douglas-Fir and, in some cases, conifers crowding hardwoods; where the spacing between mature trees are so close that they are within each other's growing space, while recognizing that trees in wetter sites will naturally grow more closely together (Grand Fir/ Douglas-Fir) than in drier sites; and, to open the canopy to allow for or aid regeneration of other trees of the same of different species. Old growth recruitment trees need to be identified for each ecosystem type, so that over long periods of time, natural succession will (hopefully) result in the emergence of composition and structures that define an old growth or late successional forest. Through time, old growth recruitment areas need to be developed in all landscapes in order to replace old growth.

6.3.4.3. Using Benign Harvest Methods

For its harvest method, MGC uses single-tree and group selection. Since the 1980s individual tree selection has been practiced consistently at MGC. An early "natural selection" forestry advocated taking only trees already selected out by natural processes (suppressed subdominants). But, this light touch practice favors grand fir over Douglas fir—most tree regeneration at MGC is grand fir—and confines pine, oak and associated hardwoods to a suppressed existence in all stand interiors by shading out.

Individual tree selection, as practiced, failed to reduce fire hazard and halt insect and disease infestations. It failed to reverse ecological degradation, including local extinctions of wildlife and plant species. It has not allowed for the reintroduction of light prescription fire—to which most plants and animals have long genetically adapted. Therefore, more group selection cuts will be used at longer intervals. Important added benefits of group selection cuts are the recovery of water—lost in overstocked stands through evapotranspiration—and the faster recovery of old-growth trees since their release from competition will speed up growth in girth and height, therefore achieving the structured characteristics of old-growth.

Foresters need a better understanding of the genetic dynamics of tree populations in order to manage forests wisely. It is difficult to develop strategies to prevent the depletion of genetic information, especially with intense public and industry demands on forests, without knowledge of the diversity and distribution of genes in the tree population. Although study of gene flow and genetic recombination is needed, a lot of this knowledge can come from careful observation of the forest, the mating systems of trees—e.g., pine species require pollination as a mechanism for outcrossing—and the shape and size of a forest area. MGC is not selecting for phenotypes (the physical expression, the best individuals); nor is it selecting for genotypes, although by judicious cutting of all age and size classes, it hopes to increase the long-term flexibility of the forest to respond to certain catastrophic events, such as global warming. The problem with selecting the best looking trees is that they do not always have the best genes—just the best expression of their genes at one particular place at one time. Observation is necessary, but it is not enough; genetic work has to be part of the program. Management of genetic resources is also critical to reforestation efforts. Because trees are genetically correlated with specific place, we are not concerned with a lack of diversity or genetic erosion due to the absence of inplanting. At this time, MGC is not concerned with dysgenic effects as a result of its cutting practices; it does not thin from below exclusively.

6.3.4.4. Planning Finances & Partnerships

MGC maintains relations with the broader community. MGC works with a number of people and businesses from the local community. MGC contracted with the Oregon Reforestation Cooperative (Hispanic Forest Workers) to do some logging and slash treatments. MGC hired youths as part of a Summer Youth program, a cost share program with the State of Oregon.

One worked in the office. The other three young men built a trail for the Demonstration Forest project, as well as working on monitoring, seed collection, road work, and construction of a pole barn for the fire truck. Some of the businesses that MGC works with include a local trucking company, a mill nearby, Cascadia Forest Goods, to sell most certified logs to add value to the logs into a variety of products and to market them, and the Ecoforestry Institute for forest research.

MGC also maintains partnerships for special projects. MGC and the Ecoforestry Institute have formed a Woodford Creek partnership with the BLM, who manage about 2,500 acres in the Woodford Creek Watershed. We have completed a Landscape Analysis and Design process, a Forest Assessment and Inventory for the BLM lands and most of MGC land, and a Stream Survey and Inventory for Woodford Creek. We are currently planning to conduct a Fire History/Age-Class Study. We contribute time to the local Soil/Water Conservation District and the county Watershed Council (UBWC). This Council plays an important role in restoring habitat for salmonids and endangered species.

6.3.4.5. Managing Forest Products

A percentage of the forest is managed for forest products, especially those alternate to logs. It is recommended that the forest be managed for quality forest goods. This requires more care and, perhaps, some additional initial investment of time, which will pay off with a substantial increase in return. For example, utility grade Douglas Fir or incense-cedar poles usually pay twice as much as saw logs; veneer-quality Madrone and other hardwood logs make these species quite valuable, whereas otherwise they have little value other than firewood. Alternate products, such as boughs and ferns, for the flower shop market, also offer a higher return on labor investment than timber.

Hardwoods are an important component of a fully functioning forest, so this component needs to be maintained as part of the mix of the forest. The predominate hardwood species are Madrone and Chinquapin throughout most of the forest. Vine Maple, Big Leaf Maple, and Alder are found in the riparian area. Preliminary inventory indicates that there are only a few California Black Oak, which are usually a component of Pine-dominated ecosystem types.

6.3.4.6. Managing the Whole Forest

Ecoforestry needs to manage for quality at all levels. Human criteria for quality are based primarily on the characteristics of the wood, i.e., Douglas-fir's structural strength, and with end uses, i.e., houses or furniture. For example, Pacific madrone is relatively abundant in the MGC forest and surrounding forests. However, markets for madrone and other West coast hardwoods are largely non-existent or under-valued or distant with resulting high transportation costs. The key to successfully marketing madrone is to manage for quality. The specifications for quality madrone include such characteristics are the following: (1) clear wood (the absence of knots for specific lengths); (2) straightness (a limited amount of curve and twist); and (3) solid wood without rot. Only 1-2 percent of madrone trees of 18" diameter and larger meet specifications for veneer quality because so many madrone have cat-faces and rot from past burns or past logging injuries. However, these trees provide good wildlife habitat (wood rats) and food (birds).

We need to manage for quality wood, so that as many of the trees that we do harvest can be used for their highest and best uses. For madrone the highest and best uses includes musical instruments, veneers, fine furniture, and flooring. Another example is a Broad-leaf Maple tree with figure. While such a tree may be rare for maples (less than one percent), it is quality wood from a human-use perspective and, accordingly, valuable. There is no inherent contradiction between managing for ecological responsibility and for quality goods and products.

6.3.5. *Summary: Responsible Use & Nonuse*

Ecologically responsible forest use recognizes the forest, including humans, as a whole system. With regard to human uses, ecologically responsible forest use focuses on managing human activities to serve the long-term interests of fully functioning forest ecosystems, rather than on managing ecosystems to serve short-term human interests. Ecologically responsible forest use supports the development and maintenance of stable human communities and diverse, sustainable human economies. Labor-intensive activities and value-added wood products manufacturing in close proximity to the source of wood are cornerstones of the development of ecologically responsible, community-based economies.

Ecologically responsible timber management is ecosystem-based, which means that the character and condition of ecosystems determine the types of human use that can be carried out, and in what manner. In ecologically responsible timber management, there may be reasons to cut small, young trees—for example, when restoring natural stand structure to areas where fire suppression has occurred—as well as for growing trees to old ages to provide, for example, late successional or old-growth forests and to provide high quality, mature wood.

Trees are selected for cutting in ecologically responsible timber management by considering a variety of criteria, including: Stand condition, successional processes, the need for old-growth forests and old-growth trees, and production of high-valued, mature wood. The volume of timber cut each year under ecologically responsible forest use is restricted by the requirement that cutting must maintain fully functioning forests at all scales through time. Thus, annual timber cuts will vary according to the needs of the forest. Once a forest landscape has been managed for an extensive period of time using ecologically responsible approaches, managers will be able to forecast a reliable range of annual cut, based on the annual growth of the forest and depending on the needs of the forest.

Working to protect, maintain, and restore fully functioning forests requires frequent evaluation of our activities to determine whether these activities are meeting the principles and standards of ecologically responsible forest use. The Mountain Grove Forest is significant in the region because it is managed for old-growth production, and it is a working forest that pays for its management and taxes. It has some of the most outstanding trees in the Interstate 5 corridor in Oregon, and it is an example of how a forest could be managed for wild values and for ecosystem health.

Figure 6344-1. David Barnes, Mike Barnes & Dennis Martinez stickering wood, 1998

6.4. *Local Problems: Conversion & Interference*

We exploit resources, plants and animals too fast for natural renewal. We exploit minerals and fossil fuels too fast for the wastes to be integrated in cycles. We create novel substances and use them too fast for the substances to be integrated in natural cycles. There is a conversion of planet from wild to urban ecosystems. System used to be wild with wild humans, now going towards one domestic urban system.

6.4.1. *Cultural Conversion of Places*

Agriculture converts ecosystems into simplified ecosystems that have to be maintained with large amounts of human labor to keep the system from diversifying and maturing. Even modern forestry tries to convert wild forests into single-species managed plantations.

6.4.1.1. Conversion of Land to Fields

In North America, which held the largest extent of forests on earth, forests were considered wilderness, to be tamed and converted to agriculture—although no one really expected the conversion to be so rapid or dramatic. Since the first agriculture, 10,000 years ago, forests have been cut and burned to create fields for food crops. The invention of iron plows speeded up the process because they could break up soil too heavy for wooden plows. Much later, the invention of the horse collar allowed horses to pull plows and loads with greater strength. Technological innovation, combined with accelerating population growth, lead to clearing of many forests for agriculture.

Traditional agriculture proceeds by substituting selected domesticates for wild species in equivalent niches, or by manipulation of the ecosystem, whereas modern agriculture replaces the biota, or transforms the ecosystem into an artificial system. Margalef pointed out that all agricultural systems are laid out for low maturity, to increase production per unit. Traditional agriculture changed the pattern of ecosystems. Modern agriculture simplified those systems dramatically. From the perspective of a balloon or airplane, agricultural fields are easily identified, as circles, squares, rectangles or parallelograms, with a more monotone color and texture than surrounding wild areas.

To achieve even greater efficiency, we have increased the speed of our activities, converting materials and cultures into new designs without consideration of the meaning of, or need for, efficiency. The speed of our economy is too great for many cultures to adjust to; and the thoughtless transformation of cultures may result in great, irreversible mistakes. The speed of our conversion of wild habitats to domesticated lands is too great for many species to adapt to.

Although our behavior may not be qualitatively different from our remote ancestors and the worst pathologies of wild animals, which usually result from miscommunications under certain circumstances, it is quantitatively different. More and more activities affect larger and larger parts of the planet; many problems have global effects now.

In tropical areas in the past, people practiced land use that permitted the vegetation to maintain itself despite human exploitation and the constraints of soil and climate. With population and production pressures, tropical areas everywhere are rapidly being exploited. The consequences may be disastrous.

Size is almost always the greatest threat. In spite of the fact that many Buddhists planted trees regularly, the Buddhist traditions of wooden temples and funeral fires contributed to the denuding of large areas of forest. It is our misfortune to live at a time when the accumulated effects of the conversion of nature for human ends are becoming obvious and cutting into the survival potentials of many other species.

Modern agriculture replaces the biota, or transforms the ecosystem into an artificial system. The application of modern agricultural techniques in tropical areas disregards the local realities, and is socially and ecologically disastrous. Traditional ways have operated successfully for thousands of years, although not without serious problems of their own. But, these problems may be overcome, unlike industrial problems, which have fundamental flaws and cause rapid conversion.

We exploit resources, plants and animals too fast for natural renewal. We exploit minerals and fossil fuels too fast for the wastes to be integrated in cycles. We create novel substances and use them too fast for the substances to be integrated in natural cycles.

The myth of a return to earlier rural times is only a myth; the soils have been destroyed. We must learn to create bioshelters that sustain us and provide us with shelter and more. The soils are starving for organic matter. Waste and manure need to be returned to the soil. Soils, like animals and plants, can be domesticated. European soils bear little resemblance to wild soils. American soils bear even less. Smaller farms could fertilize by crop rotation and manure. Build up soil, choose better seed stock; make hedgerows for birds to control pests.

Agriculture works best where it is least perfect: that is, the farmer still hunts and gathers, keeps many kinds of plants and animals, produces little surplus, uses no chemicals, grows adapted crops, and has wild lands. That situation may be ecological and durable. Successful agriculture depends on artificial climax or sustained successional state. A pioneer is self-sufficient in more than material.

6.4.1.2. Conversion of Land to Cities

There is a conversion of planet from wild to urban ecosystems. System used to be wild with wild humans, now going towards one domestic urban system. Cities convert ecosystems into cityscapes, a special artificial ecosystem with fewer plant and animal species, disrupted water flow as factor, household wastes as factor affecting the landscape, a network of corridors that perforate landscape and cut off wild flows, an increase in the number of small patches, and a reduction in other kinds of patches and corridors, woodlot, stream, golf. Flows include energy, materials, information, people, and pollution.

In a converted ecosystem, there are three imposed ecosystems with minor linkages: (1) a natural system of primary productivity based on depauperate system with few trees and layers, a simple trophic structure of birds, squirrels; (2) a human system, with imported food and water, smaller system of carnivore predators, such as fleas, lice, and bedbugs, and decomposers, such as bacteria, fungi, and gulls; and (3) a distant support systems for food, materials, and energy, but also smaller emotional support system of pets, such as cats, canaries, and fish.

The daily inputs for city, in terms of sunlight, atmospheric deposits, water, food, fuel, manufactured goods, new buildings, roads, and infrastructural support, is tremendous. The daily outputs, including heat, water, sewage, solid waste, and pollutants, are likewise tremendous, although they are skewed to unusable wastes, including heat.

These extra inputs and outputs have effects, side effects, or rather main effects that are unwanted or unanticipated. By thinking in terms of side-effects, we have been unable to manage the side-effects of our massive technologies. They are in fact unmanageable in a mindset that thinks of them as side-effects. A holistic rationality might be better to use, where everything is an equal effect, and we manage out technology to have all the effects.

Land is taken over and covered, but then idle land may total 9-28 percent of urban area.

Villages lower connectivity to the landscape by increasing patches and corridors. Agriculture gets more homogenous, decreased fallow areas. Stream corridors are destroyed, environmental degradation. Connectivity is lowered, matrix is minimized. And, these things happen: Disturbance of nutrient mineral cycles. Disruption of atmosphere, drought, storms. Changed microclimate, with heat islands and dust domes. Lower photosynthesis/ productivity. Lower diversity leading to homogenization, with cosmopolitan species. Inefficiency of use of energy and materials. Decaying infrastructure, roads, sewers, buildings, and houses. Disruption of supplies, due to social and political actions, e.g., strikes, breakdowns, attacks. Budget crisis from loss of tax revenue. Increase in violence, sickness, drug use, crime, and impoverishment. Increase in mental and physicals illness from stress. It is almost as though human beings are major agents in changing the wild planet into a dust planet.

6.4.1.3. Industry & the Artificial

Artificially created environments are cultural environments. Nature thus acquires characteristics from agriculture and social institutions as well as from geology and climate. The practices of environmental conservation must be complemented by careful policies of environmental creation. Societies have images of the future that influence their policies, and those images can be shaped by knowledge and persuasion. Human beings can and have created new ecological values by collaborating with, or following the laws of, nature.

Many ecosystems in the temperate zone are artificial. The tame character of ecosystems in England, for instance, results from human intervention. English parks are based on an imperfect understanding of natural systems, and on their potentialities, as well as on a series of happy accidents. Much native vegetation is a social artifact. In Scotland, for instance, forest cover was reduced from 55% of the total area to 5% by primitive stock-keeping and agriculture; moors decreased by half, but meads increased eight-fold. The soil was more fragile, so the accidents were not happy there and the forests did not grow back. Some forest plantations have been started. Rene Dubos mentioned Kentucky, Western Europe and Japan as examples of radical conversion from the native fauna without disorganization.

6.4.2. *Interference as a Local Problem*

Humanity is exploiting nature recklessly, by converting ecosystems without paying minimal attention to their health. Many ecologists, such as Eugene Odum, have observed that complex communities have existed for thousands of years in relatively stable environments, even though these environments are characterized by regular disturbance and constant exploitation. As a result of our growing population and increased use of technology, these environments are now vulnerable to human interference, which is a different thing from disturbance or exploitation. Disturbance, by definition, is an event that can be caused by climate, biological entities, or other actors. Exploitation is the normal use of a resource or of a species by another species, including the human species (this ecological definition differs from a sociological definition, which means 'selfish or unethical use,' although it may suffer from negative connotations due to the latter); in fact, ecological exploitation has a rejuvenating effect on populations.

Interference is an activity that can degrade, destabilize, or destroy entire ecosystems. Interference is not a form of disturbance, exploitation, or competition; it is destruction without gain to any species. Sometimes it is caused by planetary events, such as volcanic eruptions, but in the case of human interference, it is the destruction of the structures and processes of evolution for a large-scale, one-species, short-term gain. Interference behavior that characterizes the nonecological activities of the dominant human, industrial culture. The pandominance of ecosystems is related to the biological and cultural characteristics of the species. Ignorance and indifference are identified as major reasons for continued interference.

Although rare large-scale or novel disturbances can interfere with ecosystem processes, the term 'interference' is reserved for constant destructive or novel effects. The destruction of ecosystem processes in nature by the action of one or more species is rare; any species that did so would become extirpated or extinct, unless it was not dependent on a single ecosystem, as is sometimes the case with wolves or human beings.

Human populations have increased exponentially, with billions of people in giant urban ecosystems. Agriculture has produced monumental yields, but only at the cost of tremendous erosion and great subsidies of energy, fertilizers and pesticides. Dams have been built all along rivers, and riverine forests have been cut, altering rivers and fishing grounds. Settlers and industrialists in the Amazon are destroying vast tracts of rainforest, as part of a political strategy to move peasants out of cities. Industrial forestry in the Northwest America is content to take a high percentage (well over 90 percent) of a forest for wood and pulp, destroying the basis for the continuity of the forest, as well as all beings that depend on the old-growth, fungi, and physical properties of the forest to live. Changes have been made without regard to the long-term impact on the ecosystem or on its human population. We dominate as many systems as we can.

Human exploitation at the tremendous physical scale that occurs in industrial states is different from exploitation by other species, because it results in the destruction of the entire system, the very basis for renewal of a system that human beings, as well as other species, need for life. Human actions are damaging global biogeochemical cycles, such as the carbon or nitrogen cycle. For instance, deforestation, burning, wetland loss, and industrial processes are releasing massive quantities of carbon dioxide into the atmosphere, which disrupts the carbon cycle. Although the destruction of large species, from whales to frogs, has a dramatic effect on ecosystems, the destruction of microbes, which generate oxygen and recycle nutrients, has a critical impact on the entire food web. These actions are global, like a large volcanic eruption, but, unlike a volcanic eruption, they are constant and hourly. These pandominant human activities are best referred to as interference, and may be related to our industrial style.

Interference has been a rare phenomenon on earthly ecosystems; it has happened in the past as the result of global catastrophes, such as meteor impacts. Now, interference, as opposed to more limited and predictable disturbances or exploitations, is threatening the stability of all ecosystems. It is dangerous to interfere with the processes of ecosystems because it disrupts the communities on which other species, and ultimately human communities, depend. Furthermore, in the deepest sense, it violates the idea of living together with other species on the planet. The proper relationship of humanity with nature should include competition and exploitation and mutualism, but not interference.

We kill millions of animals in laboratories to insure our safety, we kill billions of plants and animals for food and clothing and products, while indulging in the sentimental preservation of some individuals of other species. Animals do not need to be saved from natural death, a great regulator of life, but from unnecessary suffering, experimentation, and premature extinction. The world would not be a better place without sharks, silverfish, rats, cockroaches, or hyenas. They need their own places. The places, entire ecosystems, need to be saved. If we diminish variety in nature, we debase its stability and wholeness. To save ourselves, we must preserve and promote the variety of nature. Perhaps we should reconsider our unconscious role in nature as agents.

6.4.3. *Humanity as an Agent of Change in History*

What are the forces of history? Certainly, we should include geological processes, as well as solar system effects, such as the output of the sun or meteorites. Certainly, we should include the environment, such as climate and the distribution of resources. Especially important are human impacts on ecosystems, such as deforestation, identified by John Perlin as very important, perhaps the reason for the decline of the Hittites and Babylonians. Another impact is desertification, according to Uwe George and others. Disease patterns, according to W. H. McNeill, are crucial. To disease, or germs, Jared Diamond adds steel and guns as forces that have shaped human history and societies. Then, there is simply luck, the position of a culture in the stochastic chaos of nature.

By their activities, human beings change the places they live. Much of the change is easily incorporated in the cycles of renewability of the ecosystems. However, humans often change the directions of such systems by simplifying or degrading the systems. In this case humans act as agents of interference.

6.4.3.1. Humanity as Biological Agents

Humans have had a great impact on nature, and should be considered themselves as a force of nature and history. One could consider humans as special agents. One analogy of humans as special agents is as a parasite: A consumer feeding on another living organism, usually inside, drawing nourishment and weakening the host. States acted like macroparasites, according to William McNeill, but becoming less violent or unpredictable over time, as they adjusted to their host populations.

As crowding increases competition, there is more pressure on remaining reserves. The system parasitizes humanity and nature. Humanity becomes an autoparasite, a new pseudospecies. Technology enlarges the number of niches for us; tools fit humans to different habitats, displacing other species. We steal from animals and plants, from the earth, from our own descendants. Hobbes foresaw this war of each against all. The systematic destruction of human beings and animals is not an isolated peculiarity. A fat parasite often kills it host and then dies itself. Perhaps, humanity is an agent of a different sort, a systems agent that encourages only positive feedback.

Perhaps human expansion is like a cancer. Alan Gregg (1955) compared the world to a living organism and the explosion in human numbers to the proliferation of cancer cells. He sketched other parallels between cancer in humans and humans' cancer-like impact on the world. Cancer cells proliferate rapidly and uncontrollably in the body; humans continue to proliferate rapidly and uncontrollably in the world. Crowded cancer cells harden into tumors; humans crowd into hardened cities. Cancer cells infiltrate and destroy adjacent normal tissues; urban sprawl devours normal open land. Malignant tumors shed cells that migrate to distant parts of the body and set up secondary tumors; humans have colonized just about every habitable part of the globe. Cancer cells lose their natural appearance and distinctive functions; humans homogenize diverse natural ecosystems into artificial monocultures. Malignant tumors excrete enzymes and other chemicals that adversely affect remote parts of the body; humans' motor vehicles, power plants, factories and farms emit toxins that pollute environments far from the point of origin.

It is not in a tumor's self-interest to steal nutrients to the point where the host starves to death, for this kills the tumor as well. Yet tumors commonly continue growing while the victim wastes away. A malignant tumor usually goes undetected until the number of cells in it has doubled at least thirty times from a single cell. The number of humans on Earth has already doubled thirty two times, reaching that mark in 1978 when world population passed 4.3 billion. It is over six and a half billion now. After thirty-seven to forty doublings, at which point a tumor weighs about one kilogram, the condition is usually fatal—that would be the population equivalent of 5.4 billion people. We have exceeded that; the question is if it has been fatal—large complex systems may take a long time to collapse—or if the system has more flexibility than an organic body.

The metaphor of cancer may be more appropriate than a footprint. After all, a footprint can stimulate some kinds of ecosystems, such as short grass prairie. What humanity does is transform the ground under the footprint into a new human system.

6.4.3.2. Humans as Ecological Agents

Every species exploits its environment to the extent that it can, with no regard to consequences. Usually, each species is checked by another, because there are so many competing for the same food, and equilibrium is maintained.

Partial knowledge and technology has allowed us to exploit our environment beyond what is desirable for us or for other species. While continued, moderate exploitation is necessary to live, massive, unbalanced exploitation is unwise. Wise use of resources would not make the world less habitable. We are part of the system and must protect its health.

By distorting the equilibrium, we have destroyed whole species and favored many others, many wild as well as domesticated. Rats and mice have been carried to all parts of the world and live in direct competition with humanity, invading our buildings for food and shelter. Crows and coyotes have also profited from their human association.

Basic principles need to be examined in relation to human ecology. Natural populations are maintained at ecosystem limits; this maintenance is achieved by the production of excess young and the elimination of the weaker; mating and parenthood are denied to the young by instinct in most species, until a territory sufficient to raise, feed and protect offspring has been acquired. If the population becomes excessive, glandular conditions are activated to induce stress and complications, which reduce the population.

6.4.3.3. Humanity as a Geological or Climatic Force

No single change is exclusive to humans as a species, but they are excessive, rapid, compounded, and large-scale. There is movement of soil, but also massive erosion. There is movement of minerals, but also disruption of mineral cycles. There is the addition of novel elements into the atmosphere, but there is also a massive release of carbon.

When people use more of the earth's supplies in a certain period than can be replenished in the same period by the sun, they are eating into the natural capital. Humans have caused the extinction of hundreds of species. Rhinoceros, buffalo and crocodiles are disappearing. Getting timber for fuel and construction, clearing land for agriculture, has destroyed whole habitats. Demand for timber has been insatiable, for houses, ships, paper, and fuel. Trees have been cut from vulnerable watershed sites, with resulting floods, erosion, and diminution of rainfall and water table. Domestic animals inimical to growth were introduced, such as rabbits and goats. The introduction and maintenance of sheep in Spain, Italy and Cyprus has changed whole ecotypes.

Sixteenth century Spain, under Philip II, experienced unprecedented growth; shipyards flourished; gold was brought from South America; wars were fought. But, every year it cost thousands of hectares of centuries-old forests to build and maintain the fleets. By the end of the seventeenth century, the rich Iberian forests had disappeared. After the soils eroded away, there were local famines.

Vegetation holds soil in place, reduces wind speed at the soil surface, and improves water absorption and transport in the soil. Erosion destroys soil and makes it difficult for plants to be reestablished. Recovery, if it occurs, may take decades. Erosion is an ecological catastrophe on a planetary scale, causing thousands of higher plant and animal species, and countless lower species, to be lost forever. This is what is planned in Brazil and South America. It is not known how massive deforestation through overgrazing, firewood collection, and timber exploitation will affect terrestrial and atmospheric systems. Perhaps we should just accept erosion. Erosion is picturesque. Cezanne's paintings of France are striking. The abstract terrain of Greece is pleasing to many.

Israeli scientists doubted the theory that Arab methods of cultivation were responsible for spread of desert in North Africa and Middle East; desiccation on that scale is beyond even modern technology. They concluded that deserts are usually created by a relatively small change in climate. However, grazing practices could cause a small change in climate and thus contribute to desertification.

Only in the nineteenth century beginning with G. P. Marsh, did people start to realize that humanity has done as much to change the environment as the environment has done to mold human history. Marsh, the first U.S. ambassador to Italy, was one of the first to study the role of humans in changing the face of the earth. When he visited the near east, he was shocked to find deserted cities, silted harbors and wastelands instead of flourishing civilizations. He concluded that ecological errors had led to the deterioration of agriculture in Mediterranean countries. He advocated agricultural conservation practices.

Environmental factors have shaped the course of human history to a greater extent than had been realized. The decline of Rome is a study in forest ecology. There were previous and later catastrophes in the Tigris and Euphrates valley, Greece, Khmer, Maya, Midwest United States, and the Australian outback. Many people did not change their behavior in time to solve the problems. Worse, the current civilization is global, not local; so, there will not be a migration to unaffected lands. Ecologists have not unraveled most mysteries of ecosystems, so the long-term consequences of most human interaction cannot be predicted.

6.4.4. *Practicing Noninterference*

Exploitation, in the ecological sense, is necessary and beneficial to biological populations. A machine metaphor approach, with its assumptions of interchangeability and quantity, apparently has difficulty distinguishing between exploitation and interference. An ecological metaphor, that is more receptive and reverential, may be more appropriate to understanding organisms and nature in general. Such an approach would stress noninterfering observation rather than controlling manipulation.

A rule of noninterference states that human beings ought to avoid behavior that disrupts essential ecological processes or destroys biotic communities. As Paul Taylor states his rule of noninterference, it requires a "hands-off policy" for whole ecosystems and biotic communities; the rule stated here is concerned with limited and sustainable exploitation of ecosystems already shaped to some extent by human activities. Noninterference would not lead to chaos, poverty, or stagnation. It would permit the rational exploitation of resources.

We need to practice the rule of noninterference so that all beings can enhance their lives and habitats. This rule could be defined by positive laws and by negative restraints on behavior. This attitude would entail using what is necessary, exploiting some ecosystems completely, changing a place to fit human aspirations, and killing plants and animals for sustenance. But, it would also mean limiting humanity and its technological effects, limiting human use to local impacts, and letting other beings live without interference.

6.5. *Local Problems: Technology*

Local problems can be subdivided into physical and cultural problems. Although it is tempting to divide physical problems into natural and human generated, given the scale of human influence, it is too difficult to separate them definitively; humans contribute to natural trends, and some trends add to human problems. Humans themselves create carbon dioxide and wastes, by breathing and excreting, and also by concentrating, burning, recombining, and synthesizing. Our activities, from hunting and growing to deforestation, transportation, urbanization, and industrialization, produce more wastes, on a larger scale than most other animals. For instance, 25-50 percent of all aerosols, that is anything ejected into the atmosphere, are put out by human activities, from deodorants to coal-powered energy plants; volcanic action adds a significant percentage.

The purpose of technology is to create a tool to solve a specific physical problem. But, this can create other problems, if the tool is inappropriate or has deleterious effects. There may be a disjunction between the effects of technology on human activities and its effects on the ecosystem or atmosphere.

6.5.1. *Physical Problems*

Is pollution a problem? What is pollution? Usually pollution thought of as materials, but what kind of materials? Things that are useless? Side-effects? Things that do not fit? Resources out of place? Things that cannot be cycled by a system? Contaminants? Poisons? Ugliness? Anything not wanted, such as light at night or noise during the day? In many cases pollution is a difficulty with density or distribution. The activity of the atmosphere generally keeps gases diluted and distributed, although particles like dust can cause problems. To some extent the activity of the ocean dilutes and distributes particles and chemicals. Land-based particles and compounds have a greater likelihood of clumping, although wind and water can spread them somewhat, for instance, when runoff dilutes salt from evaporation.

6.5.1.1. Nature-dominated Changes

The planet has a long history of concentrating or diluting particles, as well as changing the composition of its spheres. Volcanic eruptions have added carbon dioxide, sulfur and water to the atmosphere, and molten stone to land and sea. The 1991 eruption of Mt. Pinatubo in the Philippines ejected 20 million tons of sulfur dioxide, which caused 0.3C (0.5F) degrees of atmospheric cooling. Through photosynthesis, plants have added enough oxygen, often considered one of the first 'pollutants,' to change the operation of atmospheric processes, such as oxidation. Do ecosystems cause or have pollution? Or, do living organisms eventually use the 'pollution' as a nutrient? Animals add carbon dioxide to the atmosphere and chemical wastes to their habitats. Inadequate recycling of plant and animal matter, over a long time, can lead to peat, coal and oil deposits. Although these materials can be poisonous, because we regard them as resources, we do not consider them as pollution. Pollution seems to have to be a nonresource and nonneutral to be pollution. Perhaps it is the dose, as Paracelsus said about poison.

The dynamics of the planet, from tectonic motion to volcanic activity and storms, creates change and challenges for individual organisms and ecosystems. Climate change can be 'caused' by changes in orbit of the planet. Milutin Milankovitch (finally translated in 1969) identified three principle cycles that cause variability in the planet climate. The longest is the elliptical orbit of the earth around the sun, a 100,000 year cycle. Thus, intensity of the rays varies during parts of the year. In 2004 only a 6% difference between January and July. The second cycle is the tilt of the earth on the axis, which varies from 18 to 24.4 degrees. The cycle is 42,000 years. The third is the wobble of the earth on its axis. The cycle is 22,000 years. At extreme of cycles, variation in sunlight is less than 1/10th of 1 %. But that can change temperature by 9 degrees F. These cycles can cause an ice age only when continental drift puts land near the poles.

6.5.1.2. Human-dominated Changes

Human activities, especially from agriculture and industry, have the effect of precipitating other changes. Our farms, fields and mines can dominate an entire landscape. Our roads dominate landscape patterns. Even new technologies of wind and solar farms, because of the scale of energy use, are starting to dominate coastal or sunny landscapes.

6.5.1.2.1. Land Conversion

We have converted a large percent of wild forests and grasslands to cropland (currently about 12 percent by area). We have converted wild, old-growth forests to modified forests and tree plantations. We are converting rich estuaries and shorelines into fish farms. Much of the destruction of land can be traced to our ignorance of ecological connections and to our inconsiderate use of gigantic machines and tools, using unlimited amounts of fossil fuels.

6.5.1.2.2. Biodiversity Loss & Extinction Rises

Currently, 100 species per million per year are entering extinction. The extinction of species is certain, and there is a high degree of certainty. Temperatures of mountain habitats are easily measured, as are conditions that mountain species can tolerate. As climate warms cold-tolerant species have nowhere to go but up, and we know the height of the mountains. We know the planet will heat by 2 F this century, or 5 F, if business and industry are conducted as usual. Chris Tomas et al. found that at the lowest degree of global warming (1.4-3 F) about 18% of species are 'committed' to extinction. At higher rates the number goes up: 3.2-3.6 F then 25%, over 3.6 F then 33%.

6.5.1.2.3. Chemical Pollution

Chemical processes driven by solar energy let complex molecules build up. Chemical orders underlie the biological order of life; one self-replicating molecule allows life to continue. The science of chemistry has been able to make wonderful advances in materials, from nylon stockings and parachutes, to replace silk and hemp. Many new materials were based on hydrocarbons from oil. The new molecular patterns, however, did not react by degrading in natural ecosystems; there were no predators capable of consuming the molecules as food.

We are not sure what the minimum or maximum values are for various chemical elements in biogeochemical cycles. If the cycles continue, the elements should be enough. Elements, however, exist in nested environments. Smaller pools of elements are more vulnerable to interactions with pollutants. The pollutants themselves often have longer life spans than complex molecules. Amounts of many pollutants get concentrated in the environment.

Sulfur dioxide (from blast furnaces) causes tissue degeneration and interferes with enzymes in plants. Sulfur pollution can kill entire forests; the Norilsk Nickel Combine in Russia has killed over 4000 square kilometers of larch forest and serious affected another area of equal size with its sulfur emissions. Sulfur pollution from burning coal and oil in factories in the Midwestern United States combines with rain, fog or snow to make acid rain in New England and Canada (only recognized since 1972), 100 times as acidic as normal, causing declines in crops, sugar maples, and forests.

Although there are a few chemical responses to pollution, such as liming the ground around pines against acid rain, they are expensive and difficult to apply. The prevention of pollution remains the best option.

6.5.1.2.3.1. *Stratospheric Ozone Depletion*. Ozone has an annual metabolic flux of millions of tons. Ozone, with three oxygen molecules, is created from the action of lightning discharges, making a lucky coincidence for life on land; before an ozone layer started forming, the solar emissions like ultraviolet light were too dangerous for animals to move to the surface of the planet. On the ground, however, ozone is a pollutant that can cause tree death by reducing root and leaf biomass. With sulfur dioxide, ozone can influence ecosystem health. Low-level ozone, mostly from electrical and machine discharges, can damage crops like wheat and soybeans (about $40 billion in 1988).

Stratospheric ozone can be depleted by a variety of pollutants, such as methyl bromide or chlorofluorocarbons (CFCs). Methyl bromide is used for fumigating logs, as well as tomatoes and strawberries. Lighter than air, it drifts into the upper reaches of the atmosphere. CFCs, originally used as refrigerants, pose another danger, a long-term, broad-spectrum, invisible danger. They accumulate in the stratosphere, where they are broken apart by sunlight and react with ozone. Worse, the CFCs absorb wavelengths that carbon dioxide does not. Far worse, a single molecule of CFC-12 traps 20,000-times more heat than one molecule of carbon dioxide. The marvelous science of chemistry cannot seem to be dissociated from the dangerous of its applications. Although banned in most nations for the past decades, CFCs can last 75-110 years in the atmosphere. Since the ban, the ozone layer is stabilizing.

6.5.1.2.3.2. *Aerosol Loading*. An aerosol is a suspension of particles in a gas. The particles can be molecules, pollutants, or viruses. Insecticides, paints, hairsprays, and drugs are spread with aerosols. Often the propellants, hydrocarbons, are or more dangerous than the particles, creating Local particulate concentrations in atmosphere. Other chemicals used for cleaning medical instruments or electronic parts, especially terpenes, end up in the higher atmosphere. Maximum quantities for these have not been set, although we can correlate it with ozone depletion.

6.5.1.2.3.3. *Carbon Dioxide Increase.* The amount of carbon dioxide in the air has changed dramatically over millions of years. In the past, concentrations of CO_2 were much higher, perhaps 12 percent, rather than the 0.00038 percent today. It was quite high at one time, due to volcanic action. It has been much lower as systems matured during and after the ice age. We now can measure human additions to carbon dioxide in the atmosphere. Carbon dioxide is a molecule that can hold heat in the atmosphere, due to its chemical shape and characteristics. CO_2 is also a trigger for a more powerful greenhouse gas, water vapor, since heating allows the atmosphere to take up even more water. Heat travels where CO_2 is effective. If the earth were a black billiard ball, then doubling the CO_2 would raise temperature 1.8 F. However, because it is wrinkled and wet, plant and cloud covered, doubling the CO_2 would increase temperature exponentially.

CO_2 is very long-lived, over 100 years, and 56% of it from industrial processes is still aloft. CO_2 interacts with water vapor, methane, and sulfur, affecting how those gases retain heat or contribute to cloud formation. CO_2 is good for some plants, mostly trees. But, plants in extra CO_2 have tougher leaves, less nutritional value, and higher amounts of defensive chemicals. One species that will benefit from changes will be parasites. Mosquitoes will spread malaria in some places.

The CO_2 is already in the air. We have no easy way of getting it out. So, the course of climate change is set for next several decades. Significant CO_2 is removed through natural processes, which also generate quantities of CO_2. We could remove quantities, but it would be expensive, and may not be at a scale large enough to be effective. We do not know the threshold for anthropogenic change, but it could be 2.3 F according to Steven Schneider.

6.5.1.2.3.4. *Ocean Acidification, Nitrogen Pumping & Phosphorus Loss.* Oceans are becoming more acidic. This has influences on CO_2 uptake rates and on the health of animals and plants. Applied fertilizer, usually anhydrous ammonia, which is oxidized to nitrates, can acidify the soil. Erosion from these soils can increase ocean acidification.

Although the bulk of the atmosphere is nitrogen, only a few physical processes, such as lightning, and biological processes, such as leguminous bacteria, can make it available for plants to use. The rate of removal from atmosphere is many millions of tons per year. The nitrogen cycle pushes nitrogen through the compartments of the vegetation and soil, from the actions of precipitation, leaching, fixation and other processes. The cycle is relatively slow (see Section 3.1.3.1 and 3.2.4). It has stayed within certain limits for many millions of years. Although we probably will not significantly alter the nitrogen cycle, we can increase nitrogen losses through activities such as clearcutting. Synthetic fertilizers and fuel combustion adds another 100% of reactive nitrogen to the biosphere.

Phosphorus, like nitrogen, is an element closely associated with life, and living processes preferentially concentrate it. Phosphorus runoff is a problem. The phosphorus cycle essentially runs into the ocean, as a sink, at a relatively high rate, and is returned to land surface by geological events or smaller events such as fish predation by birds and animals (see Section 3.2.5). Another smaller sink for phosphorus is guano deposits. Organisms keep phosphorus in a relatively closed system, which keeps it from entering sinks. Phosphorus is a limiting nutrient for life. Too much of it in one place, or too little, can cause problems. We are increasing phosphorus 12-fold in systems. Waterborne phosphorus and nitrates cause eutrophication of streams and lakes, and even some estuaries and seas (and this can affect the albedo of the planet).

6.5.1.2.4. Water pollution

Water is a universal solvent; it is such a great solvent that absolute purity is only a theoretical goal; even highly distilled water contains gases and solids. The fresh water we drink contains about 1% solution of carbonates, with various nitrates, silicates, minerals, compounds, and trace elements. These elements in normally pure water are absorbed by plants. Obviously, pollution is the fault of water.

6.5.1.2.4.1. *Biological*. Although many animals, such as cattle and sheep are raised on ranges, they often spend months in feedlots being fattened with grain for human consumption. About 95 percent of this food goes for respiration or ends up as manure, which overwhelms natural forms of recycling. Many domestic animals, especially kept in intensive conditions in feedlots, produce many tons of feces, which piles up in mounds, before leaching into the water table and polluting water. Free range domestic animals can compact soil and seedlings, reducing grass or forest reproduction. Normally, dung beetles or termites remove the feces, although they often cannot cope with the wastes of that scale of production.

6.5.1.2.4.2. *Runaway Plastic Nurdle Concentrations*. Charles Moore, sailing in the North pacific subtropical gyre (one of 5 high pressure areas in the world) found a floating trash island that went on for thousands of miles (perhaps twice the size of Texas). The gyres cover 40% of the ocean or 25% of the entire planet, and all of them are attracting islands of trash. Much of Moore's 'island' was made of plastic, from fully formed pieces down to small nurdles. Plastic is a petroleum-based mix of monomers shaped into polymers. Other chemicals are added for inflammability or suppleness. Plastic is replacing iron and glass as containers; it is lighter and more easily molded. Every year we produce 450 million kilograms of 'phthalates' used to make plastic soft and pliable (known to be toxic to human reproduction systems). They can leach from packaging and coatings. In some food containers and plastic bottles, phthalates are found with a compound bisphenol (BPA). We produce 3 billion kilograms of BPA every year.

Only 3-5 percent of plastics get recycled. Glass and iron are more easily recycled. PET and HDPE (numbers 1 and 2) can be recycled. Plastic retains pollutant and gives off deadly vapors. Products made from plastic recycling are limited to carpet and boards and jacket linings. Except for some incineration every piece of plastic made still exists. Recycling also uses resources and energy and creates pollution. But it does reuse resources and it is wiser use.

Plastic does not biodegrade, it crumbles into smaller fragments. Plastic can decompose in seawater. And it can contaminate marine live at the molecular level. Samples contain styrene monomers, dimmers and trimers (which seem carcinogenic in mice). Plastic is moving into the food chain. The danger is eating it or becoming entangled in it. There are miniscule pieces of plastic, called nurdles (lentil-size pellets of plastic in raw form), in the water. By weight, it can total 6 times more than plankton. The pollution seems invisible and ubiquitous. They are easily mistaken for food, can be ingested, and can screw up genes. They disrupt the endocrine system, so that some male fish and gulls have female sex organs.

Like sand on a beach, the entire biosphere gets mixed with plastic particles. These particles change the properties of water and soil. Plastics pollution at this level and scale is almost completely unrecoverable for recycling or breakdown (from burning or solution).

6.5.1.2.5. Freshwater Drawdown

Rates of human consumption of water are tremendous. Aquifers many thousands of years old are being drained. We are using almost all of peak water in every system. Peak renewable water limits are the total renewable flows in a watershed. Peak ecological water is where, in any hydrological system, increasing withdrawals reaches a point where any economic benefit is outweighed by the ecological destruction caused by the action. Furthermore, the efficiency of use is poor and needs to be improved; in parts of the Balkans, over 60% of the water is lost through broken pipes.

6.5.2 *Cultural problems*

Part of the problem with technology is the lack of limits in a culture. We rarely deny a new technology, before we come to depend on it, and thus become trapped by it. Technology has greatly increased the kind and quality of materials used for buildings and machines, especially plastics, aluminum and other light metals and silicon constructs. Yet, the scale of technology produces pollution that reduces the productivity of natural and agricultural systems.

6.5.2.1. Risks & Threats

Effects become problems, if they are too large, cause interference, or are not understood. Problems become threats if they are not solved within a required time frame. Threats to our survival rise from a disjunction between our powerful technologies and the wisdom to understand the effects and limit their use. Threats to human survival include: Environmental degradation, extinctions, climate destabilization, nuclear weapons, terrorists, and use of untested technologies. They seem to become threats when we underestimate the risks of applying industrial processes to global scales. We are too insulated from small real danger, although not from global slow invisible ones. We just do not recognize them. We have problems with scale. We have a human scale, based on our body and images, but this scale is not favored by much of the universe. The problem of using metaphors between scales is that we can miss the significant changes between scales.

6.5.2.1.1. Risks

Natural processes pose risks to every culture or nation that depends on the constancy and stability of the environment. Flood, earthquakes, volcanic eruptions, and droughts for example are not regular or predictable. In the Sahel and Mesopotamia, the argument was that overgrazing and human population caused the droughts. Exposed soil contributed to hot air and changed albedo and no rain-forming clouds. For the Sahel a single variable made most of the difference. Rising sea surface temperatures of the Indian Ocean, from greenhouse gases, was responsible for most rainfall decline. We focus on political, religious and behavior first, but find that sometimes environmental changes are culpable.

Agriculture and permanent settlement increased the risks of drought. The inventive agriculture entailed a transformation of how people change their mode of life to one that entailed a greater risk and vulnerability. Larger sedentary communities subsisted on a fused staple crops but these became prone to long-term fluctuations in rainfall floods and weather. These communities also began to impact the surrounding areas through the intensive use of wildlife and would. This lead to waves of intensification, extensive occasion and the current expansion of the labor force.

Because of an increase in risk and uncertainty, religious ideologies and management strategies achieved a reduction of that risk and uncertainties some extent by linking communities in a network. This also led to a disparity in wealth and power between workers and those affiliated with power. This situation has only gotten worse in six thousand years.

Urban centers became linked with religious establishments and administrative institutions quite early in history. The current environmental crisis is bonded to urban agglomerations that were unimaginable in earlier times; these cancerous expansions of urbanization have placed humanity at unprecedented risk. Although the system is capable of serving humanity through judicious integration of food resources and distributions to ensure equity, it has in fact led to disruptive, disastrous consequences as certain urban centers, especially in industrial areas, use the world for ruin the short-term gain.

Every civilization encounters a risk spectrum, which may push the civilization to find new increases in the area food or energy. The need to solve such risks pushes the system further from its original state sometimes at increasing speeds. The conjunction of long-term risks can be called a crisis. When European colonists settled in the Americas, they recognized the similarities of the environment, but not the difference in patterns. Cutting only familiar species of trees changed the forest dynamics and led to destructive impacts. The spectrum of risks shifted and human exploitation eventually had to be restructured.

Human beings often begin by adapting themselves to the dynamic of the environment. Over the long term, however, they modify these dynamics to suit themselves. They appropriate the environment by reducing its complexity in exchange for the increasing complexity of their societies. There does not seem to be a return from complexity. In this sense complexity is a trap. People cannot stop investing in knowledge and the system they modified. The current crisis as well as many in the past, is primarily a function of how people trap themselves by coming as close as they can to the limits of the environment. This of course is a form of trap, made worse as risks enter a spiral.

A risk spiral results from the transformation of environmental mental complexity into social complexity. Human actions therefore can create new risks and risk spirals to occur. The deep-time perspective can reveal proximate and ultimate causes of the collapse of systems.

Social and annotations or cultural traditions that may appear in efficient or illogical in the short-term may reduce risk and increase resilience in the long term. The risk is driven by human cultures attempts to cope with risks or to exploit opportunity. The process involves more management of the environment and although different parts of the environment operate in a range of scales, most of the natural dynamics and landscape occur slowly by comparison with human dynamics. As a result humans adapt themselves to the immediate dynamics of the environment at the beginning, but over time cultures serve their own needs by modifying the environmental dynamics. Human cultures thus become dependent on colonized systems, which require certain social institutions, especially for organized production and storage.

Machine technology can reduce risk, as can management expansion. However, if the risks are perceived as smaller, then people take more risks (sometimes a challenge or danger is more fun than a safe, optimum environment). If every hot or sharp surface is labeled or protected, people can be surprised when they get hurt. In one sense, knowing dangerous conditions is enough to encourage people to act in a safer manner. Is technology then a trap also?

6.5.2.1.2. Threats

What are the greatest threats at the moment? Climate change or species extinction? Social equity or levels of luxury? Humanity, that is most cultures, seems to be treating the threats as problems and pushing them forward to the next generation to solve. Although we act as though we cannot tolerate risk, we are willing to accept a very high level risk for the next generation and the planet itself. Threats to our survival rise from disjunction between our powerful technologies and the wisdom to understand the effects and limit their use. Threats to human survival include: Growth in demand for resources; exponential growth in population; transformation of the atmosphere, geosphere, hydrosphere, and biosphere; conversion of wild ecosystems into domestic; deforestation; release of pollution into land, air and water; environmental degradation through use; extinctions; destabilization of systems and cycles; the release of novel substances into historical systems; the use of untested technologies; the use of highly destructive technologies from giant earth movers to nuclear weapons; uncontrolled genetic changes; economic failures; social failures; cultural error or inflexibility; the use of violence or terrorism to achieve social objectives—obviously, this is not a complete list.

Some of these threats are the result on unconsidered growth of population, demands, and conversions; the scale is far more damaging than just the activities. Other threats have to do with the unconsidered use and scale of technology. Many have to do with our personal and cultural failures to understand the system in which we are embedded. Humanity seems to be amazingly poor at predicting what important issues are going to be important with in the next 30 years. For example, the 1972 Stockholm conference on the human environment did not mention major threats such as mass extinction of species, tropical deforestation, desertification, ozone depletion, or climate change.

6.5.2.2. Problems of Civilization

Civilization has become so beneficial and desirable that we do not question its direction, size or momentum. But, internal problems have major effects on civilization as a whole, not just its technological brilliance. The external problems affect regions and the planet.

6.5.2.2.1. Growth & Momentum

Unending economic growth is emphasized in some economies and cultures. Yet, growth can cause a community to fall out of balance or scale with its surroundings. And, being out of balance can lead to massive disruptions.

Population growth, even if not combined with technological innovation, can lead to greater deforestation and land conversion for agriculture and urban areas—which pushes the regional systems further out of balance. Economically, we reason that growth is necessary for living standards to rise, and individual self-interest has proved to be a stronger motivation than patriotism, altruism, or recognition. Modern economics depends on economic growth to avoid crisis. The major premises assume that the population will grow, social good is related to equitable distribution of material products, and if resources are limited, technology will erase the limits. A large literature has treated perpetual growth as the only conceivable state of affairs. Kenneth Boulding suggests that it is a short-lived 'cowboy economy.'

Capitalism depends on growth for stability. There is some analogy with plants (to be elaborated on later). Some stability can be gotten from growth in early stages; later stability must result from limits and metabolism. Growth in plants can delay the onset of senility by ridding the plant of waste products in more diluted form. However, too much growth produces a strain on tissues and early decay. In fact, one herbicide promotes excess growth as a means to kill plants labeled as weeds.

The production of wealth from growth depends on technology. The technological perspective is oriented toward materials and not humans or forest processes. Nature is considered to be a resource to be exploited. The immediate objective of technology is to create wealth through knowledge. Technological activities are justified on humanitarian grounds, scientific discovery increases the well-being of human society, yet the social consequences of scientific activity are ignored; short-term suffering will be offset by long-term benefits, it is claimed. But because the long-term view is not taken, long-term benefits will be worse.

Economic growth can produce great wealth for some. Inequality is more the result of differential development than of exploitation. According to Boulding the greatest source of the differential is different rates of accumulation of knowledge, capital and organization; the rates are essentially internal properties of cultures. Although a minor element in terms of transfers, it is a large psychological perception, which may need to be compensated for in a global community. However, gross production may not be as desirable as thought. The world prices of food and industrial raw materials have increased far more rapidly than those of manufactured goods. It can be seen that economic growth is not equal to progress.

6.5.2.2.1.1. *Growth & Stability*. Mesarovic and Pestel stated that "the issue for the economy is not to grow or not to grow; it is how to grow, and for what purpose." They claim that if a workable world system is to emerge, it must be after the establishment of an organic pattern of growth. Due care is devoted to describing such a pattern and contrasting it with other, tragically inapplicable patterns of growth. Their treatment of the world system itself was regionalized and multileveled. They recommend that the establishment of organic growth was necessary with no need for special no-growth policies for populations or economies. They assume that further industrial growth will continue, that economic growth is good, and that this growth solves human problems as long as it is organic. Kinds of growth, linear or exponential. The J-curve graphically represents exponential growth, such as by human populations. A positive linear increase is generally steady, such as food production. Exponential growth is said to be bad, and organic growth is said to be good. In fact, although organic growth is better, there is little difference during a world crisis—both reach asymptotes of suffering. One need only regard the population crashes of lemmings and others to see how organic growth can go wrong.

In the organic world, growth is healthy only when the rate of change is decelerative in the long run; cancer and population are accelerative. Mesarovic and Pestle fail to realize that continued economic growth in any form is a threat to the stability of the biosphere.

Economics became enamored of growth during a critical time in history. Rapid European expansion occurred at rates rarely exceeding a growth of 1% per year, and with unparalleled opportunities for expansion into sparsely settled areas (North America, Australia, South America, South Africa). Many cultures now do not have these opportunities; the continents are claimed, and violent population growth may have wrecked their hope for development by ravaging every resource.

The economy has been growing almost constantly since it has been studied. We have been trying to force it to grow, rather than let it stabilize or contract. Some have argued that contraction causes losses and suffering; yet, growth has caused exponentially more losses and suffering. Mesarovic and Pestel, as well as many others, confuse growth with development. Some theorists, like Samuelson, have concluded that growth is necessary to rid the economy of disparities. Even if it stopped growing, the economy could still develop.

6.5.2.2.1.2. *Size & Impetus.* The larger a moving thing is, the more momentum it has. Stars have far more momentum than snowballs. Perhaps big science and big technology have too much momentum. Theodore Roszak acknowledges its schizoid attraction and repulsion, with the twin promises of glorious accomplishment and hideous death. Who could escape being torn between yes and no, if even our end would shine with radioactive, Promethean grandeur? Our image of big science—the scientist as tragic hero, isolated in chaotic nature, but strong in his proud individuality, perhaps driven to research by hubris and madness—is a barrier to any new vision, especially a small vision.

We cannot imagine beauty in the old and messy nature, and we are afraid to try to do without luxuries or to try to sacrifice anything to try to change the momentum of industrial civilization. The most likely result will be the total destruction of the combatants, nations, and natural habitats. Sadly, the only people who do not know this, or admit it, are those in decision-making positions, who are compelled to prepare for what they subconsciously know will be a terrible disaster. Their power has trapped them in the momentum of their nation, afraid to be caught in any criticism. Yet, they direct the money, skill, and knowledge of their citizens into projects that lead to misery, servitude and hideous death, and not to life, liberty, and happiness. Our civilization is based on its early momentums. We pray it never stops.

6.5.2.2.2. Technology & Technopoly

Technology has reduced the globe to a single, closed system, which humans can share according to their financial powers. Our direct experience of the world has become shallow, in spite of faster travel. Travel used to broaden the mind, but now it narrows it. We travel in sealed corridors like boxed goods, comforted by homogenized foods and a few common languages. Technology or social structure can mask the internal stress from fast economic growth.

New technologies compete with old ones for dominance in a world view. The medium of technology contains an ideological bias. Tool attacks tool, according to Neil Postman; printing attacks manuscripts, television attacks printing, painting attacks rock art, and photography attacks painting. Postman refers to this fight for dominance as technopoly, and defines technopoly as a form of cultural AIDS; the cultural immune system is inoperable. The immune system protects the body against invasions and uncontrolled growth of cells.

The change to Technopoly may have started with James Watt's invention of the steam engine in 1765. Adam Smith in 1776 justified the transformation from small-scale, personalized, skilled labor to large-scale, depersonalized, mechanical mass-production. He argued that money, not land, was the key to wealth. In a technocracy, an unseen hand would eliminate the incompetent and reward the efficient. Several years later, Richard Arkwright, a barber, developed the factory system in cotton-spinning mills, where he trained children and others to conform to the regularity of the machine. It was the first mechanization of production. Twenty-seven years later, the power loom eliminated skilled workers altogether. Every ten years a new invention changed industry. Whitehead thought that the greatest invention was the idea of invention.

Technologies, in a technopoly, make other things invisible. This has the effect of eliminating them from consideration. Now, instead of being the most important of things in a culture, the invisible things, like the environment, become the irrelevant and useless. Other things, like religion art and history are redefined. August Compte argued that things that could not be seen were unreal and undeserving of attention.

Technopoly is dismissing philosophies and traditions, as well as moral democracy and cultural beliefs. Not having a transcendent narrative or moral order, technopoly has to depend on techniques for control the information from technology. A bureaucracy is one filter. Bureaucracy is a technical solution to the crisis of control. It is administrative not governmental, as de Tocqueville recognized them. A bureaucratic form restricts information to what is asked or can be put in boxes. It is to make the use of the information efficient. Bureaucracy is independent of culture. It is a very low-context extension. It also has no intellectual political or moral theory. Detachment allows escape of responsibility. Not responsible for human consequences of decisions, just efficiency of that part of the bureaucracy.

Humanity becomes an autoparasite, a new pseudo-species. Technology enlarges the number of niches for us; tools fit humans to different habitats, displacing other species. We steal from animals and plants, from the earth, from our own descendants. But, science and technology are spiritually impoverished, divorced from awareness of values and purposes. Technology must be placed in perspective. The analysis of complex problems is beyond the specialist as is the synthesis.

By the time of the Frederick Taylor system of scientific management, in 1911, the primary goal of human labor and thought was efficiency, not the production of goods. Technical calculation is superior to human judgment. Humans are at the disposal of technique and technology. Why did it work in America? Perhaps the American character of wonder and frontier life. Or, the audacity of American capitalists in robbing America's past and heritage. Or, by providing people with sufficient abundance and comfort. Old beliefs were discarded and history was disconnected from change and the future. Technology was something to believe in. It never made mistakes (only humans did). Antibiotics always cured. Airplanes always flew. Well, maybe in our memories.

Science and technology are the chief instruments of progress. They were supposed to bring superstition and suffering to an end. Technologies depend on information. They also have to control information. In technopoly, according to Postman, cultural symbols are trivialized by corporate enterprise. Symbols become common place by use in television and movies. The promiscuous use of images may seem like irreverence, but it is worse; it is trivial overexposure. Should all symbols be used for commerce? Is that okay? Technopoly tries to fill the void of dead narratives with its idea of progress without limits, improvement without costs, and rights without responsibilities. Society can be engineered is a thing of technopoly.

Science and technology are spiritually impoverished, divorced from awareness of values and purposes. Technology must be placed in perspective. The analysis of complex problems is beyond the specialist as is the synthesis.

6.5.2.3. Economic Problems

Economics posits rational actors in economically efficient optimization policies who would spend only as much money averting global warming as would be lost to costs. Efficiency here is not about death or destruction but finding the least cost and highest return solutions for the business of life. Saving the commons however is a serious market failure because it depends on morals not profits. Institutionalists argue that more is needed, such as better organizations and norms, which go beyond the market. Climate change could slow progress, and science is uncertain. More cooperation, on things like global warming are needed. Better organization is needed.

6.5.2.3.1. Consequences and Costs of Pollution

The industry gadfly Dixie Lee Ray claims that 'side effects' cause us to worry to the exclusion of considering the benefits of a new technology. Her example of the internal combustion engine is ambiguous. In fact, it has had great undesirable effects on society, regions, and the planetary atmosphere. Pollution is not a side effect here; it is an equal effect, along with mechanical power. The costs of air pollution are staggering: $40,000,000,000 in health care and lost productivity in the U.S.; $4,000,000,000 from ozone damage to wheat, soybean, and peanut crops; $5,000,000,000 from acid rain damage to agriculture, forests, and aquatic systems; and destruction of 20 percent of European forests (figures from the Worldwatch Institute, 1988). Other pollutions are as bad. The oil pollution of the oceans from spills as well as the continuous discharge of poisonous sludge (up to 17,000 gallons per month per supertanker, including the BTX compounds—benzene, toluene, and xylene) and toxin-contaminated water kills thousands of animals and fish every month (including salmon, ducks, and sea birds with concentrations of metals—zinc, chromium, and cadmium).

Airborne pollutants have increased world-wide, according to a 1982 UN report by Dr. M. Tolba, Executive Director of the UN Environmental Program. Although some forms of pollution may have lessened in some industrial countries, the U.S. and Britain, for example, due to lawful control measures, other forms of pollution, such as acid rain, have increased dramatically everywhere, threatening fish, trees, crops, and buildings.

Air pollution, with acidification and toxic substances, has been implicated as a primary factor in 'forest death syndrome, first noticed in Germany and other parts of Europe. There is overwhelming evidence of pollution-caused death in Europe and eastern United States. The fact that there are other causes that work independently or with pollution does not invalidate the other evidence. To argue so, as some scientists do, is based on a logical fallacy, the semantic fallacy of complexity.

The costs of modern industrial farming in England, for instance, are applicable to China and other nations: Two billion dollars for removing pesticides from drinking water, damage from soil erosion, medical costs of poisoning and mad cow disease (90% of what farmers earn); $0.4 billion for subsidies to farmers (180%); $0.1 billion for healthcare costs for poor choices (45%); and, $3 billion at least in loss of productive land.

The costs of industry are more subtle, but equally expensive: Unhappy people act as identical replaceable machines; people are tightly regulated (leading to disrespect and violence); cleanup of pollution is prohibitively expensive (especially compared to prevention); Cleanup; health-related problems are almost too expensive (only the complexity of the effects of mixed pollutions prevents a violent revolution against industries); and, the boredom of sameness is impossible to put a price tag on.

6.5.2.3.2. Effects on Human Health & Ecosystem Health

Pollutants can contribute to or cause diseases, including cancer, lupus, immune diseases, allergies, and asthma. Pollutants can cause levels of irritation leading to death. Higher levels of background radiation have led to an increased incidence of cancer and mortality associated with it worldwide. Some illnesses are named for the places where specific pollutants were first formally implicated. One example is Minamata disease, caused by mercury compounds. Bad air quality can kill. Ozone pollution can cause sore throats, inflammation, chest pain, and congestion. Oil spills can cause skin irritations and rashes. Noise pollution induces hearing loss, high blood pressure, stress, and sleep disturbance. Contamination can have damaging effects in the brain and central nervous system. Studies have shown that the brains of animals actually shrink from prolonged exposure to contaminants. Humans can become stupid.

Changes to the environment can lead to disasters and collapse. A few human environmental disasters include: Mesopotamian soil salinization, 3300 BC; Chinese soil erosion, 3000 BC; Deforestation of the Mediterranean, 500 BC; Deforestation of Rapa Nui, 1400 AD; and, the US Midwest Dust bowl, 1930s. These are signs of a decline in the health of these ecosystems. The consequences of land degradation are many. For instance, productivity has been reduced by one-third on half of India's soils. Salinization in the Middle East and on most irrigated lands means that many crops can no longer be grown; for instance, 34% of land in Bangladesh affected, and this has quadrupled since 1990. On-farm expenses have risen 100%. Over 7% of the agricultural productivity in SE Asia is lost. Off-farm expenses balloon. Air and water pollution, road damage, desertification, cleanup costs, and health costs keep increasing. The loss of biodiversity and ecological services continues. Increased energy costs affect personal lives and industrial improvements.

6.5.3. Conclusion: Questioning a Machine Image

Modern industrial technological cosmology, beyond being another kind of order, more linear and abstract, is wrongly considered the evolutionary successor to traditional cosmologies, and is displacing them rapidly. Using the metaphor of the machine, this cosmology tries to render other images as incomplete. The machine image has allowed tremendous advances in understanding mechanical systems, and even some biological systems, by treating everything as a machine, which can be repaired with replacement parts or improved with better design.

We need to question the image of the machine. Questions widen the narrow field. Hardin points out that concerns about narrow issues, such as pollution, can cause a deep examination of the process, such as distribution theory, that cause the issue. Human activity simply produces things that we want and things that we do not want, such as pollution. As we ask questions about who pays and who benefits, we are able to think or rethink about these things and keep them in our consciousness.

6.6. ***Designing Local Technology: Integrating & Limiting***

Before designing new technologies, we can break down technology into purposes and strategies. We can then enlarge the scope of inquiry to include the fitness and appropriate application of technology.

6.6.1. *Purposes of Technology*

What does technology do, basically? It creates extensions, as tools, to our bodies, letting us access new resources and create new things. Many of our basic tools have very basic functions: To cut, burn, mend, collect or move, for instance.

6.6.1.1. Cutting (knives, shears)

Pulling down a tree for shelter or slaughtering a large animal for food was difficult for fingers and muscles. Sharpening a piece of certain kinds of rock made cutting wood or flesh easier. The first tools were stone-flaked, then ground stone, used with boomerangs and clubs. Ground stone axes appear first in Australia. Tools are simple, but effective, easily manufactured and maintained, for example, the spear-thrower, or woomera (atlatl), had hook on one end and an adze on other; it could be used for a shovel, fire-starter, or percussion instrument.

The earliest lodges may have been pit houses, covered by up to 3 feet of earth over grass mats on a frame of wooden poles, with a central opening for smoke. After the Indians acquired horses in the mid 1700s, wild horses from the southwest, and became more mobile, the shape of their buildings changed. During the winter, they lived in A-framed or conical-shaped mat lodges. Mat lodges on wooden-pole frames were easier to dismantle and move, although they were usually just stored in rock piles. In the summer, mat or deer-hide lean-tos were used on hunting trips. Later, deerskin tipis were favored for trips.

6.6.1.2. Burning

Something as simple as a knife can replace the muscular effort of chewing large pieces of food, which can be rendered more tender by another tool, fire.

The biggest energy contribution from cows and bulls is their dung. Most of the dung could be used for fertilizer at no cost to the farmer or to the world's fossil fuel reserves. The remainder could be used for fuel. It is odorless and burns without scorching, giving a slow, even heat.

By burning fossil fuel every year, we are burning light from previous ancient years. Most energy is generated by variants of the steam turbine, which relies on burning something, not much different from dung and wood, just centralized. Burning fuel to produce fertilizer to grow feed, to produce meat and to transport it produces 9% of all emissions of carbon dioxide, the most common greenhouse gas.

Burning allows us to ignore inefficient practices. For example, in 2000 fishers burned 13 billion gallons of fuel to catch 80 million tons of fish. Without calculating the real value of carbon fuel, it takes over 12.5 times as much energy to catch fish as they provide.

Later technologies tried to burn waste to break it down into component parts that could be sifted out of ashes; the burning, however, resulted in air pollution and some toxic wastes that had to be isolated. In the USA, a third of municipal waste is burned that includes the percentage recycled though).

Derrick Jensen and Aric McBay note that US paper industry burns more fossil carbon than the entire chemical industry uses as raw material. Our transportation is supported with energy from burning. Burning fossil fuels lets bacteria form new routes for mercury contamination. Burning of things for energy is bad? Yes, we could be eating it or using it to replenish soil. Is burning waste bad? Yes, for similar reasons, but also for the release of toxins.

6.6.1.3. Mending Gluing & Weaving

As people had the need to separate things with tools, so they had needs to put things together, for instance two pieces of hide or a sharp rock and piece of wood to handle it. Sticky substances from the environment were used to glue things together—mud, asphalt, animal fat or tallow. Thorns and later needles were used to pierce hide and cloth. Cloth itself was woven from threads of fibers, cedar, wool, cotton.

Then, they make clothing, for making life easier. Clothing and tool-making is a universal in all human cultures. Polynesian cultures used 3-way weaving (at 60 degree angles) to keep the weave from spreading under pressure (by the way, the words weave, woof and web are derived from the Indo-European word). On a loom for weaving, the upright threads (vertical) are called the warp; this means 'throwing.' The fabric or web is made by weaving new threads horizontally; the crosswise threads are the woof. Warp means to 'twist' or bind.

6.6.1.4. Collection & Storage

For aborigines, the whole environment was a storehouse for gathering. Sun-dried fruit on the ground, eggs. Most personal belongings could be carried with people, on their backs or in bags or on horseback. In homes, it could be stored in bedding, baskets or wooden boxes. Food was stored in different kinds of woven baskets, made from bear grass, wild hemp, and cedar and spruce roots. Mat lodges on wooden-pole frames were easier to dismantle and move, although they were usually just stored in rock piles.

With the surpluses from agriculture came the needs not only for larger forms of storage—large pots or buildings—but also for standard measures to distribute earnings measured in crops. Salish people often built separate storage longhouses and storage boxes for fish and oils. Canoes were stored in special canoe houses. Fresh and curdled milk, carried and stored in long, decorated gourds, is the basic item of the Masai diet. Inuit could store food in ice caches or smoke it.

Agriculture had new requirements to get materials to and from the fields, preparation sites and storage sites. The surplus grain had to be transported, stored, reallocated. This required organization. Information is stored, as data. Biological symbiosis results in a greater store of genetic information—a new species. Information is stored in various media or on computer disks.

6.6.1.5. Moving Wheels & Vehicles

For many lifetimes, things were dragged from place to place. Even after horses and oxen were domesticated and carried a few things, most things were dragged or strapped to poles and dragged. Eventually wheels were invented for moving water or toys. The Southwest Asian system, involved clearance of savanna, swamps, and fringe forests. It led to changes in the water regime by irrigation, with systems of embankment dams, canals, buckets, and water wheels. Pottery wheels mass-produced bowls for measuring grain and rations that were distributed to outer villages.

The wheel and the cart, for moving larger loads, was invented about the same time as the city. As paths become wider more permanent structures that can accommodate wheeled vehicles, their edges interact with human places. The wheel allowed a much greater mechanical advantage for human and animal effort. Because of its relatively low coefficient of friction, it is useful in a variety of circumstances. The bicycle is still one of the most efficient ways of allowing human mobility.

6.6.1.6. Production

The simplest form of production was gathering ripe foods where they grew, then carrying them home to be prepared. As people started to tend plants, they had to being water and soil or night soil to them.

6.6.1.6.1. Food Production

Some desired foods grew well far from their native habitat, but they required care to get them water or keep them safe from their other predators. As tools became more sophisticated the scale of production increased.

6.6.1.6.2. Industrial Production

As things were made on larger scales, new ways of making them were tried. Much human labor was replaced by energy from wood, coal, and then fossil fuels. Tools were put in sequences to make complex machines in a linear order. Tools and machines required more metals and materials to be dug up, which exposed living beings to the toxic wastes.

Peasant society featured a plow, with a domesticated animal on dedicated farmland, plus a wide range of artifacts and tools. The transition to the industrial society began in England with steam engines, textile machines and tractors, which forced the peasants off the land and into the cities. Machines began to dominate production.

At the beginning of the Industrial Revolution, the sudden change in production and distribution of goods benefited many people. For example, fabrics became much more common, and women who have never had more than two outfits in a lifetime, including one for ceremonial purposes, now had several. As the number of goods rose dramatically, they became less expensive and more widely available. By working in specialized factories people's income also rose. Science discovered many new patterns. Educational opportunities were increased by employers who had to educate their staff.

The Industrial Revolution is credited with ending struggles against famine, pandemic disease, and extreme poverty (compounded by endless cycles of despotism and war). Industrial technology is good at solving certain problems, but it creates new problems and depends on the specific characteristics and scale of a centralized society. And, these new problems included starvation, diseases, and poverty from the distribution of new wealth.

Industry did not solve the problem of war, which seems to inhabit the core of industrial culture, also, especially in terms of expenditures. Conflicts over identity and resources occurred when people saw that their needs were being ignored or threatened. Industrial culture values competition, violence and domination more than it does cooperation, peace and equality. This seems to be a historical trend.

In the last century, humanity doubled the amount of its crop land use; the number of people increased by four times; water use increased by eight times, energy use increased by a factor of 16, and industrial output increased by a factor of 40. Understandably, the quality of human life also increased, especially in terms of life expectancy.

Industrialism is a special case of production, with special characteristics, not the least of which is cheap energy. Using the benefits of science, industry has been able to produce items that aid and enhance human efforts to understand nature, as well as make luxurious places within nature.

6.6.1.7. Enhancing
Human beings were clever enough to find ways to enhance their senses, for instance, certain chemicals from plants. Someone discovered that a lens of water enlarged an object underneath it. Lenses of glass allowed things far away to seem close-up and small things close up seem larger. This allowed us to see deeper into the structure of things, as well as see new things with microscopes and telescopes.

6.6.1.8. Repair/Replacement
Tools are also used to replace parts of or repair the human body. We can use chemicals to repair imbalances of acids or bases. Other chemicals can relax or stimulate the body. Medical tools can be used to remove pathologies or repair breaks.

6.6.1.9. Communication & Information
Clay markings, the abacus, and now the computer allow exchanges to be recorded. Computers permit us to wildly exceed the limitations of our brains.

Technology is a long historical development that started during hunting and expanded with agriculture, and it has ushered in tremendous changes. Ivan Illich points out that in the 1930s, nine of ten words a person heard were spoken directly, one to one. By the 1970s, the proportion was reversed, and nine came out of a speaker. He noted: "Computers are doing to communication what fences did to pastures."

Any of the newer tools, such as computers, can be used just as well to bolster profits as to save forests. The government has learned to use the same technology, although the nature of the technology may in general undercut authoritarian use. Lewis Mumford thought that authoritarian rule encouraged technological progress. It makes it easier to manipulate and control. When the system promoted some of the ideals of democracy, that everyone should have a share of goods, the system gave the largest share to the rich. And, the poor took the bribe, and can wish for more and be happy. Those were 'magnificent bribes' as Mumford noted.

The introduction of silicon and the fabrication of the microprocessor is now the heart of information technologies. Computers dominate industrial production. Some computers may radically increase our ability to understand and shape the future.

With expanding computer capabilities, virtual worlds can be created that can embody many of the values of the material world. The generation of these worlds would require fewer resources than if the activities had occurred in physical space. The only problem is that it takes a lot of energy and space to create those virtual worlds. The virtual world is a model of reality, but not having the origins of reality, its simulations could meet needs where tangible material products no longer are necessary to satisfy some of those needs, which may resemble Maslow's hierarchy needs. Obviously the lower needs, such as food or comfort, could not be met in by virtualization.

As tools increase in complexity, from knives and levers to computers and space stations, so does the knowledge needed to support them. Complex modern tools require libraries of information that has to be continually increased and improved, then spread and understood. Technology first simplifies life, then complicates it. Some technologies, considered network technologies, increase benefits when others also use them: Mobile phones, internet, and computer operating systems.

6.6.2. *Usefulness of Tools & Technology*

Perhaps the first responsibility for design dealt with effective usefulness—either the digging stick worked or it did not work. How are ideas or metaphors useful? As models, systems are useful; a system is a way to explain part of the universe.

High technology is not the primary path to survival, but neither is rejection of that technology. The paddy/terrace agricultural systems are good ways to keep water useful. Some high technology satellite photography is already useful for scanning large-scale systems. Yet, equally useful knowledge comes from history, botany, and 'natural' history. Culture has been a useful adaptation to environmental challenges, such as cold, drought, and rapid change.

Energy is a useful tool of analysis of kinds of culture. A culture can be defined by its levels of energy use. A conceptual ecological model is a useful tool for identifying metrics with relevance. It would delineate linkages between key ecosystem attributes and know stressors or agents of change.

Design is obsessed with maximizing beauty or optimizing usefulness. Yet, it does so without attention to any social or environmental constraints on a maximum. Papanek advises young designers to go to developing countries, to clinics and hospitals and see what they can do. That could start a global crusade for design to be useful.

Design can use purposive policies that mobilize the adaptive capacities in these dimensions of culture and nature. Without certain knowledge, however, we have to make adaptive decisions based on partial knowledge; this is adaptive design, which is very much like adaptive management. Flexibility allows for more options under different constraints. This flexibility allows designs to be useful for longer times under different cultural values.

6.6.2.1. Alternatives

Lewis Mumford concluded that we need to use a polytechnic approach, many technologies for a need, rather than one, like the automobile, for all transportation. Even technotopia has to use alternative technologies, within the culture limits. Alternative energy sources receive a lot of coverage. There has been talk about developing renewable sources of energy, including wind, solar and nuclear energy. None of those forms of energy have been used to power our cars and trucks on a meaningful scale, although they might in 10-20 years. Other nations, such as China in wind and solar, are leading US development in such technology, so the US is falling down in preparing for the distant day when cars will be powered mainly by renewable energy and alternative fuels, especially compared to Brazil. European nations have tempered their oil addiction by taxing gas at high rates, while building more dense communities that require less driving and allows many people to walk or cycle. These shapes for cities are attractive to residents and to businesses and tourists. The density and convenience of mixed-uses, with markets, offices, parks, and schools are part of the charm.

Many Technofixes are based on an inappropriate logic, linear and cause-effect instead of nonlinearity and multiple effects. In the absence of science-based, global, transparent, and effective regulatory mechanisms and enforcement of geo-engineering projects, these projects should be halted or shelved until there is a tested scientific basis to support these activities and appropriate consideration of the associated risks for the environment, biodiversity and society. Using the precautionary principle, thought experiments and small-scale research studies conducted in a controlled setting, the technology can be tested as data is gathered to indicate potential impacts on the environment.

Design offers many different alternatives to the problems of industrial society. For instance neighborhood programs to remove fences, to build new walkways, gardens, and other community facilities, and generally help the neighborhood rebound. Denmark promotes cohousing. One of the nice things about cohousing is the idea of a common house as well as the clustering of houses along the street surrounded by open space and force it areas.

All of these issues are environmental issues; industrial ecology, universal education, health care, and city design are a part of any alternative to catastrophe. Many of the local adjustments taking place, in alternative ways of life and ecovillages, show these ways are possible first on a small scale.

The alternative to overpowering policy resistance is to 'let go.' This seems counterintuitive and even unthinkable. We have abandoned ineffective policies in the past, as with Prohibition in the US. Working collaboratively, we can create alternatives to failing economic patterns and practices. Ambiguity happens when too many alternative interpretations are present, but we can consider the most promising ones.

6.6.2.2. Appropriateness

Let us redefine reality. We have that power. If we do redefine it, then maybe we will act in a more appropriate manner. We do not need to choose between competition and cooperation, for instance, to determine their appropriate relationship. It is true that we need to balance them because all of these interactions types are necessary, in different situations.

Mohandas Gandhi and E. F. Schumacher argued for appropriate technology. Van der Ryn states that ecological design is about merging nature and technology. Certainly technology is emergent from human activity, which is emergent from "nature," but ecological design is also concerned about separating technology from nontechnical species. Advanced technology is not always necessary. To be sure, it is wonderful, but it should not be the driving force for ecological design. Conservation and fitness are far more important. Since 'Natural services' cannot be replaced by technology, either economically or completely, large areas need to be left wild. However, due to our extreme, inconsiderate interference, we need to design a protective framework, for that "nature."

Ecological design is concerned with appropriate energy use and appropriate technology. Ecological design tries to determine the source of energy and to use energy from renewable sources, such as solar energy and wind power. But, it also has to be cognizant of the scale and appropriateness of these sources and try to use small-scale, distributed sources. When possible, power generation could be integrated into the design. With efficient homes and electric transport, all of the energy needs of some areas, the Pacific Northwest for instance, could be met by established water power, which is estimated to be half of the potential.

Some forms of industrial design build with adequate physical redundancy to allow objects, such as airplanes and bridges, to fail partially. Ecological design has to incorporate appropriate levels of redundancy to allow the system to be relatively stable and flexible. Ecological redundancy has value to an ecological system. Ecological design addresses the determination of separate wilderness areas necessary for a healthy ecosphere, and an optimum human population, based on net ecosystem productivities and modified by appropriate technologies within ecological and cultural restraints.

Ecological design tries to address appropriate scales and times to scale management to ecosystem size. For instance, one can approach a forest as a partnership, and perform actions to benefit the forest as well as the suite of users. Giving back to the system amplifies future benefits. Working with forest time, not being limited to an industrial schedule, will still accomplish objectives, and you can be as slow as you want or need to be. Attempting to set up a transgenerational land tenure system to accommodate forest time, which spans human generations, will extend the life of a forest long past short economic horizons.

Ecological design adopts a precautionary principle, which asserts that if harm is threatened, and if there is uncertainty about the seriousness of the harm, then precautionary actions must be taken. Since the 1970s, in fact, this principle has been incorporated into Swedish and German environmental laws. This principle means that not doing something, "benign neglect," becomes a valid management option. Carl Walters suggests that inaction is an inappropriate alternative to gambling as a result of confusion, but inaction is a very appropriate alternative in the face of confusion—when in doubt about an ecosystem, we should not interfere. As appropriate alternatives, both inaction and action are possible.

We have to behave appropriately with other forms and scales. That is we need to keep an appropriate level of complexity. Why be too complex in our civilization and social structures? We need to arrive at a goal of an appropriate population size. Leopold Kohr notes that 'appropriate' is a relative term, like harmony. Size is often determined by function. Kohr notes that a gigantic tooth might not chew up food better than small ones. On the other hand, a larger city will likely provide more stimulating environments than a small village.

In the countryside, inappropriate developments, however small, can have large impacts. Sensitive location and design is needed to avoid urban sprawl, ribbon development, or new buildings on obtrusive sites, with incongruous materials and house styles more characteristic of suburban than rural areas. To protect the countryside we need to find opportunities for infill development, for converting and rehabilitating existing buildings, and for planning buildings in groups rather than on their own.

6.6.3. *Combining Tools Machines Automata Intelligents & Hybrids*

One thing that we have not learned to do is to predict the consequences of new technologies. This is a good reason to experiment at small scales for years before just releasing the new technology for everything. Thought experiments can help us avoid being overwhelmed by details. They can help formulate goals and interpret information appropriate to scale. The idea of science is to manage our experiences with generalities. Once the thought experiments are started, they can be refined with conceptual or mathematical models, which can simulate the changes and historical development of changes. Computer-based models can permit complex explorations, as well as suggest new patterns and further hypotheses. Through thought experiments and models, many of the dangers and expenses of our activities can be avoided.

With the evolution of technology, and with the simultaneous existence and interactions of tools, machines, automata, intelligent machines—not just thinking machines but self-directed mechanical entities—and hybrids of humans with computers and machines, we had better have had conducted many kinds of thought experiments about the ranges and outcomes of complex interactions between all of them. What would happen if a network mind achieved consciousness? Will we see it? Will we be able to contact it or need a translator? Will we be able to master it? We have almost reached the possibility of intelligent machines, even if they operate on quantum levels. Will we need complex rules of robots and human ethics?

With a complex technological civilization, we should remember that the image of the world as mechanical is not the only image. The world can be personal, as it is for the Navajo, or it can be a basic duality of humans and gods, as it is for the Dahomey, or it can be static and internal, as it is for the Yaruru. These other images may be more appropriate for fostering concern and responsibility. A new animism, or soul science, could be an appropriate approach to living technologies, as well to the feeling system of nature. This animism would allow us to behave "as if" nature and our sophisticated technologies are really intelligent and sensitive.

6.7. *Designing Adaptive Patterns: Agriculture to Industrialization*

Previous adaptive patterns have extended beyond the range of their adaptation, in time or space. For instance, it is unlikely that modern cities will ever be able to survive a ten-year drought, much less a twenty-year or fifty-year drought, or a hundred-year series of droughts. It is unlikely that industrialization, or industrial agriculture, will survive the decline of fossil fuels. Possibly our adaptive technology will not survive its effects on humanity or the planet. So, we have to design many of our adaptive patterns, from agriculture and cities to technology and industry, to fit a changing planet.

A growing population based on agriculture offered advantages, not just survival of the species, but a competitive advantage against other species. Agriculture determines what we eat and how often we eat. But, agriculture requires the conversion of many wild ecosystems over vast landscapes. People are no longer scattered over those landscapes, but concentrated in cities, trading for foodstuffs from elsewhere. What if design tried to concentrate agriculture in the cities themselves? What if the fields on and around buildings were multi-level and complex? What if we reduced our reliance on grasses, like corn and wheat?

Cities hold well over half of humanity. How well could cities withstand three 20-year droughts in 100 years? Could they have farms on roofs? Could they make vats of food? Could they keep in storage enough food in cans or freezers to last for 20 years? Could cities limit their populations?

Technology is evolving on its own, without goals, plans, or management. We might decide what we want technologies for, then assess them critically, as part of the overall shape of civilization. With management, we might refuse many technologies as too dangerous, expensive, or silly. We might try to balance technology with the goals for cultures and ecosystems, and integrate it into the forms that we desire.

Industry has brought great benefits to many people and cultures, from simply increasing the number of clothes that people have to producing incredible machines that allow materials and food to be harvested, processed and shipped almost anywhere. But, industry has also produced destruction, pollution and waste on a massive scale, as a part of its production. The creation of an industrial ecology could integrate industrial processes with ecological ones.

6.7.1. *Calculating Local Optimum Human Populations*

The population of places ranges from hundreds to hundreds of millions. Many people now live in cities. The numbers in urban areas may not seem so large, but they are far larger than the archaic populations. Several trends are evident: A long-term trend to larger cities, and a more recent movement from cities to smaller towns and rural farming communities.

How many is too few or too many? How many more could there be? Is the current number above or below the maximum carrying capacity? There is a maximum biological carrying capacity for every region. The carrying capacity is the population sustainable on a long-term basis of renewable and nonrenewable resources. For humans, this capacity must include domesticates, as human equivalents, since many domesticates compete for protein consumption. Domestic animals can extend the carrying capacity somewhat, since many of them consume agricultural wastes or use lands marginal for agriculture, but are not as efficient as wild populations. Technology can expand the carrying capacity to some extent, with higher yield crops and resource substitution, but also it reduces the capacity with unforeseen effects, from the use of pesticides, for example. War and social disorder would also reduce the ultimate capacity. Furthermore, the capacity decreases as the per capita use of energy and resources increases. Carrying capacity calculations often just consider food energy, but all needs—clothing, shelter, transportation, information generation, aesthetic satisfaction—must be included.

A number of assumptions are necessary. Calculating a population based on plant productivity is relatively simple. However, considering the need for resources and the ubiquitous Law of the Minimum, the maximum goes down rapidly. Justus von Liebig's law of the minimum describes a critical minimum, under steady state conditions, of a chemical material needed for growth and reproduction. Economists have claimed that the minimum does not apply in a growing system; alas, our system has been growing through transformation and not real growth. H. R. Hulet pointed out that a population as a function of wood production would only be 80 percent of that calculated from food production—and desert areas have far less wood than the continental average. Furthermore, the population would be even less as a function of energy and fertilizer use rates. The rate of aluminum use would support only 40 percent as many. More importantly, these rates are not sustainable, being based on high American standards of consumption. A lack of some resources is not necessarily limiting, since one group could trade with others that need crops or products from a specific area.

The current high levels of population, at a high range of standards, can only be maintained through the constant takeover of natural habitats for arable land, or through the drawdown of fossil fuels, and by economically cheating the poor and powerless. Since the quantity of wild lands and fossil fuels is quite limited, either human populations must adjust to renewable resources or technology must provide substitutes, to avoid an eventual population crash.

Eugene Odum suggested using land area as a measure of human carrying capacity. The minimum per capita acreage requirements, with a temperate area like Georgia as a model for a quality environment, is just over two hectares (5 acres). The natural areas are based on minimum space needs for watersheds, as estimated by land use surveys. Food-producing land includes acreage for domestic livestock. Sarasota County, Florida is roughly equivalent to Georgia; using this measure, a crude number for population of the county would be 73,216 people, considerably less than the current population in 2012, of 393,000 people.

A local population depends on the limiting factors of the earth, those scarcities that could be traded between the regional populations, and each regional population having a percentage of that ultimate limiting factor (maybe phosphorus or manganese)—the percentage distribution would determined by the regional productivity available for human consumption. Restated, a place may have enough food for over a million people, but it may not have enough wood to build them houses or enough steel to build trains; therefore, a group would have to trade food resources for mineral or timber resources, assuming that other regions are able to trade. Maybe Sarasota could only hold 68,000 people.

Samuel Eyre also devised a common denominator to consider organic and inorganic assets together. He assigned a nutrition equivalent unit to weights of metal, but this calculation depended on a dollar value for food and minerals. For example, assuming the daily standard human nutrition requirement of 3,000 kilocalories, money income from minerals can be expressed in terms of annual nutrition units. Assuming that wheat releases 4 kilocalories per gram and is 10 percent cellulose and 15 percent moisture, then 1 kilogram of wheat yields 3,000 kilocalories, conveniently equal to the daily food requirement of one human being. One metric ton of unmilled wheat is equivalent to the annual requirement of 3 people.

Assuming that aluminum sells for \$1122.00 per metric ton and wheat sells for \$109.00 per metric ton, 1 ton of aluminum costs the same as 10 tons of wheat. If it takes 10,000 tons of aluminum to meet the needs of a current population of 500,000 (about 0.02

metric ton per person for cars, wiring, and cans), then we need to trade the monetary value of 100,000 tons of wheat to get it—enough to feed 300,000 people! And that is 300,000 fewer people than the area can support if we need to have aluminum things.

Population carrying capacity can be formulated using the net primary productivity (NPP) of the system. Following Odum, that only 30 percent of the area should be used for producing food, the agricultural area is set. Following Lieth, but averaging over the entire ecosystem, we estimate the productivity—either for natural or for energy-subsidized cultivated land. And, of that productivity, 75 percent is unavailable for harvest (60% is underground, 5% taken by pests, 10% used for respiration and reproduction), 65 percent of the harvest is inedible, 80 percent of the edible is lost in process, and 25 percent of the processed food is not consumed—leaving only 10 percent of the original productivity to nourish people. Thus, the gross productivity, in Kilocalories per year, may seem large, but only a fraction is available as food energy. Since every human being requires 3,000 Kcal per day (for adults), the maximum number of human beings, assuming that all other needs are met, is easy to calculate. Of course, food is not enough. We need a large quantity of calories for trade and luxuries. Assuming that other surpluses and deficits cancel out, say excess energy from water power for cotton for clothes or basalt for lumber, and balancing only agricultural productivity and aluminum needs, we get a still smaller population.

The advantage of primary production as wealth is that the wealth is sustainable—plants are renewable and minerals can be recycled. The disadvantages are that the net community production (NCP) is not considered, which takes all of the food chain into account—the millions of other species. Furthermore, dollars are used instead of human work units—using human work units, the number of hours of labor to produce a standard measure, would make wheat and aluminum much closer in price. The technological production (greenhouses or algae farms) of food is not considered. Complete consideration of technology might result in a multiplier of from 1.2 to 2.7.

It is possible to calculate a sustainable population using NCP instead of NPP, however. For temperate grasslands, NCP may approach 60 percent of NPP, although 30% is much more likely. The population calculation for NCP results a yet smaller number. Because the climate is variable, the ecosystem is ever-changing, and humans have unforeseen effects, we should strive for an optimum number, which we could arrive at through arbitrary multipliers (Wittbecker, 1983). Assuming the multiplier is 70%, the optimum population is lower. For example, the calculated optimum population using this method with both multipliers for Sarasota County Florida is 52,200 people.

Each way of calculating a population has become more comprehensive and cautious and has resulted in a smaller population. The target population for planning depends on how cautious we are. Should we gamble and go for more people? If we calculate the maximum wrong, we break the system, and we may not know how to repair it. On the other hand, what if we go below some minimum? The likelihood of this possibility is low. The archaic peoples did not approach it at very low numbers. The minimum number for genetic health could be 5,000 individuals; for a guarantee of fertility, 50,000, and for minimum social contact, a guess of 25,000. Sarasota exceeds those limits.

Many people fear that a reduction in human natality would cause human development to stagnate. Natality is the birth of new ideas, also, producing an ideomass. J. B. Calhoun's idea of ideomass is a multiple of population and individual potentiality. The brain and culture give human expression almost endless possibilities. Possibly, a minimum population for ideomass is 50,000. The concept of ideomass could support a stable or declining human population without a reduction in the quality of interchange.

6.7.2. *Redesigning Agriculture*

Traditional agriculture proceeds by substituting selected domesticates for wild species in equivalent niches, or by manipulation of the ecosystem, whereas modern agriculture replaces the biota, or transforms the ecosystem into an artificial system. People-powered agriculture works well. Horse-powered and oxen-power agriculture is still harmonious, because living creatures can fit better into biological and ecological relationships than machines can. The health and fertility of one is involved in that of the whole system.

Inorganic tools can be inserted into an agricultural order, but only within limits of kind, scale, and power. A tractor, for instance, can have too much power. It starts the destruction of the system. It also depends on the destruction of systems elsewhere to get its structure and energy. The tractor, farmer, and farm become resources for the industrial economy, run by capitalist ideas.

Agriculture, growing crops and raising animals, provided more food, but it was less nutritious and less palatable. By increasing the population, agriculture increased widespread hunger. The reduction in biodiversity, by monocropping, undermined biodiversity and caused some ecological crises, that resulted in periodic and devastating famines. If the trends to more and more control, and to greater and greater profits—with the effects of fewer farmers and monocultures—continue, then agriculture may become a form of chemistry.

One goal for agriculture would be a net of no lost areas from the footprints of cities or no lost areas for crops because of cities. If people are concentrated in cities, then their reliance on corn and wheat fields could be reduced. By situating some agriculture on rooftops and lots, and making them more organic and labor-intense, cities would be less dependent on distant areas.

Designing agriculture requires the perspectives of ecological design. This kind of design first recognizes the ecological restraints of a place, the patterns of feedback, the points of disequilibrium, and the peripheral frame of the system. Agriculture has to be place specific and fitness-oriented—it has to make a goal towards a satisfactory or optimum production, rather than a maximum. It has to become part of the regeneration and repatterning of the system—it cannot keep the system stable at one level indefinitely; yields will go up or down, depending on other variables, from weather to species composition.

6.7.2.1. Domestic Animals

What is the solution to the treatment of domestic animals? How can we design areas for domestic animals? Based on knowledge about the needs of animals, physical and psychological, they have to be in contact with a natural predominantly environment for most of their lives. Animal places have to be area-limited and standards-limited. In fact, the area would be determined by standards. The number of animals would be determined by total area, especially with social animals like pigs or horses.

Zoning would affect that area. The standard area could be calculated per animal for feeding and privacy maternal behaviors, as well as social interactions. Different areas would be needed for different species. Essentially, the animals would be free-range in a natural environment. Standards would be established to limit crowding, which is not simply uncomfortable but can result in pain and life-threatening stress; in fact, research has been done on crowding in rats and other animals. Drug use could be limited to the presence of diseases and then limited to sick animals.

We also need standards for experimental animals, starting with a limit to meaningless experiments, such as cosmetics, which already have vast human populations being tested informally. Tests would be limited to deadly diseases that are not established in human populations. Psychological testing would be minimized. Caging would be temporary for test and zoo-like conditions that would predominate for the test pools of animals. The best approach might be to integrate animals into new systems of agriculture.

6.7.2.2. New Systems of Agriculture

Agriculture is a form of ecocultural play. It is nature based and culture based. The design of agriculture has to be based on the development of ecosystems as well as historical traditions. It has to incorporate failure as well as bottom-up action, although it can modify these with to-down restraints. It has to be attentive to consequences of its actions, be perceptive of changes. It can assemble niches with ecological redundancy that can be exploited reasonably for human needs in a long-lasting, sustaining pattern.

Agricultural systems can be classified using two variables: Energy type and diversity of plants. Traditional systems—shifting cultivation, nomadic pastoralism—depend on human or animal labor. Modern systems—plantation, commercial—depend on combustible fuels for energy; these systems also tend towards monocultures. Traditional systems usually incorporate greater biotic diversity, and tend to be more polycultural. Traditional systems are very labor intensive, that is, participatory.

Agriculture started out as a food management system. The first grains may have been status foods, used only at certain times of year, like salmon or other annual foods. Then, agriculture became a labor Management system that required training and encouraging people to work harder and in a special niche.

Later, it became an energy management system. It tried to control the energy sources, the converters, and the outputs. More energy put into crops and more energy extracted. To model energy, we can consider one human being is rated at 0.1 horsepower (abbreviated 'hp'). A team of oxen is 1.2 hp. A 50-hp tractor is rated at 50 hp. In tilling a one hectare field, human power is twice as effective as the oxen and four times as effective as the tractor (in terms of the amount of work performed by horsepower. However, in terms of gross costs, such as shelter food and clothing, then human power is 3.45 times as expensive as a tractor and 2 times as expensive as oxen, who require food and veterinary care. Eventually energy surpluses flow from the country to cities.

In a time management system, time constraints are also a problem. Although one person could produce a crop in 700 days, it is more effective to use 70 people in 10 days. Human labor is low in absolute levels of work. Animals constituted energy slaves.

As more effort was put into the land, agriculture became a territory (and perhaps property) management system, finding and dedicating land to crops. One could also consider agriculture as materials management. A hydraulic civilization required tools, dams, pots and labor schedules. Of course, agriculture could be considered a beer management system, catering to the desire for intoxication. Fermentation had an additional nutrient bonus from yeast as a protein. Yeasts were also used for breads.

Agriculture is a novel information system. Because of population density, there is a drop in costs of transmitting information. The brain is more tightly packed. This is advance in information technology. Information is presented in terms of labor, a greater array of goods, and special projects. Information guides energy use. Chiefs give signals that channel energy into projects. The signals are trigger effects, small changes in energy that cause large changes in the cultural output of energy.

Agriculture, finally, is an ecological system, based on ecological limits, based on natural processes, and based on interactions with other systems, including human ones. In its early stages, agriculture is constrained to early stages of succession. That is, it uses nutrients and energy for quick growth and reproduction, rather than invest in efficiency or durability or maturity. Fossil fuels have allowed this artificial condition to continue.

With relatively unsophisticated technologies, agricultural management systems can be located in cities, making it not only more efficient but less wasteful of land and energy. Wild and domestic systems could be based in the framework of a city.

Of course, with knowledge of ecosystem processes, traditional agriculture could be modified to allow the collection of significant quantities of food from mixed systems, without landscape conversion and without interference from energy subsidies or biocides. Eventually, agriculture will have to become more mature. Wes Jackson and others are working on making this transition.

6.7.2.2.1. Promise of Regenerative Agriculture

Regenerative agriculture pays attention to the total input flows for agroecosystems: Solar, human, animal, tools, fuel, fertilizer, pesticides, drying, processing, and transporting. Under some circumstances, pesticides and fertilizers might be needed to stop pest populations or give advantage to crops.

Intensification has been a trend in agriculture, but different processes need to be intensified. Exploitation needs to be more intense. Perhaps specialization does this, from secondary products from domestic animals. Agriculture tries to intensify production, to increase yield from land use, as a result of intercropping or adjusting, and to increase yield from human labor. Water control may allow multiple harvests, to increase productivity. It might be possible to breed more rapidly maturing strains.

There are many kinds of specific measures that can reduce erosion, starting with contour plowing. Plowing can be eliminated altogether with seed-drilling. In 1943, Edward Faulkner, showed there was no scientific reason for plowing. Plowing gives a short-term increase in soil quality, by mining the subsoil. Fukuoka's ideas of multi-planting.

6.7.2.2.2. Natural Farming

Masanobu Fukuoka is another of the major pioneers of sustainable agriculture. Professing no knowledge, he presents a farming method that involves no tillage, no fertilizer, no pesticides, no weeding, no pruning, and less labor. He calls this practice the "no-plowing, no-fertilizing, no-weeding, no-pesticides, do-nothing method of natural farming." The idea that people can grow crops is egocentric to him. Ultimately, it is nature that grows crops. He sees modern agriculture as 'doing-this and doing-that' to grow crops, but it is meaningless work. With his 'do-nothing' method he is able to get yields in his rice fields that are equal to the highest yields attained with chemical, do-something agriculture. He accomplishes these high yields by careful timing of his seeding and by careful combinations of plants, in a polyculture. We successfully applied Fukuoka's method to a two-acre orchard with field and root crops at Altazor Forest in Idaho.

6.7.2.2.3. Regenerative Agriculture & Permaculture

Permaculture is a design system that aims to create sustainable habitats by following natural patterns. The word 'permaculture,' coined by Australians Bill Mollison and David Holmgren during the 1970s, is derived as a contraction of permanent agriculture, or permanent culture. The idea of permaculture is considered among the most significant innovations developed. However like nature, the permaculture concept evolves with time making its static definition difficult. Nevertheless, permaculture can be described as an ethical design system applicable to food production and land use, as well as to community building. Permaculture seeks the creation of productive and sustainable ways of living by integrating ecology, landscape, organic gardening, architecture, and agroforestry. The focus is not on these elements themselves, but rather on the relationships created among them by the way they are placed together in place, the whole becoming greater than the sum of its parts. Permaculture also addresses the careful and contemplative observation of nature and natural systems, and the recognition of universal patterns and principles, as applied to specific circumstances in unique places.

Permaculture uses zones to focus efforts. The zone nearest to the house (1) is the location for those elements in the system that require frequent attention, or that need to be visited the most often. The vegetable garden (2) may also have larger scale compost bins or bee hives. The area where crops are grown (3), for domestic and trading purposes, could include orchards. After establishment, care and maintenance requirements, such as mulching, are relatively minimal. Watering or weed control is performed every week. Animals in these zones, such as chickens, can be used as a method of weed control and also as a producer of eggs, meat and fertilizer.

The next zone (4) is considered semi-wild; it is used for timber production from coppice managed woodland and the placement of aquaculture ponds. The fifth zone (5) is actually wilderness. There is no human intervention other than observation of natural ecosystems and cycles. Mollison considers this zone the source of the most important lessons of the first permaculture principle of working with nature, not against it.

6.7.2.2.4. Natural Systems Agriculture

What is the difference between ecosystems and agroecosystems? People? Domestic plant and animals? Not just people or domestics but their kind of actions, that is, their relations with their system. In an ecosystem, people are just one more group exploiting the system. But, in the agroecosystems, people are manipulating the system, that is, they are modifying the system.

The goal of Natural Systems Agriculture is not only to fit agriculture within limits of the ecosystems, but to increase its presence in cities and artificial areas. The Land Institute has worked also for over twenty years on the problem of agriculture, to develop an agricultural system with the ecological stability of the prairie and a grain yield comparable to that from annual crops in a modern, fuel-subsidized field. The Institute collaborates with public institutions in order to direct more research on Natural Systems Agriculture.

Because this work deals with basic biological questions and principles, the implications are applicable worldwide. If Natural Systems Agriculture were fully adopted, it might be possible to witness the end to agronomic methods and technologies from fossil fuel-intensive infrastructures in developing nations.

Natural Systems Agriculture is a new paradigm for food production, where nature is mimicked rather than subdued and ignored. Located in a native U.S. prairie, the Institute looks to the prairie as a model for grain crops. They are investigating the feasibility of perennial polycultures or mixtures of perennial grains.

The functions of a natural system can be achieved by mimicking its structure. With additional research, the Institute is working to show that an agriculture that is resilient, and therefore productive over the long term, economical, such that the need for costly inputs would be significantly diminished, and ecologically responsible is well within reach. The impetus to search for a new agriculture is soil loss and soil pollution. Agricultural chemicals poison soils and waters, which harms insects, birds, and mammals, including human beings.

In the United States, after two 200 years of industrial agriculture, about quarter to a third of topsoil is gone. Natural Systems Agriculture would leave the ground unplowed for years and use few or no chemicals, solving many environmental problems at their root.

6.7.2.2.5. Tree farms

Cultivation of trees seems to have begun in Africa. Where grasslands seem limited in exploitation, further food could be derived from tree fruits and leaves, or from consumers of microscopic plants. A broad-leaved tree layer appears to be biologically desirable on most lands. Much of agriculture on small farms is multilayer; two other crops can be grown under fruit trees. Lawrence D. Hills claims that growing trees for food is a rational land use. Carob, mesquite and honey locust could be mass cultivated. Productive forests could be planted on otherwise marginal lands. He states that 4-20 tons of protein per acre is a possible yield, with pasture, crops or other trees planted between rows. The most efficient systems are extensive, where nature does the work. For instance, only 1000 hours per year are needed to manage food in a hunting-gathering society.

Forests can be managed as wild forests, from which nothing or little is taken. Or, forests can be managed as tree farms. A tree farm can be defined as a tract of privately-owned forest, large or small, managed by a certain forestry program. A tree farm can be a Christmas tree plantation (usually the most intensely managed form), a multiple-use forest, managed wild forest, nut/fruit farm, or other. A tree farm can be a forest, or part of a forest, or simply land on which someone has planted trees. The kinds of tree farms can be related to the models on which they are based and to the base environment. Base environment refers to clearcut, old field, or wild forest. Up until now, there have been two basic models for treating the forest: The agricultural model that removes a whole crop annually, and the stewardship model that tends the forest, but removes as much as possible under human control. A third, wild form is possible and desirable.

A tree farm has to have certain characteristics to be good. Since tree farms are called farms and not mines, let us assume that they are expected to be sustainable. Protection of the forest is a requirement. Without a forest, there is not a farm. If the forest is degraded, the farm cannot last long. The forest has to be allowed to be healthy; the habitat has to meet the needs of the community of species; and the genetic pool of the species has to be large enough for long continuity.

Tree farm management involves occasional planting, using careful techniques, such as root spreading, but also the follow-up care, such as mulching, hand weeding, and possibly protection from browsers and direct sun. One major problem with some tree farms is that indigenous flora and fauna are thinned or removed in favor of “useful” species that can provide maximum production. This “redesign” of the forest almost always requires external human controls and inputs in the form of biocides, fertilizers, soil scarification, and artificial selection. Simplification of the forest for short-term maximization of goods usually leads to dedifferentiation and destabilization. Although such tree farms may contribute to soil conservation, wild life diversity, and biogeochemical cycles more than a plantation, they do not contribute nearly as much as old-growth forests.

Industrial forestry depends on formal knowledge of the forest, but tree farms combine knowledge with intimacy. Tree farms can be sustainable and productive—although not necessarily all of them are or will be—relieving demand pressure on wild forests, national and provincial forests, and old growth areas, which may have a better chance of being preserved from interference. Tree farms could act as buffer forests for wild forests. The tree farm is one level of application of ecoforestry; in one sense it may be the most useful area to begin with, since it is necessary to convince only one person, the owner.

The small size of most tree farms ensures that the production exists for local needs according to local demands. The small size also ensures that mistakes will not destroy an entire ecosystem. Small size is conducive to flexibility and sustainability. The blend of activities in tree farms, from intensive multi-cropping to the utility of complex, symbiotic associations, make them similar to agroforestry or permaculture applications.

Although tree farms are often tracts of privately owned forests, the tree farm tag can also be applied to certain kinds of permaculture, as envisioned by Bill Mollison, to a traditional farm with stands of trees, as thought by Wendell Berry and others, to natural farming where pines, cedars, and fruit trees are planted with grain and root crops, as described by Masanobu Fukuoka, and to permanent tree crops, such as chestnut, honey locust, walnut, carob, grown on hills and mountains to complement flat-land agriculture, as presented by J. Russell Smith. The common theme in these kinds of tree farms is the careful maintenance of the productivity of the land; industrial tree farms, plantations, and orchards do not, in general, share this theme. Maintenance of productivity, or sustainability, has always been the goal of healthy cultures or agricultures.

Finally, tree farms cannot exist independently of their ecological, economic, and cultural contexts. Without changes in taxation and the industrial financial system, tree farms may succumb to pressures to cut heavily. Without changes to Canadian and U.S. styles and levels of consumption, the demands on tree farms to provide materials may be too heavy. Without changes in values, miracle cures, quick profits, speed, paper use, and superficial efficiency, tree farms may not be able to adjust to forest time and labor-intensive harvesting.

6.7.2.3. Industrial Agriculture

There are many possible ways of getting food: Hunting/gathering from the environment, traditional farming and animal rearing, industrialized farming, meat factories, culturing plants hydroponically, vat grown meats, artificial meats based on yeast, algae or bacteria, and food built directly by sophisticated matter compilers from chemical elements.

Genetic engineering is progressing quickly, as are biological studies. After all, human tissue can be grown in labs relatively easily. So, food could be produced in vats. The food, for instance tomato paste, could be made cancerous, so that it would keep replicating cells. The cells could be kept immortal by keeping the telomeres. At the desired size, it could be prepared, sliced into cubes and canned, or freeze-dried, or irradiated and packed. Growing meats in vats would be more difficult, since a significant part of the flavor results from the muscular movement of the animal as it finds food; other tastes could be introduced through duplication of food source chemicals. Perhaps electrical stimulation of meat cells would make it more flavorful.

Modified algae could be produced in tanks, then textured and flavored by various technological processes. There is a range of possible artificial foods. Any of these solutions, of course, creates new problems, not just in relationships with other forms of life and the environment, but in scale especially. Table 6723-1 compares the total acreages necessary to feed four billion people using different methods.

Single-celled protein could feed four billion humans using only one-seventh of the oil products waste, worldwide.

A hydroponics method offers 500 times the yield with only one tenth the water required; there is no runoff and better pest control is possible.

Although leaf protein is not palatable straight and must be machine processed, the machinery is available and the cost is still only one-seventeenth the cost of meat in India. It is more efficient than grasses. It offers new stores of plants for food (300,000). And it is the most suitable kind of harvest in the tropics, with their vulnerable soils.

Table 6723-1. Methods and Acreage

Method	*Area in Hectares*	*Percentage of current*
Current production	1,507	100%
Current production, waste eliminated	1,250	82.8%
Feeding all cereals to humans	740	49%
Using the Asian Method	650	43%
Growing all food in greenhouses	60	4.0%
Using industrial agriculture, assuming vegetarianism	170	11%
Growing food hydroponically	6	0.4%
Growing algae in vats	5.4	?
Using leaf protein	0.03	?

The single-cell protein yeasts or fungi are very efficient and fast; harvests can be measured in hours, not seasons or years. Although it is a fairly expensive process—it must be grown in tanks—it can be grown on petrochemical wastes. And, it produces no wastes and has virtually no pests. SCP is of poor nutritional quality.

A comparable weight of algae contains three times the protein of beef. It is also efficient. Algae is also expensive. It concentrates pollutants. And it is amino acid deficient.

Industrial production may be the logical step under the current system. As long as it is constructed as a form of industrial ecology, wastes and resources may be recycled in natural systems, which have reduced impacts and disruptions.

6.7.2.4. Vertical Urban Agriculture

In most of his arcologies, Paolo Soleri incorporated balcony gardens, while expressly having fields within walking distance of the structure. As traditional cities struggled with tax and abandonment problems, many people started using vacant lots for gardens; some used rooftops and balconies. Participating in these gardens not only provides edible produce but meaningful work. As distant, industrial-scale farms began to have problems with the effects of biocides and rising transportation costs, other people considered integrating agriculture in arcologies or as part of green skyscrapers; this approach promises to reduce fossil fuel dependency for transportation and chemical additives. Although some schemes would require high-tech elevators or water-delivery systems, there would be some need for more intense labor to harvest and distribute the food.

Urban agriculture in high-rise buildings could use the exposure of the buildings to grow crops in windows or exposed balconies. This would have the potential to reduce trash, waste and pests. This also has the potential of interlinking agricultural ecosystems with close wild systems, especially with mobile pollinators and birds. It would allow nearby arable land to be used for crops requiring a flat surface of soil.

A building-system of agriculture would allow more control of temperature and moisture. It would offer more control of safety and security, as well as faster response time to plant problems, such as molds. Water use would be reduced and recycled. Some of the farms could use soil, others a hydroponic or aeroponic system. Plowing with tractors would be eliminated. Footprint would be restricted to the building footprint, although special care would be needed to site buildings away from the shadows and wind and water flows of other buildings, perhaps with a variable height pattern. Solar or wind energy systems could provide much of the energy needed for electrical requirements. The human shift to cities means that more should be accomplished in cities to make them as self-supporting as possible.

Some arcologies, especially terrace-based, could use a variant vertical system. Food waste could be recycled with small animal production on lower floors. Grey water recycling would replace irrigation of large areas. Carbon emissions could be better controlled in a vertical system. In a future promising expensive changes due to climate and breakdowns, a vertical agriculture that avoids many costs and could switch to labor-intensive sources of energy could provide food to people isolated in a building in a city.

6.7.2.5. Refitting Agriculture

Agriculture exists within an economic order. Through ecological design, agriculture can be reformed into an integrative, natural-capital-using, adaptive process. To be less destructive of ecosystems, and to reduce its waste, agriculture has to begin to use appropriate energy and technology, at appropriate scales. Its costs constraints have to be based on physical constraints, such as size and energy, as well as on quality.

Food output per acre has been rather stable throughout history, but it is increasing rapidly now, with the use of industrial measures, like fertilizer, large capital outlay for new equipment, and new technology. It may be feasible to irrigate large parts of the desert, if certain problems, such as salinization, could be solved. The per-acre yield, however, may be reaching an asymptote. Humanity is fiercely competitive and exterminates any species that robs fields. There is no real balance of nature on farms—too much is artificial in the cultivation and irrigation, which requires constant attention and control.

It may be possible to manipulate the entire biocenotic environment to prevent pest problems. But, it cannot be manipulated meaningfully unless agriculture is decentralized. And, decentralized agriculture is no solution unless efficiency is greatly increased. In the U.S. alone, there is 21 million tons of leaf waste from carrot and bean tops, bean and potato plants; that protein could be extracted for food. Although it may not be very palatable, it costs less than one-fifth as much as soybeans in India. Breeding is unlikely to eliminate all waste. In a few leafy vegetables, such as spinach, everything above ground can be eaten. Some plants, like potatoes, in which leaf and root growth are simultaneous, out yield others, like sweet potatoes, where tuber growth is only starting when leaves are failing.

Balanced land use means management based on sustained yield over a long term, inclusive of forests and marshes, also. The future depends on ecologically scaled projects, not on giant industrial land or water projects, and on the separation of large-scale industrial management from optimum-sized applications.

Since humanity is still part of the ecology, its actions can be examined in that context. New human niches have depended on this savings of capital of the earth being withdrawn for a temporary gain. Humans should not take the Net Primary Productivity (NPP) of a system, but the Net Community Productivity (NCP) or a smaller yield—that fraction which it is feasible to remove and use without destroying the basis of productivity. For grain or forest products, this portion is about 30% of the NPP (as dry mass per unit area and time). Higher efficiencies might be possible under very favorable circumstances, but the best calculations will have some uncertainty and lower yields should apply to most species. For wild animals, the kill must be lower than the trophic-level efficiency—usually less than 10% or 1% with some birds and fish. There are things that can be done to make agriculture sustainable and successful:

1. Diversify crops, especially adding drought resistant varieties. Grow wild lupine to combine with soybeans for food. Convert from intensive cattle raising to antelope farming. Grow more varieties of apples (reduce imports of apples from outside the area). Increase self-reliance on most foods (except those that cannot be grown there).
2. Develop new products from existing crops, e.g., oils, drugs, and fuels. Rapeseed, for instance, is used in hydraulic fluids, plastic film, nylon, Lorenzo's Oil, as well as vegetable oil; certainly, there are unforeseen applications.
3. Use appropriate technology (solar power, field drilling, organic growing); import less energy, possibly export some. Stress low-input agriculture; low-fertilizer and low-pesticide may result in lower gross sales per area but in higher net revenue per area.
4. Process the crop (for example, sell noodles and noodle products as well as wheat).
5. Market the crops and products locally; package them, advertise them, and distribute them.
6. Form cooperatives, especially for specialized market or low volume products (beets, for instance).
7. Create a land trust to protect farm land from pressures of development, even as its market value as a nonfarm increases. A land trust could funded by property transfer tax. The land trust could lease the development rights on farmland.

For an ecological approach to agriculture, we must calculate all set-asides first—that includes wild and restored areas, and common areas used for foraging and herding cultures. What remains is the area we can use for cities (often located on fertile soils and near rivers) and agriculture. That area should be divided into appropriate use areas, for regenerative agriculture or for large monocrops of corn or wheat. Monocrop areas, whether for corn, coffee or bananas, must be reduced. Some of those species can be intercropped in natural systems. Others can be limited by the area permitted for them. The diversity of agricultural plants needs to be enlarged by planting different strains, especially older, more traditional ones. If agriculture in converted or subsidized (by water or energy) systems should prove to be less than needed to feed the current (likely over the optimal) human population, then agriculture needs to expand into city areas, especially into vacant lots and onto the rooftops and balconies of buildings. This kind of approach assumes that the distribution systems and the will to use them already exist or can be employed.

We depend on vegetation for more than food: it makes up the content of much of our newsprint, construction, furniture, clothing, and packaging. Of course, much of the straw and slash should be left so that the system can regenerate. Furthermore, with shortages of minerals, many substitutes are expected to be organic. The ecological design of agricultural systems has to be responsible to the living communities and ecosystems. It can do that with strategies for a flexible living order that address fitness and inclusion with caution and knowledge with its power. Working in natural systems can be inspiring. Exploiting systems in ways that increase health and biodiversity can be equally inspiring.

6.7.3. *Redesigning Cities*

Cities are the chosen domiciles of most human beings. Yet, we rarely think of planning them. We need to think about cities as a form of ecosystem that can be made more self-sustaining and complex.

6.7.3.1. Ecovillages

To some extent since the 1950s, intentional communities have allowed people to consciously address the creation of good places with concern for scale and fitness. Somewhat later, the ecovillage movement addressed these concerns of community, ecology, and spirituality by trying to create intentional, small-scale villages, within an urban or rural setting, within the matrix of other communities and places, which would be more sustainable. Many such villages are intentionally created as models of sustainability in action, for the purpose of working against the degradation of the overall cultural and ecological environments.

Ecological, social and design principles can be related to the properties of ecological systems and can be expanded into standards that facilitate opportunities to ecovillages. These standards would have to do with energy conservation, renewable energy, the use of local resources and materials, the importance of scale for walking, the incorporation of native species and habitats into the structure, the creation of new kinds of domestic ecosystems, the protection of wild areas, providing a safe stable environment, providing a variety of building and living choices within a good range of affordability, and offering a useful mix of economic opportunities.

6.7.3.2. What is a city?

This city is a complex structure characterized by buildings, roads, residents, density, division of labor, air-conditioning, domestication, partnerships, patterns of movement, numbers, concentrations, intensity, and miniaturization. Who could produce a city just described—over a hundred million years ago? Termites.

Termites have a division of labor. Several million photophobic insects have special jobs. Workers, with no wings to cool themselves, build the tower. Structure of building with microclimates and air-conditioning due to the tower effect or chimney effect—hot air rises and is replaced with cool air from the subterranean levels. Mounds are created particle by particle, over years, and get to 10-12 feet high, but may last centuries. They can reach 120 feet deep into the soil. The principle cost is the tower. No other costs associated with cooling. There can be interior farming of fungus, like leaf cutter ants. The fungus grows without weeds or diseases. Termite mounds in west Africa have cooling fins. Some mounds use mud, or wood, some use excrement. Termites also make roads on tree trunks and on the ground; some of these are covered, where different species come together they make traffic circles. Termites develop domestication and partnerships (with flagellates to digest cellulose, and fungus). Termites do not consciously design and plan their city mounds. The structure is assembled by many millions of workers following simple individual rules.

Human cities have many similarities to termites and to other natural structures. The development of cities from campments and villages is like that of tidal lagoons, where groups of algae ended with communities. Unorganized, homogenous ensemble transforms to an organized structure that cycles energy, materials, and information, and provides benefits to its residents. Human beings have characteristics, however, that make their cities more complex, diverse and mobile. We can design cities consciously.

6.7.3.3. Why have a city?
Why should termites or human beings live in a city? To band together to survive droughts? Early cities may have been an adaptation to drought, with their food and water storage systems. To trade in one place? Cities made trade easier, by having protected places and by accommodating large numbers of temporary visitors. To worship together? Some religions in early cities were open to new worshipers. To promote specialization? Specialists rose from the requirements of cities and attracted more specialists. To increase excitement and inspiration? To defend wealth? Because it's genetic? Humans might be psychologically preadapted to city life, although the body might not be, with its adreniline rushes. Because it's inevitable? Why continue to have cities, now that technology can provide the excitement and intensification in rural communities, or now that urban problems seem insurmountable?

6.7.3.4. Problems with Cities
With cities come unanticipated or unwanted effects, sometimes erroneously called 'side-effects,' although they are equivalent to the intended main-effects. The new city ecosystem, that replaced a native ecosystem, is greatly simplified; there are fewer plant and animal species, and lower diversity leading to homogenization, especially when cosmopolitan or favorite species are present. Plant productivity declines, due to fewer plants and lower rates of photosynthesis. Connectivity to the surrounding matrix is lowered—the matrix itself is minimized by increased patches and corridors, such as roads, which perforate the landscape and also act as barriers to plant and animal movement. The number of patches increases, which decreases interior species and increases edge species, such as squirrels, raccoons and coyotes. Native patches and corridors, such as woodlots or streams, are reduced or eliminated. The agriculture around cities is more homogenous, with decreased fallow areas. Stream corridors are degraded or destroyed, making a city more vulnerable to floods. Sewer systems route more water faster to an ultimate sink, lakes or the ocean. Household wastes affect the landscape directly, if they are buried or burned. Nutrient and mineral cycles can be disrupted. Local weather can be disturbed. And, the environmental can become degraded.

Cities change their own microclimate, with heat islands and dust domes. The masses of materials used to build the city are used inefficiently. The energy to run the city is greatly concentrated—thousands of times more than in a native ecosystem—and the energy is used inefficiently. Unless the infrastructure, from buildings and power lines to sewers and roads, is kept up, it can decay and cause greater inefficiencies and problems. A budget crisis, from loss of tax revenue or improper use of funds, can affect the infrastructure and most amenities of a city. The disruption of supplies, due to social and political actions, such strikes or attacks, can lead to other problems, from displacement to disease. Even in small, well-managed cities, there is an increase in violence, sickness, drug use, crime, and impoverishment, all of which require some response from the political structure of a city. Ian McHarg noted that with crowding, there was an increase in mental and physicals illness from stress.

The human system in the city, with imported food and water, has a smaller system of carnivore predators, such as fleas, lice and bedbugs, and decomposers, such as bacteria, fungi and gulls. The surrounding native system of primary productivity is based on depauperate system with few trees and layers and a simple food chain of rats, birds and squirrels.

6.7.3.5. Redesigning & Designing the City
Much design has to do with solving one problem or a set of problems. Very rarely is a city redesigned to solve problems. And, very few cities are designed to avoid recognized problems.

One challenge for a city is to balance its inputs and outputs to minimize the effects on the residents and the environment. For example, G.T. Miller notes that for a city of a million people, there are daily inputs: Sunlight (higher or lower depending on size and shape), atmospheric deposits (3000 tons), water (625,000 tons), food (2000 tons), fuel (9000 tons), manufactured goods (7500 tons), and buildings (high or low depending on area and height and very importantly the success of the city attracting new people or businesses). The outputs do not always balance inputs: Heat leaving is often greater because of the use of fossil fuels; water may be less due to evaporation or use in processes; sewage may be high (500,000 tons) and include water; solid waste/refuse may be high (9,500 tons); and, pollutants may be significant (air only, 950 tons).

Because cities are so concentrated, and occupy a relatively circumscribed area, they require distant support systems for food, materials, and energy, as well as a smaller system for pets (monkeys, cats, canaries, or fish) and support machines, such as automobiles. This requires constantly increasing inputs and outputs.

6.7.3.5.1. Refitting Old Cities

Many cities were expansions of old trading villages or fortified garrisons. The Romans, for instance built many small military towns in France, Germany and Britain. When Spain colonized much of the Americas, the Spanish built new towns based on the Sante Fe model (in the general shape of a cross) from 1492. In old cities, corporations and individuals have built new buildings that use new strategies, such as source reduction, waste treatment, recycling of materials and water, and a shift from inorganic to organic. A building may be designed as an artificial ecosystem that can be incorporated into the surrounding ecosystems.

Many scientists and economists regard cities as wastelands, but surprising amounts of food can be grown in cities on rooftops, terraces, and empty lots (idle land in cities is commonly over twenty percent of the area). Biologists are just beginning to study wild animals and plants in cities.

6.7.3.5.2. Building New Cities

Building a new capital city is often the first thing a new nation does. The Aztec capital of Tenochtitlan was built on a island in Lake Texcoco, possibly due to concerns with territory and defense. Beijing is an example of a new city built for the purpose of starting over. In Renaissance Italy, new towns were planned and built on utopian or geometric designs. Saint Petersburg, Washington, Canberra, Tehran, and Islamabad were built as planned cities. Many of these planned cities, Adelaide for instance, were planned with a foursquare grid layout that was imposed on the site. Several cities in the Netherlands were built when an inland sea, the Zuiderzee, was reclaimed to increase territory (and reduce flooding). Many of them were placed in fertile valleys or wetlands. Brasilia was placed in the 'empty' center of Brazil. Dimitrovgrad Bulgaria was planned as an industrial center. In Canada, many new cities, such as Medicine Hat, were built where the railway company decided to put tracks. New towns were started around Hong Kong to house the booming population; many of these were planned with public housing and rail transport considered. Ireland planned several new towns in the 1960s to accommodate a growing population and new industrialization. In the same period, Japan started a series of new towns, such as Senri New Town and Tama New Town, based on the English Garden City tradition.

Many visionary architects have designed ideal cities. Le Corbusier (born C.E. Jeannerct) built cubical models of Paris. Frank Lloyd Wright designed a suburban paradise in Broadacre City. Garden cities have been proposed by Ebenezer Howard and Patrick Geddes around 1900. Some were built, often as rings around an older established city, such as

Washington or London. Most of these new cities are based on the prevailing assumptions of old cities, such as having as much energy as possible and using as much land as is wanted, for buildings, roads and parks. Many of the new towns, particularly in England and the United States, were created with automobile-oriented layouts. Roads, for instance, were designed and built with no knowledge of road ecology or the native ecology. Many of these cities were planned for an optimum population within their area, but today are proudly said to be 'still growing!' Growth is a problem for most cities, especially those that seem idyllic with many amenities and opportunities for work or pleasure. Unfortunately, by not limiting growth, those cities attract so many new residents that the infrastructure starts to fail.

6.7.3.5.2.1. *A Standard New City*. Peachtree City, Georgia, in the United States, was chartered in 1959. It was designed to have four separate villages, each with facilities for education, recreation and shopping. It was located at the intersection of two state routes. As part of the layout, a system of golf cart paths was integrated with roads to connect homes and schools (giving the city more golf carts than any other in the world).

The city area is about 60 square kilometers (24 sq. mi), with over 30,000 residents (and a density of over 1300 inhabitants per square mile). Many of the public or corporate buildings are low or one-story, as are many houses; the feel is horizontal. It could be a suburban paradise like Broadacre City.

In order to attract business, the city established an industrial park. And, companies like Panasonic automotive systems and Cooper Lighting have based their headquarters or large plants there.

One of the constant problems with new cities is the volume of traffic, Although golf carts were suggested to avoid some of the problems with traffic, this city has some cases of golf-cart gridlock.

Like many cities, water use has to be scheduled or rationed, and waste channeled and moved; garbage has to be collected and transported somewhere else. Areas are zoned for activities. Transportation has to be planned and replanned due to growth and changes in patterns. Police have to monitor order; crimes have to be solved. Murders, rapes, and robberies do not seem unusually high or low for a city of its size.

6.7.3.5.2.2. *An Ecological City.* The ecological city proposed by Paolo Soleri, Arcosanti, is a prototype arcology. Arcosanti is being built around a central concept: Arcology, the fusion of architecture with ecology. Arcology is one way to deal with the problems of urban life—pollution, waste, energy use, scarcity, crowding—using known physical and biological effects. Soleri is using: The greenhouse effect, which is the collection of heat behind glass; the horticultural effect, the control of select plants for shading, eating, and amenities; the apse effect, the use of shape to influence micro-climate to provide cool air in the desert in the summer without using energy; and, most important, the urban effect, the concentration of human potential through complexity and miniaturization, something that has drawn humans to cities for thousands of years.

Ecological cities, arcologies, are different from traditional cities, which depend on chance for amenities and build on suffering and waste for their wealth. Traditional cities have sprawled around trading or religious centers, occupying river valleys and fertile soils. Arcologies would disturb fewer ecosystems to support human populations. Being built vertically and not horizontally, and being built on less productive lands, such as deserts, scrublands, mountainsides, they would occupy less land than a similar population in an accidental city—less than one-tenth as much land. This would save established farmlands as well as native marshlands, watersheds, and grasslands. Paradoxically, because of their density and intensity, such cities leave more and better land for farming and wilderness; recycling is made easier; and transportation is shifted from motor to foot. Heavy industry and automated production is restricted to the central bowels of the city. They can be built to contain their own agriculture and waste recycling (see Figure 6837-1 for a US plan of arcologies).

The construction of Arcosanti began in 1970. It is planned to be twenty-five stories high on thirteen acres, holding five thousand people. So far, but thousands people, students and professionals of diverse ages, races, and backgrounds have participated in the building the base, which includes, residences, foundries, meeting halls, green houses, studios, schools, shops, a fine arts amphitheater, visitor center, and dining areas.

Architecture is more than just a frame for keeping the weather from furniture and appliances. Soleri employs it to sensitize people to their humanness and their part in the food chain, indeed, the whole ecological network. Arcosanti is the apex of architecture and environmental design, but it is also a center for innovative thinking—through meetings, conferences, and celebrations that address political, scientific, technological, theological, and artistic issues. Arcosanti attempts to mirror the complex workings of individuals and societies in an ecological framework. It is not a single-vision solution to all things. In Soleri's words, it is an "urban laboratory" where people can learn how cities work. Soleri is the first to consider the supporting matrix, the ecology, of cities, and the first to address more psychological needs. His plans are not perfect, nor are they designed to replace all cities. But they are a first step to bring humanity into harmony with the limits of nature.

6.7.3.5.3. Thoughts on Where & How

A city could promote appropriate technology to manage resources for its region. Dangerous technologies could be reduced through wholesale substitution, if not of materials, than by labor-intensive solutions. In many old and some new cities, traditional housing should be preferred, since its form and design are integrated into the culture, it is adapted to the local climate and is usually less expensive, due to use of local materials. Much of traditional architecture is authentic and unselfconscious; its forms fit the context of place and develop in response to place.

With arcologies, and their urban ecologies, the city could change its relationship with nature; an arcology is a good solution for an urban culture, as it solves the problems of waste, resource-use, scale, obsolescence, and segregation. The placement of a new city is important, and should be based on ecological and geological criteria. It should be sited away from flood plains and other geological threat areas. It should located be away from fertile fields, as well as from wetlands or wilderness areas. Surprisingly, the use of a single ecosystem for living, working, growing food, moving around, and creating things, disposes of many of the problems from the artificial separation of human and nonhuman systems. The city becomes an integrated ecosystem that may be more self-reliant and stimulating.

The properties of good places could be used to help guide designs for cities. Action, for instance has to be appropriate for the scale of the city as well as the environment. Because of the complexity of interrelationships, the program of actions has to be coordinated. Ecological designs become actions to create good places, such as urban places, within a good environment modified by good cultural practices. Good places have individuality, which makes them unique. Design needs to reflect that uniqueness in all its productions, to insure diversity at the urban level. Diversity can lead to richness, which is also an important quality of good places. Good urban places offer the circumstances necessary for conviviality, that is, for all residents and beings to live together. The consistency of a place permits residents and beings to anticipate changes and disturbances. When this happens, health becomes more of an attribute of living in that place. Design needs to address health above all else at the level of good places and good cities. Healthy systems can be enhanced by ecological design.

6.7.3.6. Ecocities Discussion

Doubtless, many of these ideas and principles can be applied at larger scales. Paolo Soleri started to create designs for ecological cities intentionally on a larger scale. Ecological cities would be designed to minimize environmental impacts. Partly, this would happen through density and intensification. Such a city would also try to be self-sufficient in the production of energy and food, using many areas and rooftops for agricultural production as well as for turbines and collectors. Green plant canopies on rooftops could reduce the heat island effect of large urbanizations. Air conditioning, for instance, could be accomplished through design with the chimney effect, which Soleri has integrated into most of his designs. The arcology could collect the water from evaporation and rain. It would minimize pollution. It would recycle wastes with interconnecting links in an industrial ecology. Transport would be improved through proximity and internal design. In addition the unfinished Arcosanti, there are other examples of ecocities in the making, including Curitiba Brazil, Alvstaden Sweden, and Kalundborg Denmark.

6.7.3.6.1. Goals & Enantiodromia

The goal is not only to create good places, and be connected with other good places, but to express meaningful ways to live. Unfortunately, goals are shifting patterns that are different for different images in different times, and also become responses to the fitness of past goals (see Tables 67361-1 and 67361-2).

Table 67361-1. Goals of modern individuals (or the small picture)

In	*Neighborhoods*	*Housing*	*Transportation*	*Jobs*	*Leisure*
Goal	Separation	Size	Personal	Money	Fun/rest
What's Missing?	Community	Comfort	Usefulness	Meaning/ pleasure	Fun/rest
What's the Result?	Isolation	Waste	Spread	Dissatisfaction	Fatigue
What's the Response?	Violence	Unhappiness	Pavement	Sabotage	Ennui
What's replacing that?	Ecovillages	Small homes	Light rail	Self-employment	Hobbies
And, what's Replacing it?	Villages in arcologies	Self-built	Walking	Satisfaction	Watching

For instance, in neighborhoods, the goal of separation resulted from older traditional urban neighborhoods with some crowding. The separation as it was achieved, however, lost the feel of community, as people had their own quarter-acres and personal cars to reach the local malls and supermarket complexes. They felt more isolated and more vulnerable to fear and violence (especially the middle classes). Many of these people decided to intentionally bring back the sense of community as well as reduce waste and vulnerability to violence by creating intentional communities, such as ecovillages. But, even these did not always have the density that inspired creativity and invention. An arcology could provide a better context in most cases.

Table 67361-2. Goals of modern institutions (or the big picture)

In	*Science*	*Technology*	*Management*	*Corporations*	*Religion*
Goal	Data	Technique	Efficiency	Money	Truth attendance
What's Missing?	Knowledge	Appropriateness	Humaneness	Real cost	Meaning
What's the Result?	Irrelevance	Mass produced	Bureaucracy	Conversion	Rock & roll in services
What's the Response?	Personal search	Simplicity	Law suits	Activism	Personal religion
What replaces that?	Astrology	Wood shop	Computers	LLC	Scientology
And, what replaces it?	Ecology	Personal	Work effort	Nonprofits	Loose associations

Goals are obviously imperfect. There is always some element missing that results in a suboptimal condition. And, the resulting dissonance prompts a response, which may result in an improvement or a less satisfactory element. Perhaps with continued experiments on ways of living, combined with an ecological perspective and forms of ecological design, communities can optimize human happiness or at least satisfy it minimally. What do we design for? Maximum numbers? Maximum luxuries? Maximum happiness? Based on our knowledge of systems and maxima, it is dangerous to design for maxima of any kind, or even for optima—perhaps it is best to aim for a satisficing level. New local village and city patterns have suggested that we can design for safety, design for peace, and design for health.

6.7.3.6.2. Designing Local Communities

In designing local communities, with properties, principles and standards, three approaches (and possibly more) can be used. Design can immediately address safety, peace and health.

6.7.3.6.2.1. *Designing for Safety*. Public health officials started requiring design changes in buildings to prevent injury and disease. Buildings had better lighting and guardrails. They had closed trash rooms and regular pickups of trash. Later, automobile accidents prompted officials to require higher-impact bumpers and seatbelts; these technological changes reduced injuries and deaths. Through an ecological design model, Ian McHarg started tracking broad social factors, such as poverty and exposure to violence, related to the urban environment and its history and inequalities.

At about the same time, sociologists noticed that some environmental characteristics were associated with crime and suggested that the physical design of urban spaces could influence behavior. C. R. Jeffrey suggested that the proper design of the built environment could reduce crime and the fear of crime, by minimizing opportunity and promoting positive behavior. His idea of 'Crime Prevention Through Environmental Design' (CPTED) was guided by five principles: Natural Surveillance, Access Management, Territoriality, Physical Maintenance, and Order Maintenance. Surveillance maximizes visibility through the use of design features, such as windows; access management directs people through signs and markings, but can also use landscape features to guide people to entrances and exits as well as limit access to some areas; Territoriality is confirmed by delineating spaces—although there is an emotional element that can allow people to feel warmth, belong or pride, instead of disgust or anger; Physical maintenance requires regular repair and upkeep of facilities; Order maintenance requires attention to disruptive or damaging behaviors, as well as rules stating what those behaviors are.

Much later, sociologists noticed that the isolation and design of prisons and jails may have contributed to a worsening of crime. Architecture has begun to promote better conditions and better placement for some jails and prisons. Jails especially are being integrated into the community, to reflect their function as short time, locally controlled holding facilities. For instance, the Brooklyn House of Detention is expected to reopen in 2012, with an improved façade and street-level stores, at its current location close to the courthouse and police station. Ken Ricci notes that jails are a legitimate buildings in an urban environment, part of the whole civic landscape. Ricci, of Ricci Greene Associates, has designed inmate quarters with larger views of a recreation yard under an open sky. Jail housing is changing from a linear cell model to units facing a central day room. Jails are like ecological buffer zones that allow transition between systems with protection for both systems. Some prisons are being designed to fit into their local environment in the countryside. Of course, design cannot be isolated from inequity or violence, much less laws and the justice system itself, which might also benefit from social design. For example, the War on Drugs and Three-strikes legislation exhibit the flaws in the system. We need to find alternatives to lockups. Jails and prisons need to be an appropriate sizes for communities.

Now, we are noticing that with rapid changes in societies and immigration, more holistic approaches are needed for design. The entire environment needs to be addressed in design. A participatory ecological forestry could not only restore the biological wealth of a community, it could involve more people and perhaps reduce some forms of violence (and this has been the explicit goal of ecoforestry movement in several nations). Neighborhoods could become more aware of their environment; their efforts may increase native tree cover and reduce the damage from invasive species. The Urban Community Greening (UCG) effort in Cape Town South Africa reports that it has been successful in using community agriculture, horticulture and forestry to reduce violence in informal settlements of Black Africans and refugees near the metropolitan area. Community greening efforts may reduce the risk of violence, even from new patterns of violence. After Apartheid, according to Harris (2003), new forms of prejudice and conflict emerged, including xenophobic hostility to foreigners, vigilante acts, and economic struggles around land and service issues. These new patterns merge with the old ones to complicate political change. Many other places are facing a 'culture' of violence' that may result in 'feral' cities or failed nations. The collapse of civil order threatens all residents and many larger levels of security, including global security.

The social production of criminals through prison culture could be transformed with different opportunities and involving designs. Glass walls on a street showing prison work in glass or art? David Orr has written that with only minor modifications, university buildings could be converted for use as factories or prisons or vice versa.

Urban planning considers buildings, groups of buildings, parks, streets, walkways, transit areas, business areas such as automatic tellers, industrial structures—in fact any structure that is not operating on 24-hour cycles—and all shared places. All community buildings, such as schools, might be used for other purposes at other times of the day. Especially auditoriums and gyms. They could be round the clock community centers, as some are in Sao Paolo Brazil. Urban planning addresses the safety and security of all those places. Given the large number of old structures, these can be retrofitted and redesigned to new standards along with new structures made to those standards.

6.7.3.6.2.2. *Designing for Peace*. Given that there will always be violence, it can be reduced, diminished, and localized. It can be more integrated into a community, or rather allowed at certain levels. Some kinds of violence might be reduced through participation and understanding. Community greening might work to redesign the community environment through participation and cooperation. Reducing violence results in more peaceful activities. These peaceful activities can restore environmental damage, as well as instill greater trust and create cooperative links. It can promote changes in perception and beliefs; for instance, ecological understanding increases the time-horizon of our influences and our decision-making, and it allows us to broaden our identities and cultural norms.

In general, ecological understanding and peaceful activities can reduce the risk from violence, as well as from larger ecological catastrophes. Groups and societies can develop resistance to violence and resilience after catastrophes. Both resistance and resilience, remember, are aspects of the ecological stability of ecosystems. Developing a community, like developing a muscle, gives it more strength, which allows it to address inequities and conflicts—and catastrophes—without falling apart.

Starting in Mesopotamia, and the storage of food and luxury items, cities built walls to protect their people and resources. Farmers and the poor were protected within the walls or just outside. This design feature continued for thousands of years until technology finally rendered walls impractical. Without walls, cities had to resort to different methods to deal with attacks and crime. Improved armies and weapons reduced attacks. Public welfare institutions were developed to reduce crime and poverty. Later the 'City Beautiful" movement rationalized that in a more pleasant environment, people would be less likely to commit criminal acts. Beauty seemed to be ineffective. Urban planning still often uses walls and beauty to address crime. It was recently thought that he medium of television, by showing so much violence, increased violence in the community. Then, it was thought that by showing absurd levels of luxury, television instigated violence from people who had no such luxury but desired it. Disenfranchised individuals, or individuals from disenfranchised groups, may be more likely to use violence to attains success, at least success defined by money and luxuries. Much violence results from the perceived need to use violence as a path for economic improvement; more violence results from the easy access to modern weapons.

Perhaps architecture itself can be related to violence. Hard, large, cold, threatening—biologically and mentally—buildings reflect our cosmology of the machine and that depresses our spirit. But, as the British and Japanese, to some extent, have learned, it is important to rebuild in the same form, with the original materials, wood or stone, to make sure that our buildings shape us in ways we want.

Tom Vanderbilt rewords Clausewitz to consider war as an extension of architecture by other means. Perhaps, but before that, architecture was an extension of war by other means. Vanderbilt points out that architecture is defensive structure and target. That aerial warfare and urban planning even share language and tactics. Architecture can also be used as a weapon, Eyal Weizman suggests, as when Israeli settlements in the West Bank tower over Palestinian villages or a superhighway soars over Palestinian farmland.

Decay is a problem related to violence. Some cities, such as Detroit, are shrinking cities. Other cities, such as Beijing or Beirut, are fragmenting or hollowing out. A few cities, such as New Orleans are breaking down. Others, such as Leipzig Germany or Ivanovo Russia are disintegrating. Unless cities can maintain their infrastructures and be perceived as desirable locations, residents leave or fight.

Our landscapes have become as artificial as our cities as they are converted to farmland or grazing lands. Can ecological design, community greening and urban planning make communities, cities and nations more peaceful? Maybe design can reduce the desires (or motives) and the opportunities for crime (it may never reduce abilities, as they evolve)?

6.7.3.6.2.3. *Designing for Health*. The purpose of housing is to provide shelter from the elements, which is basically the atmosphere. The purpose of business or industrial buildings is the same, although it may be extended to separating business actions or dangerous processes. But, buildings also have to provide safety from disease; they should be hygienic, providing clean water and air, channeling dirty water and polluted air. They need to provide areas for food consumption and waste. They need to encourage social and mental well-being—that is, they cannot be too ugly or noisy.

The design of many buildings contributes to isolation. The sprawl of cities, lack of public transportation on the streets, deserted streets, and tall buildings all imply or demonstrate lack of access. The urban environment includes the effluents from buildings, the waste water, pollution from products or generation of electricity, dangerous chemicals, noise, vehicle activity—roads are a problem to safety.

One design solution is density, as envisioned by Soleri and others, that is, moving things closer together. The entire city needs to be considered as a design project, vertical and horizontal, below ground and above, self-sufficient or highly connected with trade.

Feedback is also an important component of behavior. Buildings that have daily readouts or visible monitors might influence people to turn down the heat or turn off lights, to save energy or reduce waste. The system of participation has feedback loops.

Human feedback is critical, also. Design needs to be used centered. It needs to achieve ease of use as well as 'ensoulment,' in the words of Naoto Fukasawa. It needs to be non-neutral as well as persuasive with its values. It needs to be participatory for the residents and designers, with everyone performing some active role. The goals of design have to include the social transformation of consciousness and positive behaviors as well as more efficient and beautiful shapes. Community engagement with designers and designs can be encouraged through cognitive dissonance. And that can be created with notices, posters, events, and prizes. Participation encourages enthusiasm for the project. Performance design creates more empathy for other participants, where the affects of actions are anticipated and the emotions of others are experienced. Community and online networks allow observation of various kinds of consequences under different conditions. This is what thought experiments are!

Specific buildings need to mimic local landforms or vegetation. They need to perform natural functions, such as damping the wind, holding water, and preventing erosion. The native vegetation surrounding needs to be restored so it can function as wind barriers or shades. Rainwater collection systems, permeable paving, and appropriate structures have to be considered. Design needs to address ways to move people outdoors more often. It can do this with in-outdoor transition zones and areas for outdoor activities.

All of this basically has to do with health. Health is the harmony of conflicting elements, such as disease, joy, selfishness, and altruism. Ecosystem health envelops the health of species and individuals, human and other. It is not enough simply to reduce disease and violence. Health has to do with the environment. It has to do with aesthetics, and that includes all the senses—humans need music as much as beautiful forms; they need stimulating smells and tastes, as well as clean water and clean air. Sounds and smells, for instance, can complement and enhance any building or area, whether the sounds are symphonies or leaves rustling.

True sustainability requires integration with regional and global cycles. It may require tradeoffs of wilderness and waste sites.

6.7.3.7. Conclusion: Intention & Integration
Intentional communities, such as ecovillages and ecocities, find a basis for sustainability in appropriate properties and standards, as related to ecological, social and design principles. The basic concern has to be with ecosystem health, with the operation of global cycles. This will not happen without an expansion of consciousness that is required for ecological understanding at larger spatial and temporal scales.

Even arcologies need to be designed for exposure and lack of isolation, that is, they need to consider how the interior barriers, walls and open areas are situated. Both ecovillages and ecocities need to be aware of their influences on the larger scales of patterns of exploitation and interference. Unless the local patterns are integrated with regional and global ones, local improvements may not withstand stresses and collapses elsewhere.

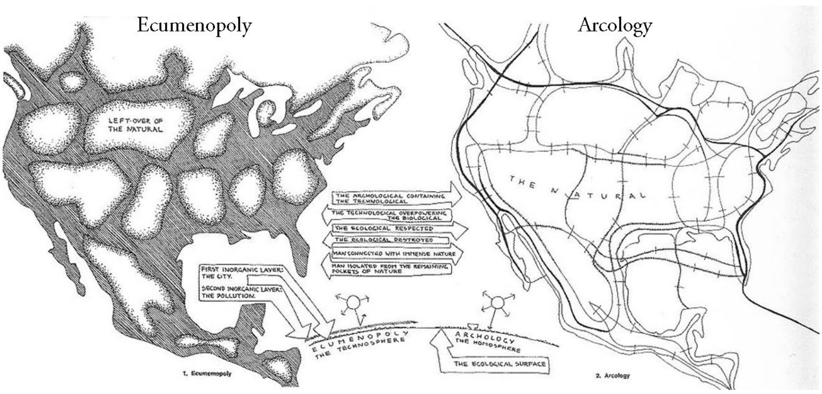

Figure 673-1. An arcology leaves much more land wild (Drawing: Paolo Soleri)

6.7.4. *Redesigning Transportation*
Maybe the best way to learn from the past is to take it up. So many examples of technology are perfect examples of beauty and efficiency. They have been left behind only as a result of fashion and a temporary glut of cheap energy. Many of them could and should be brought back and improved. Many cultures do not abandon their technology if it works and has cultural value. So, some stone axes are still made, although steel ones could be traded for. Of course, tool making has advanced and intensified in the past 50 years (and the past 400 and 3000), but it has not been treated rationally with planning and assessment.

Relearning is the process of investigating past designs without rejecting them. Strong past designs created a meaningful human order. The modern order of design has to recognize, respect, fit, and work with environmental conditions. Of course, some people use design to try to force the environment to fit human desires or to try to escape from its limits, but designers need to be cautious about displaying too much power.

6.7.4.1. Bicycles
Of course bicycles top the list. One of the most neglected fields of design is the third world. More oil lamps are needed. More inexpensive vehicles for roadless terrain. Papanek's student group invented 'fibergrass' for vehicle panels, such as bicycles for carrying heavy loads, usually with 3 wheels and a back axle. Bicycles are efficient at distances from one to 99 miles. Tianjin, China has an "eco-city" district (one of 40 in the nation) that is planned to have 90 percent of all trips be by public transit, bicycle or walking. Bicycles can use the infrastructure for roads, although specific bicycle paths can be made at lower costs. Roads in and between neighborhoods can be modified for bicycles. This would allow slower more personal traffic.

Bicycles are relatively low technology. Most riders can fix their own bikes. The advantages are: zero-emissions, less paved land, and healthier exercise for participants. Bicycles will almost always work in more condensed living patterns. Some cities have already successfully experimented with free bicycles. We should not forget other possibilities, such as roller skates and scooters (the author skated daily between Moscow and Pullman for a summer).

6.7.4.2. Trains & Light rail

Light rail works well at distances from 1 to 100 miles, especially within cities and suburbs. Trains can service areas up to 1500 miles, although cross-continental works well. Solar powered trains. Trains are examples of complex powered machines run by human operators capable of moving heavy objects or large numbers of people and their things. Most trains have been powered by burning coal, gas or other fuel. But, it is an efficient form of public transportation for moving people and goods.

Maglev has safety advantages over trains and planes. Maglev is much faster and can compete with planes on many routes. A magnetic field is created by electric coils in guidewalls and a track to propel the train. Some maglevs have rubber tires as backup for power failures. Japanese maglevs use a cryogenic system to cool the coils; that can be expensive. Of course much of the electrical energy for the maglevs will be provided by burning coal or oil (and later perhaps by water power or solar units).

6.7.4.3. Dirigibles & Floating

Dirigibles like the Graf Zeppelin, with a large passenger gondola, with dining rooms, staterooms and corridors, could be used for long-distance passenger transportation. For many, the advantages of low-impact and stately motion would outweigh the disadvantages of relatively small size and slow speeds.

Some dirigibles have been built and equipped for aerial logging in Northwestern North America. They have proven to be more efficient, cheaper, safer, and quieter than helicopter logging. Smaller dirigibles are used for day trips and advertising.

6.7.4.4. Clipper ships

Traditional clipper ships were narrow for their length and powered by three or more masts with square rigs. Although freight was limited (initially, they were used to meet the demand for rapid delivery of tea from China and other low-volume, high-profit goods), they were very fast and efficient. Most were made of wood, although later ones were iron. Sailing ships, like the clipper ships, with computer managed rigging, for cargo and passengers (3-4 masts). Modern clippers are built with sail-shape optimization (Doyle, T., M. Gerritsen and G. Iaccarino. "Towards sail-shape optimization of a modern clipper ship," Center for Turbulence Research Annual Research Briefs 2002. Pps. 215-224).

Modern sailing ships can benefit from technology that did not exist one and a half centuries ago. A fleet of clippers is used in several nations as vacation ships. Since the mid-nineties, the Danish shipbuilder Knud E. Hansen is working on a 200-meter long cargo ship in which the diesel engine is assisted by a set of 6 high-tech sails. They are made from fiberglass and take the shape of a wing, which makes them twice as efficient as the canvas sails on a traditional vessel.

6.7.4.5. Hybrid buses Taxis & Carriers

(Being edited)

6.7.5. *Redesigning Technology: Wild Lives & Living Technology*

Since we cannot foresee many problems, we do not know what kinds of questions to ask to devise solutions. Therefore, we must always wait until some system fails before trying to correct it. Therefore, we will always be reacting to natural and artificial situations. Therefore, there will always be unavoidable costs in lives and resources before some new working situation is found. There are many examples of this series: We did not clean air until the pollution reduced visibility to a few meters; we did not clean up lakes until the fish were dead, we could not swim in them, or they caught fire—we could not force ourselves to pay for the ounce of prevention, no matter how unhappy we were with the tons of cure. Although the word 'solution' is used for several headings, it is not used in the sense of a one-time, permanent fix. It is meant in the sense of simply an answer, or positive, adaptive, temporary response to challenges or problems.

6.7.5.1. Engineering Proposals for Solutions

Many critics are armed with lists of problems. What about solutions? This work accepts many of the criticisms and tries to suggest kinds of solutions, or at least good responses to many challenges. It is a guide, for suggestions to people who try to resist the local mechanical solutions by default.

Many people offer technological fixes and substitutions. They suggest that technological substitution will be effective in dealing with the increasing impacts on the system. They argue that technological options are crucial, starting with noncarbon-based energy systems and large-scale geo-engineering approaches. In the past, nations responded to environmental change, such as drought or resource depletion, by changing lifestyles (usually reverting to simpler ones) or relocating. These responses are no longer possible in a 'filled planet.'

6.7.5.1.1. The Paths of Machines

How should we design machines or machine interfaces? Will technology, and our knowledge and wisdom, allow us to design artificial beings that will fit into the current evolutionary processes? We need to design better machine infrastructures, to reduce the area they require that replaces natural support systems. We need to control accidental and designed releases from the machines, so those substances will not interfere with natural processes or cycles. We need to design to reduce the mass of machinery, as well as the mass of its energy and material requirements.

Machines have evolved culturally so that they have greater capabilities and are more efficient, but we need to redesign the entire machinomass so that it fits together and within the ecological network. Nanotechnology offers some relief from size and mass, but it also threatens a different kind of unanticipated runaway processes. Should we design machines that interface with living systems, without knowing more about living systems? Should we design robots to replace humans when we cannot even employ all the humans who want or need to work? Certainly machines can function in abiotic reaches of space or perhaps even as they do in very inhospitable earth environments. Should the machines be structured with rules that are anthropocentric, machinocentric or biocentric? Maybe the function of design should also be to limit the uses and kinds of machines, or at least address the needs and uses, benefits and costs, of machines in an ecological context rather than the narrower western economic context.

Machines are part of human ecology, like other tools. They too contribute to flows of elements, such as sulfur and nitrogen, although the machine contribution may exceed the total of all natural living and nonliving sources. Machines also increase flows of rare elements, such as lead or mercury to tens of times the natural flows. Machines also create new compounds that are suddenly introduced into a system that has no pathways to deal with them. They displace wild ecosystems, modify food webs, and create new energy flows within the system. Cars replace horses, and mowers replace deer and other grazing animals in simplified ecosystems. Video games may be the cockroaches, and leaf-blowers may be the rats of the new world, taking more energy than they yield benefits. Television may be a form of cancer that encourages the replacement of every living thing with new machines.

Of course, machines are not living yet, as we know, although they follow rules, change and evolve. We apply control to them, but they seem autonomous in many ways. They have many know and unknown effects, that we foolishly call 'side-effects' and these may diminish ecosystems, as well as people (other people, not as dominant or machine-like), or simply proliferate more machines.

6.7.5.2. Management Solutions for Technology

As technologies developed, human relationships with animals and plants changed. Hunting, grazing, and agriculture provoked large ecological disturbances. Early domestic animals were revered, but nondomestic animals were considered competitors or nuisances. Now, domestic animals are treated as processed commodities and wildlife is regarded as useless.

Technology can be used to expand or contract resources. Technologies have the capability to minimize the use of resources, but they also have negative effects. Technology has greatly increased the kind and quality of materials used for buildings and machines, especially aluminum and other light metals and silicon constructs. Yet, the scale of technology produces pollution that reduces the productivity of natural and agricultural systems. Unbridled, unconscious technology has given us benefits, but only at the cost of irreplaceable stocks of energy and environmental degradation. Instead of expecting technology to triple or quadruple our wealth, it is more likely that it has barely had a positive effect. Making technology appropriate, responsive, and conscious may go a ways to increasing its positive impact.

There is no reason not to develop complex instruments to monitor and analyze the environment. Machines do not need to be dismantled. Technological developments are more easily assessed in a small, self-supportive community, where they are not necessary. Necessity was not the mother of invention; curiosity was. And curiosity needs time, not pressure. Small communities could use sophisticated but unobtrusive technology. Evolution occurs in small populations, demes, in which a mutation has taken place. W.I. Thompson claims the metaindustrial village is such a deme. With desktop computers and libraries, satellite and cable television, advanced science would be possible in the most rural setting. Leopold Kohr states that small firms have been shown to be more productive as separate entities than large ones.

Technological processes must be brought into balance with the cycles of the earth. They must not damage or degrade natural cycles. It may be appropriate to use trees or to compete with black bears for tree use, but it is never wise to destroy the ecosystem of trees and bears. Laws on pollution and noxious wastes have been notoriously lax and sometimes wrong-headed. Minimal acceptable tolerances are legal, yet people often prefer zero amounts of many substances. Minimal compliance with them is virtuous in comparison with many companies, but it would be better to lead to higher standards.

Technology makes things easier. The cost of technology makes things harder. Every technology has a benefit and a cost. How are the two balanced? Someone has to list all the effects and then appraise the risks with them. Who does that? When should technologies be denied existence or admission? Who should decide? We need a comprehensive program for evaluating technologies on every level of every dimension for as long a time as possible—perhaps only over one lifetime, but perhaps over the time of seven or more human generations. There have to be high standards for evaluation.

Managerial strategies are needed. Technological solutions are sometimes used to avoid alternative solutions or management solutions that may require changes in lifestyles or luxury demands, but management cannot be avoided. Now that system changes are becoming global, while most technological solutions are still local, management is required. For instance, starvation is a local and regional problem, often relating crop and distribution failures. Carbon emissions are also regional and large-scale. The green revolution benefited those rich enough to buy and grow hybrid crops using the necessary chemical fertilizers and pesticides, but not those with less buying power.

Technological fixes by themselves are not adequate. Drought and crop diseases could lead to collapses of agricultural and social systems. The uncertainty of climate and stability of ecosystems requires adaptive management. Management can use other tools, such as the precautionary principle. Management can address distribution as well as production and consumption.

To manage the planet, we should probably avoid planetary scale civil works, that is, macroengineering as a large-scale management approach. In terms of telecommunications and manufacturing, large-scale might work. In terms of managing human health, we have to identify linkages not only from areas but also from parts of the human genome. And of course we have to management the environment and all the resources in the environment. We have to be able to anticipate natural disasters, as well as the mitigate or control them. We have to manage automation. We have to test or fit virtual reality technologies, especially for training in design. We have to consider population trends in population goals. We have to consider worldwide tensions the end violence. We have to assess the possibility of some kind of electronic global village. Then there is the question of some kind of global, language, such as English, used specifically in business science or aviation for example. We have to manage public issues, such as healthcare, genetic screening, the use of energy, and socially significant crime. Then of course we can guess about many of the possible at or probable developments such as increasingly cheaper telecommunications.

Is there a managerial solution for climate change? Could it be as simple as restoring forests and grasslands, and using alternative sources of energy? Could international management create large-scale migration corridors for warm species to ward off extinctions?

Design is not engineering. It incorporates some engineering. But, not the perspective of engineering, which is to fix something broken or exceed some limit. Engineers use and sometimes create new technologies. Our situation is not a problem to be solved. It is a context to fit, to learn to live with and in.

6.7.5.2.1. Responsibility

Management solutions require greater responsibility for the effects of pollution on species and habitats. Sometimes that is just a matter of allowing ‘enough time’ and ‘enough space.’ If we cannot recapture plastic pollution, we may have to minimize the release of plastics. If we have cut too many forests, we may have to restore forests to some greater extent. Some countries have reforestation programs: Costa Rica, Vietnam, and China. If people are trying to buy dangerous things or exotic species, we have to deny, regulate, monitor, or tax those things. If there is too much demand or too many people, then we have to lower those numbers. Many things would not be problems if we changed our consumption patterns or lowered our populations.

6.7.5.2.2. Goals for Use

A nation has to define the goals of technology, from simple technique to the simplification of chores, as well as to consider the concept of nonharm. Then, it has to analyze the results of technology, not just the mass production of things, but also the effects on human health and behavior. A nation has to discern what is missing from an application of technology, whether it is human scale or appropriateness. Then, a nation has to decide how to manage the technology.

Goals should be relatively simple to define, given the needs of a population and the limits of a home system. We can set goals for the conversion of mature ecosystems into agricultural ones; perhaps the maximum global limit is 15 percent of land, with local goals ranging from 10 to 90 percent. We can set goals for fresh water use, to reduce to 15 to 50 percent of any one system.

Biodiversity cannot be saved in the few, small isolated reserves on the planet, as it is. There are some good local and regional reserves, but no global ones. Ethical reasons for saving biodiversity have to come first, before economic tools of valuation or resource use and policy. Goals for biodiversity can range from reducing the extinction rate from land conversion to trying to save individual species from climate change, either in zoos or gene banks.

6.7.5.2.3. Budgets for Elements & Molecules

Several authors have calculated a carbon budget for the planet. Prior to 8000 YBP, the CO_2 content of the atmosphere was 160 PPM (before large-scale cutting and burning of forests). Prior to the industrial revolution by 1800, it was 280 parts per million of CO_2 in the atmosphere. This was equal to 645 gigatons of carbon in CO_2 in the atmosphere (the actual weight of the CO_2 would be 3.7 times more with the oxygen). For 2004, there are 380 PPM, or 869 gigatons of carbon. Tim Flannery suggests a budget of 660 gigatons, but as he states, half would stay in the atmosphere, raising CO_2 levels to 550 PPM or 1210 gigatons by 2100. It might be better to drop to 3 gigatons of new carbon per year. Carbon in living things comes to over 1 trillion tons. CO_2 is 387 ppm now. If we think 350 is safe and we want to bring down CO2 to that number, we should be reducing our output to below 285 until the new goal is reached. Some have formed a active group to reduce to 350, and this is a good start, but we need to be lower as soon as possible.

The benefits of Contraction & Convergence, a suggestion by UK politician Aubrey Meyer, are promising. Everybody has an equal right to release CO_2 or 'pollute with greenhouse gases.' This right could be traded similar to the Kyoto agreement. Under a global C&C agreement, citizens of the US would have to buy or trade carbon credits from poorer countries where people use a hundred times less. Meyer suggests three steps: (1) Reach an international agreement on a cap on atmospheric CO_2 concentrations. Then, (2) estimate how to cut back to that goal, and (3) divide the budget among the worlds population on per capita basis. This approach would reward fast-increasing populations and would not be fair. To be fair, in terms of ecological and cultural carrying capacities, would take a different calculation.

A fair budget could be figured in this way. Figure a world carbon budget, as an emergency budget using total from 8000 YBP divided by the current population for 10-50 years in the future. Then, for a permanent budget, use the numbers from the period 1400 or 1800 for 10-50 years in the future. Then calculate planetary cultural carrying capacity. Sum all the capacities and assign it 100%. So, for instance, if China has 13% of cultural carrying capacity, regardless of the actual population, then it gets 13% of the carbon use at the 1800 level. This kind of budget would be tied to the actual productivity of regions, combined with any technological advantages. Of course, the budget should be reassessed regularly, every five or so years.

Budgets should be made for all critical elements and molecules, such as nitrogen and phosphorus. We think that the boundary for nitrogen in systems is 39 million tons per year (removal from the atmosphere). It is 133 now. Nitrogen losses can be reduced by planting winter crops. The CAFOS animal feed operations should recycle their own nitrogen. Biofuels need to be discontinued, especially from corn, but also from grasses and trees. A global budget for phosphorus would limit the rate of flow into the ocean, which has been a sink for millions of years, to under 10 million tons or less per year; we may exceeding some critical maximum limit already. The rate increased exponentially when humans started contributing to natural erosion and movement with agriculture, deforestation and conversion to cities and roads. Better agricultural techniques can reduce it significantly.

Ozone budgets are relatively well-known. The gases from industrial processes, HFCs and CFCs, are 10,000 times better at capturing heat energy and last for many centuries. The Montreal Protocol reduced CFC gases in the air. It was the first victory over a global pollution problem. Many companies benefited from the change and from redesign of processes. There was some reduction in ozone loss from substitutes, like hydrochloro-flourocarbons (HCFCs), which still cause some depletion, and Hydroflourocarbons (HFCs) cause almost no depletion. The Kyoto Protocol could be as effective, if all nations would agree. Kyoto does not get ratified by the US or Australia due to prohibitive costs. The cost of compliance might be high, but we need to measure the costs of doing nothing. Well, hurricanes can cost 10 billion US dollars. Emissions trading in sulfur dioxide was invented in the US in 1995 to deal with pollution from burning coal. It is very successful.

6.7.5.2.4. Evaluating Technology

We need some global organization, perhaps like the State of California's Department of Toxic Substances Control (DTSC), to focus on evaluating new technologies, especially alternatives to treat, recycle, clean up, and eliminate or reduce hazardous waste at its source. DTSC uses demonstration projects, data analysis, and life cycle assessments to provide support to other DTSC programs and help developers bring their ideas to market.

Such an organization would deal with remediating chlorinated solvent groundwater plumes, with life cycle assessment of the impacts of a product, and with evaluating nanotechnology. It would have to decide when to accept or reject a technology that promises some advantage, perhaps starting with potential impacts on the planet, then on ecosystems, then on human cultures and human individuals.

6.7.5.2.5. Containing Technology

The intent of many corporations and governments is to transfer technologies rapidly to the marketplace. Many technologies, however should require longer testing periods and required modifications. A suitable global organization would also decide under what conditions the effects of technology could probably not be contained. Does technology always escape and produce its effects on the nonhuman environment as well as on other cultures? If so, then technology is always ecological, that is, it is always part of the environment. It always generates some change in the environment it is part of. It is not the same environment after the introduction of the extension of technology. Any addition (or subtraction) is a change, and any change has many effects on everything. The loss of wolves in Britain did not simply subtract one species; it affected all other species in varying degrees. The conditions of survival all changed.

Attempts at containment raise questions. When should we reject a technology that promises some advantage? How do we balance technology against human or nonhuman lives? Perhaps we should start with potential impacts on the planet, then on ecosystems, then on human cultures and human individuals.

6.7.5.2.5.1. *Applying Precautionary Principles.* Technology has to be held to standards according to the precautionary principle. For instance, we have to require a minimum testing sequence for new technologies, with a minimum waiting period. Perhaps we should require a moratorium for some new tools. A moratorium is a legally authorized period of delay in the release or performance of a technology.

Some groups implement the precautionary principle as the basis for environmental policy, others for human health policy. The principle and the main components of its implementation (the 1998 Wingspread Statement on the Precautionary Principle, in Raffensperger et al.) are stated: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof. The process of applying the precautionary principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action."

Several groups and government bodies in the United States, including the Board of Supervisors of the City and County of San Francisco, have made the precautionary principle the basis for environmental policy. The Precautionary Principle should be applied if there is the possibility of environmental or health damage, and if there is uncertainty as to whether an effect will occur (and its potential magnitude). Precaution is about anticipating and avoiding negative effects or damage. It requires more science, from different fields, to make the best possible decisions for preventing harm. The precautionary principle requires more, not less science than traditional decision-making methods. The managing body has to acknowledge the uncertainty and ambiguity involved in any decision.

The principle is especially important with gene technology. A substantial proportion of soybeans, corn, and cotton grown worldwide is genetically modified. To date, most genetically modified plants are grown in the US, followed by Argentina and Brazil. Many consumers are concerned about the use of gene technology in food production, although less concerned about its use to produce medications and vaccines. However, the principle means taking precautions, rather than the thoughtless denial of the experimentation necessary to establish risks and dangers. The experimentation is crucial, but it should not be rushed for political or economic reasons.

6.7.5.2.5.2. *Integrating Technologies & Lives with Design: Amish & Swiss Approaches.* Technology needs to be integrated into society. It needs to be made appropriate to the goals and desires of a culture. The notion of appropriate technology, however, was developed in the twentieth century to describe situations where it was not desirable to use every new technology or those that required access to some centralized infrastructure or parts or skills imported from elsewhere. The eco-village movement emerged in part due to this concern.

Technology needs to be integrated into the entire environment. Some technologies have negative environmental effects, such as pollution and lack of sustainability. Some technologies are designed specifically with the environment in mind, but most are designed first for economic or ergonomic effects. The effects of technology on the environment are both obvious and subtle. The more obvious effects include the depletion of nonrenewable natural resources, such as petroleum, coal, ores, and the added pollution of air, water, and land. The more subtle effects include debates over long-term changes, such as atmospheric heating, deforestation, natural habitat destruction, and costal wetland loss.

The underground part of Biosphere 2, in the desert in Arizona, is a larger technosphere that supports the operation of the biosphere, with 200 motors, 100 pumps, 60 fans, valves, computers, miles of wiring and ductwork. These machines circulate air faster and scrub algae better than the minimal natural processes in a closed environment. Kevin Kelly refers to it as a marriage of ecology and technology, a symbiosis. Dorian Sagan considers that man-made systems are ultimately natural, a phenomenon of metamorphosis. Perhaps biosphere is a form of the planetary biosphere reproduction.

Technology changes institutions and the relationships between them. As an institution adapts a technology, its view changes. A new technology threatens other institutions, which have competing technologies, so the whole mass has considerable momentum and investment. As the nature of institutions changes, the nature of communities, and cities and cultures, changes.

Technologies change the structure of things with new metaphors. As metaphors (like totems) are good things to think with, technologies become things to think with. The whole idea of technology, according to Evan Eisenberg, is not to eliminate work or to replace nature with synthetic artifacts, it is to restore the balance of work and leisure that hunters understood—it is to find the best way between the dirt and the mouth. Sometimes this can be done with simple tools. When complex tools, such as computers, are used, they have to be designed to be appropriate to the use and environment.

A nation could promote appropriate technology to manage resources for its region. Dangerous technologies would he reduced through wholesale substitution, if not of materials, than by labor-intensive solutions. Traditional housing, for instance would be preferred; its form and design are integrated into the culture, it is adapted to the local climate and is usually less expensive, due to use of local materials. Much traditional architecture is authentic and unselfconscious; its forms fit the context of place and develop in response to place. With arcologies, the urban ecologies designed by Paolo Soleri, the city can change its relationship with nature; an arcology is a good solution for an urban culture, as it solves the problems of waste, resource-use, scale, obsolescence, and segregation.

One way to balance technologies is to create a program for recovering old technologies that are useful under many circumstances and may be more appropriate than more complex solutions. Digging sticks, for instance have been useful for collecting or harvesting vegetables. And, they can be used just as effectively in rooftop gardens as in Amazonian rainforests or Australian deserts. Another way might be to base an approach on the Amish or Swiss.

6.7.5.2.5.2.1. *The Amish & Technology*. The Amish have developed an attitude toward technology based on their biblical cosmology and philosophy of life. The Amish are a contemporary, 'low-technology' farming culture living in the eastern and central United States, having fled several nations in Europe to find religious freedom. The Amish, although decentralized groups that vary in conservatism, in general, accept only technology that permits them to maintain their isolation from a secular, consumer society. So, for example, some use limited access to telephones, electricity and electrical appliances, and automobiles.

While the old order Amish are permitted to use batteries, generators, and many devices powered by those sources, they reject electricity from power grids, and the use of 110-volt electric appliances and computers. The prohibition of power-line electricity serves as a way to separate them from the outside world, so that their Bible-based standards will not be diluted or forgotten. The act of rejection of electricity also contributes to bonding in the community and is an acknowledgment of the need to submit to authority. There is no need to debate the possibility of every new worldly appliance to come along; it is removed from individual decision-making. The decision also effectively isolates the Amish from pervasive media like the internet that surely would have compromised Amish community. The rejection of electricity general serves to delay social change that may erode fundamental value beliefs.

Many Amish decisions about technology seem to be very flexible. For instance, people who are sick and need refrigerators are allowed to have them. Sometimes an Amish home will have a telephone to serve many families, usually for emergencies or communication with other Christian neighbors. When an Amish family purchases a secular home, some Amish churches allow a 'grace period' of 6-12 months during which the Amish family may continue to use electric power, until the home can be adapted to Amish standards.

Many Amish use candles for light. Some still use windmills for power or pumping water. Amish typically make use of various batteries for devices such as flashlights, and recharge them using a diesel generator. Some Amish accept the use of solar panels to generate energy to charge batteries, heat water or power an electric fence. Solar energy is recognized to be part of 'God's grid.' All of these forms of power serve a practical purpose, but are limited in scope, thus restricting the type of technology that can be used.

Simplicity and humility: The Amish stress simplicity and humility. They avoid any behavior or expression associated with self-exaltation, pride of position or enjoyment of power. They believe that God is pleased when people work in harmony with nature, to care for animals and plants. Amish always live in rural communities. Most Amish travel in horse-drawn buggies, although some modern conveyances and conveniences are used restrictively. Technology is not considered inherently evil—those technologies that are banned are those that might distract or damage the community.

However, the Amish are embedded in a technological society. They depend on the use of their neighbor's high technology, such as telephones and automobiles. They also depend on an industrial system for their 'low-tech' tools and materials. The Amish do not reject all modern technology, but choose pieces of it to use it in a controlled manner to live consistently with their values. They subordinate technology to the good of God, family, and community, and that subordination becomes a symbol of their separation the secular, which can hold evil. The Amish life might seem extreme in its simplicity and austerity, but Amish leaders are responding to extreme situations with extreme measures.

The Amish model may be impractical as a model for larger society. Some of the technologies the Amish reject are instrumental in the realization of human potential and improvement. It may be unwise to give them up entirely. Even if there was a general will in our society to adopt the Amish model, it is unlikely that the material needs of the current population could be met satisfactorily without some of the technologies the Amish reject. At least the transition to the Amish model would be extremely difficult. Third, human nature being what it is, even if we generally acknowledged the wisdom of the Amish model, few of us would be willing to give up the material comforts that the Amish reject. On the other hand, if civilization faces collapse soon, extreme measures may make the Amish model practical for many people.

6.7.5.2.5.2.2. *Swiss Technology.* Accelerated technological change has become a fact and involves the evaluation, development, implementation and substitution of technologies within innovation-driven enterprises. The Swiss embrace new technologies for improvements and trade advantages. But, they are reasonably cautious about adopting technologies. Strategic technology management needs to address these issues. Management control has experienced a fundamental change and in parallel, the question arises whether current management control systems can adequately cope with complex technology issues in technology-based enterprises. Previous technology management control approaches may be inadequate. Management needs to develop a Management Control System in technology-based enterprises.

The Swiss Jura Arc is an illustration of the construction of a local system of production using new technologies (Maillat et al., 2000). Conventional production systems can be transformed into systems based on microtechnologies that result from a combination of conventional micro-engineering technologies and newer technologies, such as optics, new materials and microelectronics. A technology district formed as individuals made decisions to reconfigure the production process and management. The environment is the focus in innovating the production process. Dynamic complementarities and interdependencies, between production and local institutions, are emphasized. Theoretical linkages are identified between the industrial, technological and territorial dynamics.

The Swiss pay attention to the implications of technological change on their society and on the dependencies of environmental, public and private interests. They use a holistic approach to technology management, a systems approach, which analyzes and contrasts technology management on corporate and national levels. With different levels of observation of technology, multiple perspectives can be used to manage new forms of technology.

6.7.5.2.5.3. *Certifying Technology.* Like electronic appliances and forest management, technology could be certified in terms of its performance qualities and impacts. With certification, the entire history of a technology would be made visible and known. Certification traditionally has been driven by consumers facing negative impacts. Although existing rules and laws protect people from faulty products, there is currently no way to protect them from an inherently harmful technology. Certification inherently requires more attention to and knowledge of system impacts and limits.

Most criteria are numbers on costs, impacts, and wastes, but they could reflect pollutants produced and the synergistic effects with other pollutants or technologies. An international certifying body, an independent, third-party group, could use a systems and practices approach to proscribe the use and reach of a technology. Although certification will be blamed for management failures and higher costs, it could reflect real, long-term costs and could keep high standards to improve the overall balance and health of the ecological and technological system. Certainly, certification will cause shifts in patterns of use and appreciation. It addresses issues of equity and justice as well, not only for human generations but ultrahuman beings, who also participate in the planetary system.

Certification will allow consumers to choose technologies that enhance common values, within the large-scale economic and political trends that shape human culture. Technology problems are part of a matrix of industrial social practices and policies, but there are now pressing economic and ecological reasons to revamp them. To be successful, certification has to address industry shortcuts and economic shortcomings. The goals of certification should include making technology benign and sustainable, as well as protecting ecological systems from harmful technologies.

6.7.5.2.5.4. *Using Appropriate Technology.* Appropriate technology is that technology designed with special considerations for the environmental, ethical, cultural, social, political, and economical aspects of the community it is intended for. Proponents of appropriateness claim those methods require fewer resources, are easier to maintain, and have less of an impact on the environment compared to techniques from mainstream technology, which is wasteful and environmentally polluting. This form of technology offers labor-intensive over capital-intensive approaches. Laborsaving devices are used when there are low capital or maintenance costs. In practice, appropriate technology is often something described as using the simplest level of technology that can effectively achieve the intended purpose in a particular location.

E.F. Schumacher, in his book, *Small is Beautiful*, popularized the movement used by Gandhi. Schumacher was very strongly influenced by Gandhi's philosophy. He took the village development idea further with 'intermediate technology' in early 1970s. Many others, such as Buckminster Fuller, Victor Papanek, and Arne Naess, contributed to the appropriate technology movement.

6.7.5.2.5.5. *Embracing a Technology Diet?* In the case of industrial nations, we have been embracing excess for many generations, so that we are crippled by stress and sickness. Perhaps all we need is a diet, an emergency diet. The essence of a diet is to restore oneself to health, by restricting unhealthy consumption. As societies and cultures may also be guilty of this kind of behavior, so they need to put themselves on a diet. We know that people are unable to perform well on unbalanced diets or sometimes even behave in a human way, so the diet would have to be whole and healthy, just without excess or overindulgence. A diet for a small industrial planet could be presented as a series of actions based on technical, managerial and design ideas.

For example, we could start a carbon budget for planet, and cut carbon use drastically by decarbonizing the power grid with solar, wind, and other sources, then ban new coal-fired plants and regulate existing ones. We could extract CO_2 from the atmosphere, by planting trees and designing a permanent agriculture. We could regulate our population, by basing it on biological/cultural carrying capacities and by starting a Year of Consideration with no births.

We might freeze our energy use at 1950 or 1910 per capita levels. We could cut waste by using less and sharing, by designing more ecological technologies, and by creating entire industrial ecologies. We could cut transportation, by not traveling as much or as wastefully, and by using old-fashioned practices like walking or by using virtual technology like the internet. If we did travel, we could optimize transportation with hybrid or solar cars that get 4-200 40 mpg or better. Trains could be solar electric or maglev. Ships could return to sailing technologies. Airplanes could be grounded 3-4 days a week.

We could seriously cut the automatic or planned expansion of human, urban, and agricultural areas, cut conversion of wild ecosystems, and preserve wild areas as wisely as possible using north-south ranges and north-south corridors, even through cities and fields.

6.7.5.3. An Ecological Cosmology for Technological Civilizations

What kind of system of science and technology is needed to support the quest for sustainable development under dietary restrictions? They would have to address rapid fundamental changes, human-induced changes. They would have to address nested and emergent factors from population and economy to technology and government, as well as the ambiguity and uncertainty of the global system. The system may need a new image to alter perceptions mired in an industrial worldview. This is the realm of cosmology, using a coherent image to explain and understand the planet. New technologies can actually contribute to making a new image for an ecological cosmology. The planet can be observed and photographed from space. Computers can create databases of ecosystems and create simulation models.

Mathematics can make the workings of complexity visible. The independence of cultures and nations, as a result of new forms of agriculture and technology, can allow microcosmic cosmologies adapted to local environments.

Cosmology incorporates a complete set of ideas about the nature and composition of the universe used by a cultural system. This idea of the universe provides people with an orientation in their cosmos. Melville Jacobs offered a catalog of ingredients that could be included in a world view: epistemology, prepsychology, logic, a theory of disease, the supernatural, geography, climate, history, zoology, astronomy, biology, myth, music, and theology. The contents, limits and functions of cosmology have not been rigorously defined. This introduction formulates an expression of what cosmology is and what it does, then generally examines cosmologies to determine common traits.

Cosmology forms part of the ideological system of culture. Cosmology is a collective image of the universe (Ezra Pound stated that the image is an emotional and intellectual complex in an instant of time. He used the figure of a Chinese ideogram as an expression of a complex image created by throwing groups of elements together without predication (which is a characteristic of assertion). It includes beliefs about the origin, structure and destiny of the universe.

These characteristic cosmological statements (in Table 6753-1) result in specific behaviors. For instance, if the universe is a machine that implies that anything can be fixed, or if that is too difficult than something else can be substituted. That means that nothing has a unique value. The choice of an image for a cosmology has serious consequences. The price mechanism of modern economics ignores the possibility that something may disappear; it assumes substitutability, that is, one form of capital can be substituted for another (and this leads to the disregard for any one form, such as land). The modern industrial image of nature as a resource has resulted in pollution, material shortages, and environmental degradation. A culture that degrades its ecosystem risks its own extinction.

Table 6753-1. Three Battling Paradigms

Archaic	*Industrial*	*Ecological*
Humans are same as other species (only the masks differ)	Humans are different from other species, and masters of their destiny.	Humans are one species among many in a community.
Humans can learn to do human things	Humans can learn to do anything.	Human life is linked in an intricate web of connections. With unintended consequences.
Humans are limited by human characteristics	Humans can change when they have to.	The earth is finite. Limits constrain aspects of human life and change.
Humans are the same as always, but they can improve some things for a while.	Can improve everything. Every problem has solution. Progress never ceases.	Nature bats last, regardless if human inventiveness can lever carrying capacity.

Many, but not all, archaic cultures are a form of fitness and limitation. Most archaic groups try for adaptation before domination. For instance, according to Gerardo Reichel-Dolmatoff, the goal of the Desana Indians is the cultural continuity of their society in its place in the rainforest. In Desana cosmology, technology was useful for cutting branches and catching fish. In industrial American cosmology, technology has no bounds and can do anything it wants, and should. For the Desana, fishing is best, although rituals are important; for

Americans, the industrial system is superior to all others, which should convert to it.

Four historical stages in the history of cosmology can be distinguished: Mythical, rational, mechanical, and ecological. Each stage is characterized by a different set of ideals, morals and tenets. In the mythical stage, the relationship of humans to nature is one of kinship or affinity. All beings fall within moral consideration, except for profane areas and other tribes (Michael W. Fox calls this symbiotic). In the second, rational humans analyze and deduct the operation of nature, but only regard other humans morally, in general. Sometimes moral consideration may be extended beyond all of humanity to other conscious or living beings. Kinship is not a cosmic relationship, but hierarchical and human. Rituals become stylized. In the third, mechanical men try to explain and dominate external processes. Time is linear, and nature is demythologized. Each individual is responsible for moral standards, sometimes leading to self-righteous anarchy. Finally, the ecological stage interacts with nature much like the mythic, but understands the rational and mechanical sides. All things are treated morally, in an 'I-Thou' relationship (M. Buber, I and Thou). The human place in nature is not diminished or glorified. (Fox calls this stage spiritual.) This fourth stage does not reject or judge the other stages, but incorporates practicality and paradox. It makes no distinctions between right and wrong or good and bad; these polarities are more like positive stimuli useful to evolution. Hence, there is no evil, as considered in the previous three stages. Only an evil that results from lack of wisdom.

Many of the cosmologies that have existed basically belong in the first three stages. Even ecological resistance or deep ecology may not be ecological enough to describe human participation in the balance of nature. Process and ecological philosophies take an anthropocentric view of humanity as an endpoint to evolution, as with Teilhard's one consciousness on earth, the Omega Point. The view of a holocosmology is the opposite, if anything. It considers living beings the results of evolution, whose only goal is experience or living-time. Relationships are personal and spiritual.

Modern technological cosmology, beyond being another kind of order, more linear and abstract, is wrongly considered the evolutionary successor to traditional cosmologies, and is displacing them rapidly. Where human understanding is still underdeveloped, humanity cannot afford to suppress the diversity of thought necessary for adaptation to the diversity of environments, or to eliminate ecosystems and the societies adapted to them. The ecological, social, and political problems of today do not have simple, disciplinary solutions. The problems are cosmological and must be solved on that level. But a single cosmology cannot solve all problems in all places. A framework that protects local cosmologies as important functions, that is fit around them, not as a replacement, but as a means of preservation, understanding, and integration, is needed. Such a framework could be based on ecosophy, the philosophy underlying the deep ecology movement.

6.7.5.3.1. Deep Ecology Movement

When Arne Naess presented his deep ecology alternative, starting in 1972, he contrasted it with the shallow ecology movement, which he characterized as fighting against resource depletion and pollution—its objective is the health and affluence of people in developed countries. Deep ecology is a movement that goes beyond a concern with pollution and resource use, with its humanity-in-the-environment image, to consider humanity in a relational, total-field image. The movement promotes human equality, conservation, and local autonomy. In principle, it proposes a biospherical egalitarianism, that is, the equal right of all beings to live in place.

Table 67531-1. Contrast of Industrial and Deep Ecology Views.

Industrial View	*Deep Ecology View*
Nature is a human resource	Nature has intrinsic worth
Human pan-dominance of nature	Human harmony with nature
Unrestricted growth	Population fit to nature
Unlimited resources/substitution	Limits to use of resources
One-way progressive technology	Appropriate technology
Unrestrained consumption	Intelligent frugality
Unsustainable economic growth	Homeorhetic economy
Global management	Local/regional control
Competitive, destructive relations	Cooperative relations
Material goals	Spiritual/material goals

Naess characterized deep ecology in his article thus: It is a relational total-field image (knots in a field of intrinsic relations), with biospherical egalitarianism (key words: respect, understanding, right to live and blossom, space and crowding). It is based on principles of diversity and symbiosis (where diversity means live and let live rather than either/or, and symbiosis means coexistence). It takes an anti-class posture (key words: exploitation), in the fight against resource pollution and resource depletion (ecologists as informants). It seeks to create and use complexity, not complication (there is multiplicity and lawful factors; and division of labor, not fragmentation). For effectiveness, it depends on local autonomy and decentralization (to strengthen local regions and encourage self-sufficiency). The movement is based on a philosophy of ecology: Ecosophy.

6.7.5.3.2. Technology Design Related to Properties of Culture and Life

We can use the properties of ecosystems to consider design concerns with technology, although those concerns might be better linked with the properties of a culture: Conduct, wholeness, flexibility, adaptation, endurance, and vitality. Each of these properties should help us understand the limits and alternatives to design technology.

6.7.5.3.2.1. *Conduct Related to Design Technology*. Conduct is the course of cultural behaviors through a behavioral landscape. The concept of the epigenetic landscape can be used to explain why people become trapped in the use of a technology. The use-need path or chreod is deeper than the cognitive path that relates technology to history and need. So, we have to use the technology even though we may be aware of simpler solutions, such as bicycles or evaporative cooling. If the need chreod is too deep with investment or profit, we cannot explore the cognitive chreod. This may explains why necessity cannot be the mother of invention; the necessity path, eating to avoid starvation for instance, is too deep to allow exploration of a shallower path of daydreaming or design. The broader behavioral landscape of leisure is needed. Conduct can be described as the stable path of culture through a landscape of possibilities. Once the course has been set, it is most likely to channel most subsequent behaviors, unless some event or catastrophe triggers a deeper course.

6.7.5.3.2.2. *Wholeness Related to Design Technology*. Culture provides an identity for its members. It tells them who they are, where they came from, and why they are special. Identity is basic to human existence. People are identified by their roles. A person is an incarnation of his and her group—even in industrial culture, one is identified as an astronomer or farmer. Specific technologies are often part of an identity. Identity is that persistent quality that can be described apart from its performance in interactions, but not isolated. The relationship between identity and wholeness is a rhythm, with unique patterns. In fact, culture is concerned with all things and beings in a whole. If the rhythm is whole enough, it could incorporate appropriate technologies into it.

6.7.5.3.2.3. *Flexibility Related to Design Technology*. The rules of a culture lend order and stability to the whole, as well as flexibility. Flexibility means not being over connected, or not being too rigid or too efficient. Than means that culture is able to slough off older technologies for newer ones—or new ones for appropriate technologies that fit better into a sustainable pattern. That way culture is able to keep some options and unused connections open. Some of the flexibility comes from different ways of establishing connections in specific places. Culture is bounded by ideas and habits, but is open to flows of energy and materials. It is a loose-fitting patchwork of ideas, relationships and things. It requires order, but not too much order. It is tolerant of discontinuities and contradictions, and this gives it flexibility. If the contradictions between technology and moral behavior become too great and maladaptive, however, the culture can collapse. Flexibility can allow choices.

6.7.5.3.2.4. *Adaptation Related to Design Technology.* The patchiness of culture is parallel to the co-constrained construction of a species and its environment. Co-constrained construction enforces coevolution, the emergence of a highly ordered complexity to full structuration. Culture has to balance between embracing change and resisting change. People show a desire for new technologies, tools and products, but often fear and resist change. Resistance to change is a normal part of a cultural process. A culture modifies and is modified by the environment, and both can adjust and survive. Technology is part of a culture and it aids survival in the wider environment. Each technology is a way of exceeding the limits of the environment. This changes the environment, which pushes new changes in human thought and technology. Technology itself, however, has not been used for improving ecological balance. It could and it needs to be used that way to aid survival.

6.7.5.3.2.5. *Endurance Related to Design Technology*. A cultural system is stable and persistent in time. It is a general property of some systems that acquired information is used to close the door to further inflow. A mature culture needs less information, since it works toward preservation, and closes itself off to information that does not fit the shape of the culture. The effect of maturity is to allow a maximum variability between systems with slight external differences, such as place or initial conditions. Cultural shapes need to be loose enough and diverse enough to change when new information is required. Cultural stability is the ability to maintain cultural identity under the flow of external forces and disturbances. A culture has to be able to resist disturbances that are too disruptive. Sometimes those disturbances result from an inappropriate technology that then needs to be modified or rescaled. If the technology cannot be modified, it has to be resisted. Resistance is a positive act for a self-reliant culture. Culture also has to be resilient enough to recover from intermediate and small disturbances from the environment or technology.

6.7.5.3.2.6. *Vitality Related to Design Technology*. To be constant and stable, a culture has to be vital, that is, it has to be productive, to be able to convert energy and materials into foods and structures for survival. With order and integration come stability and security, without which no one can survive. Primordial security comes from a physical, knowledgeable relationship with nature. Stability can also be related to compartmentalization, communications, and the richness of interactions and connections. The system, with all of its technologies, is self-creating. It renews itself as its contents change, as disturbances change the parameters of the system. But, technology that does not fit the culture or its environment is a barrier to cultural renewal. If a culture is vital enough to be productive with less complex technologies, then it can judge and choose technologies according to its best longer-term interests and not be trapped in the depth of habit or investment. When human societies were small, the amount of control and security required was small. Although societies have grown to immense sizes, human security has not, despite incredible increases in the sophistication of technologies. Perhaps that is because vitality does not always require sophisticated technologies beyond a certain point to achieve goals of a good and stimulating existence.

6.7.5.3.3. Technology Design Related to the Properties of Life.
We can use the properties of life to consider design concerns with technology. These properties are: Movement, cellular structure, irritability, growth and development, adaptation, and reproduction. Each of these properties should help us understand the limits and alternatives to design technology. Because of the emergence of technology from human creativity, many properties of technology seem similar to living.

6.7.5.4. What is Necessary?
Everyone agrees, to some extent, that we need science and technology to meet human needs. And, these systems have to be integrated systems of production, consumption, and distribution. They have to be postindustrial and ecological.

The most meaningful actions have to be at the largest scale possible—hence, global ecological design. But to be good at global, we have to think in the solar system. The cosmic address of our place is: Earth, Solar System, Orion Arm, Milky Way Galaxy, Local Group of Galaxies (Milky Way Group?), and Local Supercluster of galaxies, universe, and perhaps local cluster of universes.

We tend to think of civilizations or nations as metaphors for behavior. Primasck and Abrams suggest that identity with 'generations' might be more meaningful than civilizations. But, generations are shaped by cultures and now by global influences and trends.

Advanced communities have to adapt biologically sound processes. Pollution is only a symptom of imbalance and improper resource utilization. The wars on pollution and on poverty are as ineffective as the wars on people. A serious problem is our lack of understanding of the extensive, long-term effects of pollution on the atmosphere. Once it is determined that materials and wastes, especially nuclear or chemical are dangerous and long-lived, they should be minimized. There are ways to reduce generation of wastes by acting on the flow: Reduce number of products; reduce the quantity of waste in each product; increase the durability of each product; and make sure that the cycle is a spiral. The best results might come from a mix of these strategies.

The greatest threats facing ecosystems and biomes, and the organisms and species adapted with them, are not just disease organisms or pollution, but the synergistic effects of fragmentation, pollution, and climate change. And these are best addressed all at once.

We need to relax, paradoxically, to have more time. A problem with the degradation theory is that time and leisure are needed for technological innovations. People starving rarely invent their salvations. We need to have faith in our strength and resolve so that we can act wisely with technology and design. The computer offers computing speed and storage of information, but despite our faith in it, it is not enough to solve any problems. Paradoxically, we need to be less adaptive. As Rene Dubos pointed out, we may be able to adapt to pollution and habitat destruction, simply because, like rats and bacteria, we can adapt to radical changes, even if other plants and animals that we value cannot adapt and perish. Therefore, we need to implement thoughtful plans and designs.

6.7.5.5. *Remastering Technology*
By Alan R. Drengson
(Being edited)

6.7.6. *Redesigning Industry*
Industries were developed to produce material needs on a large-scale, so that more things could be supplied to more people. The scale had the effect of lowering the costs of items, so that almost anyone could afford things, such as clothing or toys that had been out of their economic reach.

Industry has special requirements that have to be met for it to be profitable. It requires capital investment, special designs, regulated labor, free materials, a directional flow, and free environmental services for renewal. Industry has effects other than low-cost or profit, which can seem like costs: People have to act as identical, replaceable machines, and they have to be regulated, due to disrespect and violence; pollution and its sometimes required, sometimes expensive cleanup responses; negative changes in the health of workers or consumers; and, the samenesses of the products.

Industry developed within the context of a western civilization that held dear a few cosmological ideas: It's us against the environment, other men, and animals; it's the individual (or corporation) that matters most (although each is replaceable); we can control everything with machines and should; resources are infinite; and, the ability of technology to fix problems is also infinite. Industrial culture is a package deal, complete with Christian conservative virtues and Newtonian physics. The package inflates many luxuries into needs, so that the cost of a simple car becomes a need, even in a city with advanced mass transport.

Industrial design is not just about designing products, but about designing the factories and processes within an ecosystem context, that is, the land, cycles, and connections. This requires consideration of anything that has some connection to the industry.

6.7.6.1. An Artistic Approach
The architect and designer William Morris reacted to the plain aesthetic of industry and the replacement of art labor by machinery by starting the English Arts and Crafts Movement in partnership with Edward Burne-Jones and D.G. Rossetti. The movement was a reaction to the 'soulless' machine production that resulted from the industrial revolution and a search for authentic and meaningful styles for a new approach to production. He applied his theories of hand-craftsmanship to the designs of churches and houses, as well as to designs for textiles and wallpapers. As a pattern designer, he was concerned not only with patterns based on a close observation of nature, but also patterns of work and accomplishment. Morris was concerned with preserving what was valuable in the natural and 'built' worlds, the very things that were threatened by the faceless movements, such as industrialism and modernization, with the attempt to control everything from production to prayer.

While the Arts and Crafts Movement was a reaction to industrialization, it was not specifically anti-industry or anti-modern. Quality production could be accomplished with a design, labor, tools, and machines. Workers could use machines to produce furniture and other things. The difference was in the control of the designer in all stages of production and the use of machines to supplement labor rather than replace it. Designers and workers would work together to develop higher standards of handicrafts.

Morris actually designed artifacts for machine production, as long as the process did not involve the complete division of labor and indifference to craft talent. In building a desk, for example, one person or team would handle all the legs of the piece and another all the panels; a third person or group assembled the parts, and a fourth handled the finishing work, such as paint and varnish—all according to a plan of a furniture designer, who would or would not participate in making the item. Machines would be used appropriately. The Arts and Crafts movement sought to reunite what had been ripped asunder in the nature of human work, having the designer work with his hands at every step of creation.

Although dismissed as a romantic, Morris stimulated a movement towards artistic sensibility based on ideals and principles that many people find true. His work had effects on western architecture, cottage garden design, and on the Garden City planning movement.

6.7.6.2. Industrial Ecosystems

Like agriculture, industry draws energy and resources from the earth and dumps its waste back. But, it draws too many resources too fast, and there is nothing that has coevolved to live on the waste. Unlike a pioneer stage of succession, industry is, in Evan Eisenberg's words, at a "fetal" stage. It relies on the maternal biosphere, or the biospheric matrix, to feed it and lick its wastes. Alas, this fetus is very large and could kill the mother soon, unless the fetus matures or the mother reacts faster. Industrial processes require access to materials and markets from reliable transportation. Speed, flatness and temporality are changed by the process.

Paul Hawkin and others have suggested the possibility of an industrial ecology that could mimic a mature ecology in its use of recycling and wildness. Industrial designers and managers need only reduce the capital use of energy and streamline recycling. Despite a few paths of plastics recycling, aluminum or steel, most industry is a one-way path from energy and materials to waste energy and materials. Major changes are occurring, though. The scale of civilization now makes externalization unfeasible. The costs of pollution and waste are being internalized; other inputs, such as labor and capital, are becoming more expensive. Economies will have to internalize or be forced to internalize. With the internalization of costs (since the losses as well as benefits will accrues privately), the system will benefit from intrinsic responsibility.

The Danish have created an example in Kalundborg. Statoil sends most of its byproducts to industrial neighbors. Sulfur to a sulfuric-acid plant, heat to local greenhouses, gypsum to a wallboard plant, gas and wastewater to a coal-fired electric utility, which sends its waste steam to Statoil and fly ash to a cement company. A flowchart with boxes and arrows might make it resemble the charts of mature ecosystems.

Industrial Ecology has been called the "science of sustainability." It looks to natural systems for the new principles of design and operation of community and industrial systems. Environmental footprint, local carry capacity, closed loop economies, zero waste and by-product synergies are some of the concepts that leading communities and organizations are capitalizing on today.

However, isolated attempts at industrial ecology have been less successful. Biosphere 2, for example had difficulties balancing gases. The underground part of Biosphere 2, in the desert in Arizona, is a larger technosphere that supports the operation of the biosphere, with 200 motors, 100 pumps, 60 fans, valves, computers, miles of wiring and ductwork. These machines circulate air faster and scrub algae better than the minimal natural processes in a closed environment. Kevin Kelly refers to it as a marriage of ecology and technology, a symbiosis. Dorian Sagan considers that man-made systems are ultimately natural, a phenomenon of metamorphosis. Perhaps the biosphere project is a crude form of the planetary biosphere reproduction.

Industrial work is bad for physical and psychological health. It offers bad physical conditions, high pressure, and low control—sometimes deaths. Conversion of places into flatscapes destroys them. Problems with wastes require heroic cleanup efforts. Industry is trapped in its hunger for profits and resources. Our industrial relationships go bad, because they are not mature, and mostly importantly because they are not whole. Industrial ecology is still an expression of dominance of nature, as human industry tries to fit in a human landscape supported by wild ecosystems. Industrialization also has other things backwards as well, such as producing things for the lowest price. Rather producing things at the lowest cost instead the lowest price. That is what marginalizes people and nature. They do not have a cost or price.

One problem with an industrial ecosystem might be how it fits with natural ecosystems. A related problem might be the total energy and material in the industrial system—that is, the scale might overwhelm natural ecosystems accustomed to solar energy budgets. Although we can expect many species to invade or exploit an industrial ecosystem, we need to choose them carefully so that they do not overwhelm the system.

We can use the properties of ecosystems to consider design concerns with industry, starting with 'Course.' Living systems do not display homeostasis—constant value—so much as a particular course of change in time—homeorhesis (from the Greek meaning 'same flow'), according to Conrad Waddington. The course is stabilized, not the constancy. Changes to a system are symbolized by trajectories in a multidimensional phase space or landscape. Homeorhesis is a significant phenomenon in evolution. Waddington applies it to the tendency of a process to continue in its original pattern, even if disturbed. Homeorhetic mechanisms protect the system from many disruptions. Negative feedback counteracts the effects of change to maintain the system in a steady state or homeorhetic state. A mature community is self-perpetuating and homeorhetic, with a dynamic balanced energy-matter budget.

The course exists in a natural topology with valleys and hills. The valleys occur in various shapes. Some could be very narrow canyons, others large meadows, similar to old mature earth forms, with meandering rivers. The name for a characteristic of an attractor surface in multidimensional space is a chreod, not a valley. The cross-sectional shape of the chreod describes the reaction of the system to fluctuations. With a steep slope, for example, it is difficult to divert the developing system from the bottom of valley; even with a strong force the system will return immediately as soon as the influence stops. With a shallow slope, like a flood plain chreod, it is easy to divert the system; it meanders before returning. But actually the perturbations alter the landscape itself, making a steep valley again, not just shifting the river. As the environment changes, the system changes with it.

Ecosystems have many properties and are affected by many environmental conditions. Their changes are symbolized by trajectories in multidimensional phase space; orderliness can be described in terms of constraints on trajectory courses, and these constraints are visualized as attractor surfaces. If the system starts from any condition, represented by a point in multidimensional phase space, the trajectory will move to nearest attractor surface and then move along it. If industrial design can be fit, with proper scale and energy impacts, into the order of ecosystems, then the whole system could function with minimal disruption

Another property is identity. An ecosystem has an identity as a whole. The ontology of any living system is the history of the maintenance of its identity as a whole through continuous self-making, or autopoesis. If there were no identity, there would be no differences and so no relationships. Ecosystems are part of an unending, imperfect process, without any final state. Furthermore, the human attempt at perfectibility through self-improvement causes disharmony, which is part of the same imperfect process. Each system is a practical application to place. Unknown factors determine a large part of the operation of any system.

Furthermore, there is chaos in every system; there are plagues and random frenzies. Industrial ecological design has to accommodate the uncertainty and imperfection. In grassland, industry has to be part of that grassland.

Diversity is an emergent system property. The environment has been constant enough for organic evolution, but variable enough for natural selection to be challenged. Variability challenges organisms to adjust and thrive. Variability, even in small ways, leads to diversity. Diversity, as a measure of genetic variability in ecosystem, enlarges information. A mature system needs less information, since it works toward preservation. The limit of maturity allows maximum variability between systems with slight external differences, like temperature.

The industry has to enlarge the system, and increase diversity, but help the system stay within the limits of variability to preserve its basic structures and functions. The variation of climate, for instance, an external disturbance, can change the physical and chemical parameters of the forest. Acid rain causes biochemical and soil chemical reactions, which in turn provide in-form-ation to other organisms, which use it to regulate their physiological processes that can affect the forest, e.g., insect damage changes the level of seasonal growth of trees. Damage to trees from pathogens, or disease agents, is an internal disturbance. Industry can produce some disturbance, like any natural phenomenon, but it has to be limited to the stability and resilience of the system. The use of energy has to keep pace with the process of maturation of the system.

The property of Coconstruction suggests that the organism and environment are co-implicative, co-defining, and co-constructing. They engage in a process of self-assembly, where the complete self is the organism-environment system. Construction requires participation, complexity, and development. The process of construction involves a self-presentation offering new symbiotic relations and novelty. Novelty always enters with environmental change, which serves to maintain the openness of the system. Novelty enters with fluctuations. The "strategy" of ecosystem development is increased control of, or homeorhesis with, the physical environment and novelty—probably to protect itself from perturbations. There is a fundamental shift in energy flows, as increasing amounts of energy are used for maintenance. As more and more energy is used for maintenance, the net community production (NCP) approaches zero. The mature system becomes more efficient, as it supports a larger biomass with the same amount of energy. The food chains become more weblike, dominated by detritus chains as opposed to linear grazing. Construction depends on diversity for the reciprocal constraint. Local context allows for more rapid construction. The constraint forces species to change. Industry, when young, resembled pioneer ecosystems—as it matures, and is shaped by ecological design, it may more resemble a more mature system, with less gross productivity and a more scaled and directed productivity that fits within the limits of the ecological framework.

The property of stability is the ability to maintain the identity of a system under the flow of external forces and disturbances. Stability can be refined through the specifics of constancy, resistance, resilience, and accommodation. Stability can be related to ideas of compartmentalization, communications, richness of interactions, and connections. Ulanowicz suggests that stability might be explained by diversity flow topologies, where flow topology is a descriptor of how ecosystems develop. The stability of ecosystems, as originally proposed by Eugene Odum, becomes the result of regular flows of energy and materials. Growth and development are characterized by a qualitative formalism of increasing ascendancy, which explains the drive towards coherence, specialization, and self-containment. Industry cannot kick any of these properties out their topological courses.

Productivity, the final property, is the ability to convert energy into living forms and the ability to incorporate materials into living forms. Productivity, in general, depends on the vigor, or strength or vitality or health, of the system. Health is the overall ability of a system to maintain itself under a normal range of environmental conditions (which may include hurricanes, volcanic eruptions, or fire). Health is a dynamic measure of ecosystem organization, vigor, and resilience. Organization is described by diversity and connectivity; vigor is related to the amount and speed of productivity; and resilience is a measure of reaction to stress. Too much stress, for example, leads to unsustainable patterns of behavior; continuous stress leads to a breakdown of processes that becomes irreversible—the system dies. To relate health to growth and productivity, we could say that the capital of an ecosystem would be its physical environment and its gross primary productivity; interest would be the net ecosystem productivity. Our measurements of productivity, however, are not adequate. We are measuring over a year or two only to establish a growth rate or productivity. We should be measuring over centuries.

The production percentage would be the amount necessary to keep the ecosystem healthy. Obviously, a pioneer community may change the conditions to favor a new level of the system with new components. With a goal of maturity, an industrial ecosystem could furnish some of those new components, as long as they fit into the processes that lead to productivity. This may limit the scale of industry, so that economic scales may become less important than the ecosystems scale, with its limits and long-term changes.

An ecological industrial system would be concerned with the interrelated design of the movement of things and energy, and with the creation of power and waste. If resources stayed in place then the culture in each place could specialize in value-added economics, instead of moving the raw resources around. The system could optimize the scale and style of mass production, so that some needs, such as clothing and transport, could be made efficiently and inexpensively, but to be high-quality and long-lasting (within the constraints of the need for change and fashion). The system would emphasize repair, reuse, and reassembly; in fact, this part of the system could be extended to local shops and crafts people or engineers, which would involve local populations.

Figure 633-1. David Parker makes a dam at Mtn Grove with an excavator

6.7.7. *What About Civilization?*

The real question is whether any civilization that human groups have formed is sustainable. We know that foraging groups (hunter gatherers), and some herding, horticultural and agrarian societies are sustainable, mostly because of their size and limitations. But, we do know if this is or will be true for modern civilization, especially an urban, industrial civilization. Amory Lovins suggests that modern civilization is imperiled by three main problems: The dissolution of civil society, weak support systems, and dwindling public wealth to address problems and suffering. Ignoring these problems could lead to worse violence and terrorism that would further undermine communities and nations. Perhaps the problems are unavoidable and emerge from our commitments to science, growth, and flirtation (commitment) to edges of chaos.

The direction of modern science seems imperative. Francis Bacon thought that we had the power to remake nature for human needs, and that history was moving to a complete human mastery of nature. Many other thinkers state that nature is moving towards a goal, of consciousness or completion. This might be the controlling idea of modern civilization: Progress leads to a perfect heaven on earth. Progress cannot be stopped, and the suffering and bad ideas in its name are tolerable side effects. The atomistic aspect of science concludes that nature is composed of indifferent atoms and selfish genes, and not a holistic structure with integrity. Nature is simple, orderly and predictable; she can be dominated and controlled. Therefore, we can do anything, or try anything we want, and see what happens.

In a similar way, growth has become an imperative, also. Civilization, with population and energy use, has to grow to be efficient and successful. But, growth can affect the extent and kind of problems. Growth can lead to an unsustainable pattern of civilization were over energization and overuse can lead to inappropriate sinks and explosions in ecosystems, starting with human ones.

We can think of the complex of civilization as rational response to climate change; we can think of cities and centralized religions and governments, as responses to drought, in a different way than nomadism. This alternate direction became more complex. Government became important to coordinate larger numbers of people engaged in irrigation of plants and storage of surplus food, to distribute rewards, settle disputes, and defend against aggressive neighbors, whose crops may have failed. Religion became more important as the climate became less predictable, as people looked for ultimate rewards.

The direction of modern civilization is based on myths and fallacies that are not rational or sustainable. For instance, one American myth holds the contradictory views that civilized processes cannot rip the fabric of nature, but if it could, it could repair nature. Another myth is that the US is doing everything it can to help the disadvantaged and poor in its nation as well as around the world—this is ridiculously not so. The poverty of other nations affects any one nation. Ignoring international diplomacy, military decisions to protect the nation are based on the fallacy that military actions will provide security for one nation even if the rest of the nations are unstable. Extremism and violence threats affect every nation eventually. This is more so, when nations are linked in global travel and trade.

After traveling in Italy, as American Ambassador there, G.P. Marsh pointed out that civilizations have collapsed due to ignorance of natural laws. He recognized that climate change could contribute to collapse, as well as that human actions could result in large-scale harm to the environment. At first humans responded to and adapted to environmental changes; then they started changing the environment in all its diversity and dynamics to suit our immediate needs. Sometimes, civilizations collapsed, if the there was imbalance or excess. When earlier civilizations collapsed, however, they were isolated from groups by natural barriers as well as by looser links of trade. The drivers of the collapse were local and maybe regional. In general, groups were self-sufficient. When Maya civilization collapsed, the urban political structures, the people were able to return to simpler forms of foraging or agriculture.

In an interconnected global civilization, massive ecological or social failure in one region might threaten the stability of the entire global system, if people cannot go back to a state of relative isolation and self-reliance. Furthermore, the role of chance or contingent events becomes larger, as droughts, shortages or diseases affect different groups or areas. Geoffrey Chew suggests that the collapse of civilizations is not really a problem for learning, but it is a problem of not learning, as when cultures choose not to learn from past mistakes. Of course, like death, collapse is hard to learn for the dying or collapsing entity—in fact the lesson cannot be learned if the collapse is complete. In order to avoid collapse, a culture has to learn from the past. But, nothing in our past has prepared us for the number and strength of global connections. During any collapse, many cultures have been able to adapt and evolve by expanding into other areas, but this is no longer possible in a completely occupied, territorialized, owned planet.

Every civilization faces a spectrum of risks, which may push the civilization to find new sources of land, food or energy. The need to solve such risks pushes the system further from its original state and can accelerate the operation of the system. Acceleration makes decision-making, especially weighing alternatives, much more difficult. The conjunction of long-term risks can lead to a management or governmental crisis. We have never planned or designed our civilization to respond to impacts and the dynamic changes of the entire planet. We never designed civilization to respond to complex challenges or to slow or invisible catastrophes. Thus, we are not responding to many kinds of catastrophes, and when we do, we only shore up a quick fix, regardless of the regularity of the catastrophe. Sometimes we may not recognize that the catastrophe is an effect of our designs and activities. Sometimes when we do recognize that, we think that we can use the same mindset and approach to correct the problems later, when it might be more economically or politically feasible, yet it rarely is.

Furthermore, we are engaging in several large-scale experiments, which can conceivably impact large areas of or possibly the entire planet. These experiments are not just our civilization, but also our way of growing food, traveling, and converting landscapes. They are experiments on the change in the makeup of the planet, because we select so many different kinds of organisms that we need and we transformed so many ecosystems. Civilization is a large part of that transformation, now. Albert Einstein noted that problems cannot be solved at the same level of awareness that created them. Because the global system creates problems, such as environmental destruction, it cannot solve them by continuing that behavior.

Problems can be solved at a different level, by new type of planetary civilization with different values and social institutions. Many problems are not global, regional or ubiquitous. Change can results from either random mutation or accidental behavior. But, conscious invention can produce new structures with new capabilities. If a global civilization is to form and to survive, it must develop into a completely new type of social system. A blind, consumer society cannot be transformed into a conserver society without constructional change.

Because modern civilization is dynamic and developing, it has the potential to change itself to be more stable and less intrusive. Individuals, groups, and nations have the ability to design social and living systems. We do not require more data or knowledge before we start redesigning systems. Buckminster Fuller said that to change something you have to build a model that makes the existing model obsolete—it is not necessary to fight existing reality.

In this approach, a eutopian strategy needs to dedestruct the destructive impacts of civilization. Maybe we can design a general self-regulating feature to lessen environmental stresses when they become apparent. But, we need to be able to see and understand them first. Another thing that a eutopian strategy can do is to dewesternize civilization. We also need to deglobalize those things that should not be globalized, such as traditional cultures. Perhaps what we need is a form of cultural anarchy that could be coordinated through the United Nations or new framework. Culture is the process that gives meaning to the lives of people who live in the culture—it is not decoration or artifice, it is a body of knowledge that allows people to make sense of the world. We need the eutopian framework also to dehomogenize the world. We tend to be drifting toward a more homogenous world since our weak global culture tends to be bland and generic. Yet, if it wipes out all other cultures, there will be no rivals or successors. Traditional cultures are not failed attempts to be industrial; they are manifestations of the human experience of specific places. They allow us to be aware of our place in this area of the planet.

One serious question is what to do with those nonurban or nonindustrial cultures that choose to continue to be nonurban or nonindustrial. Should we make a park for them? Should we isolate them in some way or have some kind of boundaries that sort the technology that they can use? Maybe the word Park is not the best way the best word, since they are not zoological specimens. Maybe we cannot save them that way, but what we could do is allow them to create the boundaries they want.

Vaclav Havel has suggested that a fundamental shift is needed to change the direction of the current civilization. His deep conviction is that the only option is to enlarge the sphere of the spirit. It may not be enough to invent new machines and new institutions. We must develop a new understanding of existence on earth. Only by making a fundamental shift will we be able to create new models of behavior and new sets of values.

Morris Berman considered that as our civilization matures, we could recognize that visual communicators sometimes manufacture misleading memories, which can be as dangerous as 'hot steel.' One solution is that everyone has to participate in design, to become a designer, perhaps as everyone may have been in a foraging society, where we made everything and built everything ourselves. The future of civilization is our common design project, Berman stated. He suggested that designers have more power than they realize, especially in critical situations, and ours is critical. One great threat to human future is consumption or overconsumption. At the present, design itself fuels mass overconsumption. We could leave a better legacy by using our best ideas immediately, and not rely on copying our chromosomes. We have made many major errors in human civilization, from our agricultural conversion of ecosystems to the production of plastics and synthetics and to our unplanned growth. Human civilization cannot afford major mistakes. We have to try balancing civilization as a local and global phenomenon.

Figure 132-1. Soleri in School of Thought dialogue

6.8. *Designing Education for Design through Education*

Buckminster Fuller stated that an educational revolution, based on synergy, should be the highest priority for civilization. It would start with an inventory of all known principles, using his world game for theoretical exploration. To inventory the resources of the planet, we would convert general accounting systems to a holistic, planetary ecological accounting system, intergenerational and cosmic rather than annual and agricultural. Wealth would be refined from a scarcity model to an energy model. By making ownership onerous, excess property would be eliminated, and we would be liberated from our slavery to 'thingness.' World sovereignties, with their suite of barriers, would be modified. Humans would apply their unique skills as problem solvers by realizing our competence at design science.

David Orr suggested that we need a complete restructuring of the educational process. We need to create a new curriculum in ecological design arts that would combine analytic abilities, ecological knowledge and practical wisdom to fit human activities into the limits of ecological systems. That does not mean that technology could not expand some of those limits, just not ignore them.

6.8.1. *Design as a Special Problem*

Is design a technical problem? Design is not that narrow. Design requires understanding the process as well as the tools and goals. Can design be taught? In schools? By a technical method? The standard way to teach design has three steps: A design problem assigned; students model solution; and, faculty evaluate the model. This approach is good as a thought experiment, which is really important, but it is not complete. The evaluation focuses on the object, not the process or the fitness. It does not ask if it is meaningful or if it fits the local ecology and culture, or if it is socially or ecologically appropriate.

Traditionally, design is taught from master to apprentice or mentor to student. A designer acquires knowledge and technique from practice and imitation. History and principles may be learned at that time. Recently, design started to address specific problems, where students model possible solutions and faculty evaluate their work. The evaluation focuses on the object, not on the process or its fitness. It may address questions of goodness or meaning, but it rarely tries to fit the surrounding culture or ecology.

Maybe if education was a process of always starting over. We need to start over with physics and biology, ecology and anthropology, so that real learning is a chance to start over and redo the way. Start with the environment, the physical and ecological aspects of it. What is a place? We need to explain it and know. How did it come to be, and how is it changing? How do we fit into it and exploit it in a healthy way? Then, include the surrounding habitat. Then, trails and connections.

Instead of pushing designers into narrowing closures of special education, education needs to synthesize fields for an integrated comprehensive anticipatory approach, as Buckminster Fuller urged. Society is becoming larger and more complex while training for designers has narrower focuses. One way to widen design is to encourage play as a strategy.

Play is the method of learning for most juvenile animals and a means of enjoyment for many adult animals. For humans, play is imaginative experience, entered into freely. Much human activity is play, in place in a community. Even science and philosophy are forms of play, attempts to solve the puzzles of existence. Play has a growing importance in learning and information gathering.

6.8.2. *A Design Curriculum*
In suggesting a Comprehensive Anticipatory Design, Buckminster Fuller expanded on what the curriculum would contain. Being a highly technical person, Fuller concentrated on physical sciences and technology, although he did add political geography and ergonomics to his list: Synergetics, General Systems Theory, Theory of Games, Chemistry, Physics, Topology/Projective geometry (the mathematical coordinate system of the universe), Cybernetics, Communication, Meteorology, Geology, Biology, Science of Energy, and Production engineering. And, these would form a good basis for design.

Newer physical theories could be added now, including Chaos theory, Fractal mathematics, catastrophe theory, and complexity theory. And there are more biological theories, also: Island biogeography, conservation biology, ecoforestry, genetics, cognitive science, and ecopsychology. Finally, ecology, with its ecological perspective, and radical ecology, with its form of participation and ethics, would make design more holistic.

But, Fuller also believed that design would arise from the understanding and application of technology, regardless of cultural history, psychology, or social values. This has never proven to be true. Educating in design requires knowledge of artistic wholeness, conviviality, history, heritage history, narrative history, deep history, and cultural history, as well as some of the basic and interdisciplinary fields, starting with philosophy and religion (as how people are bound to place and culture by shared values), and including ecological economics and accounting, humane politics, and aesthetics.

More than information and knowledge, or even understanding, designers need self-discipline, creativity, courage, the ability to learn, and the acceptance of failure, designers need to be able to form and critically assess principles. A design based on principles is easier to understand and replicate. A sample first principle might be to 'contribute to the excitement and promotion of life (actual being). Animals learn through a kind of empirical testing from trial and error—for humans, books are a kind of redundancy of trial and error learning, or as Buckminster Fuller said, 'trial and error error error.' Evolution is trial and error process of learning; all learning contributes to the evolution of a global pattern. Other general principles could include (the first five are adopted from Cowman and Van der Ryn, 1993): (1) Solutions grow from place. Ecological design begins with the intimate knowledge of a particular place. Therefore, it is small-scale and direct, responsive to both local conditions and local people. If we are sensitive to the nuances of place, we can inhabit without destroying. (2) Ecological accounting informs design. Trace the environmental impacts of existing or proposed designs. Use this information to determine the most ecologically sound design possibility. (3) Design with nature: By working with living processes, we respect the needs of all species while meeting our own. Engaging in processes that regenerate rather than deplete, we become more alive. (4) Everyone is a designer. Listen to every voice in the design process. No one is participant only or designer only. Everyone is a participant designer. Honor the special knowledge that each person brings. As people work together to heal their places, they also heal themselves. (5) Make invisible nature visible. Visibility allows the connections to be seen and understood. Following the connections shows how new flows of deigns could fit in natural processes.

And, (6) Act from the bottom, restrain from the top. Act locally in parallel, within the constraints from the top and any blueprint. (7) Cultivate feedback, so things move in circular patterns. Many kinds of negative and positive feedbacks, especially over shorter time scales, can give indications about runaway flows or collapses. (8) Develop rather than grow. Growth brings stability to immature systems, but mature systems stop growing before the scale changes their form or fitness. (9) Use a sideways approach to design, rather than focus on an arbitrary center. This approach often covers the whole thing in its context. Design needs to shift from focusing on objects to regarding flows in systems. (10) Work with errors, which are unavoidable. Sometimes errors point in new directions. Work with and allow disequilibrium. If you structure the system to allow change, it seeks stable flow. And, (11) Pursue the satisfactory (saticficing in H. Simon's words) instead of perfect maximum or even a calculated optimum. Nature and evolution produce satisfactory solutions to challenges. (12) Promote and design for redundancy. The activities of two communicators combine to make the universe of the observer more ordered and redundant. After all, the goal of life is experience, not efficiency; and redundancy promotes experience as well as stability.

In our excitement to design good things for ourselves, we have to be careful not to dispose of a tremendous base of traditional ecological knowledge (and we might avoid movements, like the Bauhaus School, with its slogan of "Start from Zero" with its desire to sweep aside all rules). Relearning is the process of investigating past designs without rejecting them. Strong past designs created a meaningful human order. The modern order of design has to recognize, respect, fit, and work with environmental conditions. Of course, some people use design to try to force the environment to fit human desires or to try to escape from its limits, but designers need to be cautious about displaying too much power.

The path to economic power is through the application of the human mind, according to Toffler, and he urges that "revolutionary" forms of education are necessary. What is more revolutionary than traditional education? Learning about plants, animals, families, and cultures is more relevant than theoretical knowledge; computers and economics can be learned after adolescence. We have more than enough information and secondary knowledge.

We must learn to respond to all kinds of catastrophe, especially those that are slow and constant. Ecological design can learn from cultural history to foresee as many consequences as possible. We need to see a different world emerging, one in which: A sense of quality design is part of children's education; professionals are trained to appreciate the complexity of places; the planning system is used creatively to set frameworks for development; developers know that the effort they put into coming up with a good design will be appreciated; and where bad design is no longer acceptable.

This section has outlined a shift in attitudes, expectations and practices that is already under way. Everyone involved in development can play a part in designing places. Design education has to add a holistic education beyond that of a native culture. Unfortunately, the information students learn often fades away after only a few years—even if they manage to do well on tests. In the past the educational system has switched between depth and breadth. Design education has to balance both, so that deep knowledge is placed in a broad context.

Figure 632-1. Fire station at Mountain Grove forest with classroom above

7.0. Managing Design Levels

Even after heroic designs have been composed and applied, they have to be maintained and managed. Management is a continuous requirement. Management is necessary to keep the designs from being abandoned or subverted. Human settlements can be managed in small-scale ecovillages and communities. Large human settlements, or urban areas need to be managed in watersheds and regions.

The history of human use has resulted in numerous problems, which could overwhelm any attempts at frameworks or designed landscapes. For instance, the continual growth of industrial societies, not just populations, but the entire infrastructures, could overwhelm any design. The historical inequities between cultures, and even within most cultures, unless it is addressed, could tear apart the society before it could improve circumstances with designs. Thus, design has to include such things as poverty and unfairness, bad distributions and human greed. Corporations are examples of situations where legal changes and scale have released an entity from any normal ethical or legal restraints. Corporations have to be limited before designs can be effective.

Many design factors have to be considered, from economics and city shapes to religion and the power of religion to bind people into voluntary limited arrangements. These factors could distort a design, so design must account for them, also.

7.1. *Local Problems: Growth, Inequality, Poverty, Dominance & Slavery*

Growth serves as a mechanism of evolutionary adaptation, by carrying out genetic instructions in the environment; but growth is also conservative and stabilizing rather than innovative and reorganizing. Growth is homeorhetic; in a homeorhetic process, the flow is constant, not a stationary state. Flow processes follow fixed trajectories, called chreods. Growth, from fertilization, embryo states, birth, youth, and maturity, represents a homeorhetic process following more or less fixed chreods, programmed genetically and conditioned environmentally. Chreods seem to be like electron paths, that is, probabilistic. Sometimes, growth can be problematic, when a physical body grows too much flesh or a population keeps growing past the carrying capacity. Other things, such as ideas, and wants have no natural size to exceed, but can cause other kinds of problems at inappropriate scales or locations.

7.1.1. *Growth of Populations & Economies*

Variability in resources and weather, as well as dynamics with other populations, cause changes in a population. As a result of these influences and interactions, a population can grow or shrink or die out. It can stay in place or disperse. Natural growth of a population is related to development and maturity. Population growth occurs when the birthrate exceeds the death rate, or when immigration from other populations exceeds emigration. Under many circumstances growth confers a survival advantage. At some point a population stabilizes. Economic growth can track population growth, although economies can grow with stable populations.

7.1.1.1. Brief History of Human Populations

A population of individuals grows, or overgrows, like a population of cells in a body. And, individuals, like cells, receive signals from the environment that tell them when to die. Unlike cells, however, which rely on chemical signals, these other signals are in the form of food supply, climate, and predators. Some animals try to avoid such signals by moving; some plants try to avoid those signals by growing larger or producing chemical defenses. Human beings have used movement and technology to overcome those signals. And, we have become very good at converting ecosystems to food systems and using technology to control our home environment.

Regarding the success of human population growth, it is possible to relate it to explicit changes in ideas and technology. Agriculture, for instance, sparked an acceleration in population growth. It offered more food in one place. It allowed a sedentary lifestyle, which permitted larger families, especially for increased labor requirements. This increased population density in small areas. And, it triggered a demand for more food to feed more people in a permanent area.

The ideas of storage and urban settlement allowed more people to live together. But, large populations allowed diseases to survive, also, including those that would die if human populations were isolated. Other changes that permitted growth included improvements in sanitation, water and waste flows, and building.

Urban cultures responded to population growth by intensifying resource extraction (which still continues with the green revolution and genetic engineering), by relying on more technology (that can result in overfishing or overharvesting), by integrating support systems, e.g., transportation and banking, by increasing centralization, bureaucracy and stratification, and finally by migrating.

Cities grew and continued trading at larger scales. Early globalization affected populations by introducing diseases from other groups into isolated populations, resulting in catastrophic losses of peoples. This lead to changes in immune systems, also more symbiosis between hosts and agents, and much later, to public health changes like sanitation.

Traditionally, population growth has been a simple issue of the pressure of numbers against resources. However, there are many other factors that contribute to this, such as lifestyles, energy use, waste, and ecosystem conversion. Population is a complex issue, but many pundits try to simply it by saying that if populations continue grow, the economy will do well. That might be true if resources were infinite and ecosystems were invulnerable, but they are not. Others say that the danger is a confrontation between a pessimism and smugness. Neither extreme is a good approach to addressing the limits on or impacts of populations.

Design of populations through planning has to balance migrations, levels of luxuries, needs, inequities, and many other things. International agreements can balance emigrations and immigrations. Some violence erupts from uncontrolled migrations, but this can be ameliorated with the lessening of institutional inequities and the need to migrate. The United Nations control of common areas, especially the entire atmosphere and hydrosphere, can set limits for the unbridled expansion of economics and populations. Finally, a shift in human consciousness, that results from new images of the planet and human destiny, could make these changes agreeable and desired.

7.1.1.2. Growth of Populations

Agriculture, growing crops and raising animals, provided more food, but it was less nutritious and less palatable. By increasing the population, agriculture increased widespread hunger. The reduction in biodiversity by monocropping caused some ecological crises, that resulted in periodic and devastating famines.

Despite famines that caused hundreds of groups to wobble or collapse, the overall human population has kept increasing. The world population is increasing at an alarming rate. By 1900, the rate started to increase steeply. At a rate of increase of two per cent per year—

below the current rate—the earth's human population will reach 50 billion by 2100. By 2280 it would be 1.2 trillion. That is 300 years from now (1980).

Nations that seem to have adequate resources, may be growing too fast. Even the Union of Soviet Socialist Republics, with all its potential agricultural land, and its uncertainties of drought and frost, may be increasing their population too fast, as may Canada and Australia. Population growth can become a political weapon, in a democracy, when two groups coexist, with neither ecological differentiation nor geological separation, and only breeding control for coexistence. For instance, in Sri Lanka, the Sinhalese and the minority Tamils, breed for political control, ignoring population control. Voluntary controls fail; the population increases by almost two and a half percent per year. The problem of population control is a tribal problem, not a racial or economic one. It is a local problem, more than a global one. Even with trade and charity, in most areas population is limited by local resources and local limits; only in a few cases, such as the Netherlands and Hong Kong, can a population be supported by massive ghost acreage elsewhere.

Sir Charles Darwin's view of humanity was that it was not domesticated. Humans were still wild. Unmastered, they have no breeding control; therefore, they will eat to the limits of the natural food supply and press against social and biological limits. The global population explosion, an example of autocatalytic nonlinearity, is not considered a problem for many thinkers, such as Eric Jantsch, who believe that this growth constitutes an essential factor in the creative act of gestalt formation. Growth does lead to intensity at some stages of development in the life of an individual, group or species, but growth can stop, and development can also lead to the kind of creative intensity that is identified by Jantsch and others with mindless growth.

The principles of ecology can offer information on human societies. For instance, the principle of competitive exclusion states that two dissimilar races cannot occupy the same niche in the habitat. If humanity is wild, and not domesticated, this may help explain war and racism. Territoriality is no longer a rule in human ecology, though the instincts may still be operative. Human ecology defies maintaining its population at an optimum level. The young are overproduced and protected; the least fit are not eliminated. Medical science has also increased the number of old and maladapted dependents of society. Problems with populations bristle with social and political implications. A balance in birth and death rates is necessary for ecological stability. We have controlled epidemic death and infant death diseases. We need to correct the overbalance in births. Toughness and ingenuity might be required.

7.1.1.3. Growth of Economics

Although economics is a social science that studies human behavior, it considers itself a positive science, that examines "what is" with theories, as opposed to a normative science, which addresses "what ought to be." Keynesian economic theory, the predominant theory in industrial countries, holds that the full utilization of resources is necessary to ensure full employment and the maximum social good. This economics depends on economic growth to avoid crisis. The major premises assume that: Population will grow, that social good is related to the equitable distribution of material products, and that if resources are limited, technology can erase the limits. The economist Kenneth Boulding referred to this as a cowboy economy, an economy that has yet to bump against real limits.

M.D. Mesarovic and Eduard Pestel stated that "the issue for the economy is not to grow or not to grow; it is how to grow, and for what purpose." They claim that if a workable world system is to emerge, it must be after the establishment of an organic pattern of growth.

Due care is devoted to describing such a pattern and contrasting it with other, tragically inapplicable patterns of growth. Their treatment of the world system itself was regionalized and multileveled. They recommend that the establishment of organic growth was necessary with no need for special no-growth policies for populations or economies. They assume that further industrial growth will continue, that economic growth is good, and that this growth solves human problems as long as it is organic.

Exponential growth is said to be bad, and organic growth is said to be good. In fact, although organic growth is better, there is little difference during a world crisis; both reach asymptotes of suffering. One need only regard the population crashes of lemmings and others to see how organic growth can go wrong. In the organic world, growth is healthy only when the rate of change is decelerative in the long run; cancer and population are constant or accelerative. Mesarovic and Pestle fail to realize that continued economic growth in any form is a threat to the stability of the biosphere.

Economics became enamored of growth during a critical time in history. Rapid European expansion occurred at rates rarely exceeding a growth of one percent per year, and with unparalleled opportunities for expansion into sparsely settled areas, such as North America, Australia, South America, and South Africa. The economy has been growing almost constantly since it has been studied. We have been trying to force it to grow, rather than let it stabilize or contract. Even if it stopped growing, the economy could still develop. Mesarovic and Pestel, as well as many others, confuse growth with development. Mill did not.

7.1.1.4. The Assumptions of Growth

The metaphor for the economy used to be a simple mechanical model for turning resources into products. It was assumed that to be successful, the economy had to grow and turn a profit continually. Unfortunately, the assumptions of the model were also simple and failed to consider human needs and natural cycles, causing great suffering and great disruption. These assumptions resulted in overgrowth, with increases in complexities and costs. Overgrowth contributed to economic and ecological instability (refer to Section 6.6.2. for a longer discussion).

Continued growth of the "free market" is amoral and pathological, benefiting the elite of authoritarian regimes as much as the oligarchs of democratic ones. It refuses to recognize, much less to pay, all of its costs, such as depletion, loss of security—which may be most important—or extinction. The entire system perpetuates mass poverty and justifies it by blaming individuals, but the system itself fails to reduce inequity or poverty. This loss reduces effort; it is responsible for tiredness and low kinds of health, productivity, and esteem, things that are necessary for personal and systemic renewal.

Some theorists, like Paul Samuelson, have concluded that growth is necessary to rid the economy of disparities. The need to grow is intrinsic in this kind of economic system. A large literature has treated perpetual growth as the only conceivable state of affairs. Capitalism depends on growth for stability. In an organic system, however, growth contributes to stability, but it cannot continue beyond maturity, due to real physical and biological limits. Mature organisms grow to maturity, but then they can keep developing without growth during maturity.

7.1.1.5. Economic Growth or Development

Many physical structures, such as talus slopes, grow by addition, until some physical limit, such as gravity or the coefficient of friction, is passed, then they stop growing. Some stability can be gotten from growth in early stages; later stability must result from limits and metabolism. Growth in plants can delay the onset of senility by ridding the plant of waste products in more diluted form. However, too much growth produces a strain on tissues and early decay. In fact, one herbicide promotes excess growth as a means to kill weeds. A biological organism grows to maturity, which is a stopping point for size. The organism continues to develop, however, experiencing and learning the environmental complexities through mating and then to the end of life. Development may include growth at some stages, but development refers to the continued change after growth has stopped. Mechanisms for growth can become pathologies when central authorities meddle in stable lower orders.

Development instead of growth would equalize wealth more efficiently—after all, economies have been growing for at least 400 years and increasing the disparities. There is no necessary association between development and growth in economics, as Daly and others have shown. Growth means increase. A community is forced to accept an upper limit, beyond which it cannot grow any further. Further growth results in destruction or disruption of itself and nature.

There is another distinction between growth and development. The ecological social approach (or a redistributive environmental strategy) to development makes it irrelevant to discuss global limits to growth. Local limits are far more significant to majority of population. Regardless of how much food exists, people will starve unless they can get it. Redistribution of resources and improvement of environmental quality (in the home environment) are more important than increased production by sophisticated technology. The natural capacity of regional photosynthesis must be limiting factor in development, especially in tropical and subtropical areas.

We have economic growth; we can see the numbers. But, the growth is premised on saving costs by forcing down wages, or by reducing the number of workers in the name of efficiency, and forcing overqualified workers into service jobs. The growth promotes inequality, improvement for a few and impoverishment for most. It is the growth of a tumor, issuing a healthy glow from a fever and the false image of health. Profits go up, but public services decline for lack of funds. There is no money for schools, none for libraries or parks, little for private institutions, and little for national, state or local governments. Where did it go? Profits? Profits for individual corporations, profits for individuals? Could we find them, can we track the money? We should be able to, since the management revolution has made paper trails everywhere. Perhaps the trails are too complex.

It has been said that international goals are best realized through national self-interest. This must be the old wisdom. It might have been true, if nations were perfectly rational and knowledgeable; they do not seem to be. Nations now seem to be the handmaidens of corporations, whose interest is only in profits for shareholders. The views of shareholders are notoriously short-sighted. The UN is limited by images and ideals of progress. The UN's solution to economic problems is "sustainable development"—that is, "growth that respects environmental constraints," as if growth respects any constraints. The Bruntland Report indicates a five to ten-fold increase in world industrial output within the next hundred years before population stabilization occurs. While the appeal of growth is unarguable, it is really not likely to be sustainable in any meaning of that word, since sustainable growth does not recognize known ecological limits. Furthermore, the UN has no power to coerce its members when it does make good recommendations.

7.1.2. *Inequality—Economic & Social*

The assumption of inequality is new with agricultural civilization. At the time of Bacon, it was assumed that there was: An absolute, immutable, omnipotent God, everything was sorted into a great chain of being, economic subsistence was preferable, and social inequality was unavoidable. Later, Darwin incorporated a different set of assumptions into his theories: Absolute space-time; atoms as discrete units; economic discrimination, and continued social inequality. These assumptions contributed to the misuse of his theories to justify social and economic conditions at the time.

Many modern political ideologies and economics have been shaped by the principle of endless wealth. Adam Smith once calculated that the real price of anything was just the toil acquiring it. Inequality in a world of abundance could only exist through human suppression and exploitation of other humans. The invalidity of this principle of plenitude came with the recognition of limits.

With surplus, came redistribution and the beginning of inequality. By 4400 YBP in Mesopotamia, there was status differentiation, as evident in the sizes of homes.

Government has become subservient to economic actors, according to John B. Cobb, Jr., partly because the ideology of economics is so positive. It proclaims that continued growth will solve most of the problems of modern civilization, from poverty to conflict, although the promise has not been fulfilled. The problems have increased: From food shortages, housing shortages, and energy shortages, to unemployment, inequality of opportunity or goods, environmental deterioration, increase in weapons, and insecurity.

Growth has been touted as the answer to inequality. We have economic growth; we can see the numbers. But, the growth is premised on saving costs by forcing down wages, or by reducing the number of workers in the name of efficiency, and forcing overqualified workers into service jobs. The growth promotes inequality, improvement for a few and impoverishment for most. It is the growth of a tumor, issuing a healthy glow from a fever and the false image of health.

Economies are out of balance. Modern economies, embracing the idea that "nature is capital," draw on the accumulated "capital" of ecosystems for production. By ignoring the real cost of the capital, as well as the costs of natural services, such as nutrient recycling, soil building, and atmospheric renewal, these economics create a temporary wealth—similar to the healthy flush of a fever, perhaps—and a long-term imbalance. When an economy falls out of balance with its local environment, massive disruption often results; industrial economies have only avoided disruption by trading advantageously with other economies, by using fossil fuels, and by promoting general institutional inequality.

The economic government, according to Robert Reich, creates a corporate hierarchy, with pervasive inequality between all levels, rather than a democracy. To keep profit growing under any circumstances, corporations have been willing to accept damage and conflict.

Nations are basically exploitative of other nations and smaller cultural groups, which may not be considered nations because they lack a permanent military: The United States concentrates on Latin America; Europe on Africa; Japan over Southeast Asia; Russia over Eastern Europe; and China over Tibet. The reasons for this continued behavior include: The rapaciousness of society; the acceptance of war; and the economic advantages of large-scale operations. The cultures of industrial nations are based on unethical accumulations of materials. Inequality is maintained by power, not persuasion, and also by the assumption that solutions are extrinsic and external and have to be found by spreading out rather than intensifying efforts to find solutions at home.

The predominant value in small cultures, and then large, was harmony. This minimized conflict that might have resulted from inequality. Confucian concepts of ritual and etiquette helped to regulate social conduct and made people feel good about their station. For example: "Inequality is the nature of things" and "seek no happiness that does not pertain to your lot in life." This may not work at the scale of nations and global corporations.

7.1.2.1. Distribution of Wealth

In almost every size of human groups status is divided unequally. In hunting groups, better hunters become the hunting leaders. The success of a hunter allows the hunter to distribute the cuts of the game between others, often according to an understood set of rules. In larger groups, with a surplus of materials, the materials are distributed according to status. People have equal access to status positions in society. The number of positions of prestige is adjusted to the qualified candidates. Status is separate from wealth. An animal divided up according to ratios regardless of who kills it.

J. S. Mill narrowed the scope of economics to production and the scarcity of means; he considered distribution to be a political process, since it depended on laws and customs that varied widely in different cultures and ages. One function of culture is to distribute material goods or energy. Economic culture defines the means of production and livelihood, techniques of distribution, and values and norms underlying economic behavior (can be more closely related to kinship. Order is a cultural problem. Order provides stability and security. Cultural order is necessary to deal with the redistribution of wealth and power.

With the creation of more wealth or new wealth, the distribution becomes skewed. Accumulation increases. More kinds of wealth become invented, dangerous, and useless, and more skewed. But, as long as an economy does not reach the limits of wealth, it can keep growing; these new kinds of wealth allow that. Cultures encourage the unequal distribution of resources.

Wealth is based on production in capitalist countries. The production of wealth from growth depends on technology. The technological perspective is oriented toward materials and not humans or ecosystems. Nature is considered to be a resource to be exploited. The immediate objective of technology is to create wealth through knowledge. Technological activities are justified on humanitarian grounds, scientific discovery increases the well-being of human society, yet the social consequences of scientific activity are ignored; short-term suffering will be offset by long-term benefits, it is claimed. But, without a long-term view, long-term benefits will be worse.

7.1.2.2. From Difference to Inequity

Inequality is more the result of differential development than of exploitation. According to Boulding the greatest source of the differential is different rates of accumulation of knowledge, capital and organization; the rates are essentially internal properties of cultures. Although a minor element in terms of transfers, it is a large psychological perception, which may need to be compensated for in a global community.

Most of the wealth used by modern economies is nonrenewable. These resources are limited, interrelated and distributed unevenly. Forests are a special problem; although trees can grow to a good size in 30-40 years, forest ecosystems may take 300-600 years to develop and then last for thousands of years. Oil, coal, peat, and some woods are functionally nonrenewable. Geological time periods are required to produce them.

The distribution of symbolic and real wealth is very inequitable as the result of historical trends, old economic rules, and cultural confusion. Karl Marx considered that misery is caused by class conflict about distribution of material things. Some of the problems of distribution have to do with the size of society and the scale of its operations. For instance, in Hutterite communities, usually less than 150 people, the distribution of goods rarely failed; people got their share, rarely less or more. With a larger group of Hutterites, the distribution started to fail, and the group divided.

The modern market distributes some benefits to all, but its scale allows unfairness. Economics are the harmonious distribution of wealth among people. But, problems outside small-cell scales. Kohr points out that Marx failed to link misery to the scale of economics rather than the system. The problem is with overgrowth more than style, which is why socialism based on overgrowth looks the same as capitalism overgrown.

7.1.3. *Poverty & Consumption*

Poverty can be defined as a lack of needs, such as food and clothing. Affluence and inequity seem to be producing new forms of poverty, such as lack of use (use-value of feet in Los Angeles) or the potential poverty of not having what is possible elsewhere in NY or Paris. Modernizing needs creates these new dimensions of poverty, and this leads to new discrimination. A violent cargo cult that seizes traditional cultures. The opposite of this is new forms of wealth, such as useless wealth or harmful wealth that actively subtracts from the enjoyment of life.

Ecological analysis would force us to look at the obvious—generating nonmarketable use values occupies the center of every culture because it provides a satisfactory life to its members. Needs are almost completely defined in terms of commodities. Even relation needs a commodity, travel, to be fulfilled. Once the need is defined and partly satisfied, it becomes a right. From walking to the right for passenger miles at high speed in a mere fifty years. Stung by the suffering of people with new unsatisfiable needs, we have offered to produce more, safer goods. Instead of ecologically analyzing the relationships of needs to satisfactions.

Consumption is touted as the solution to poverty. We all live, thanks to modern advertising, in a dream world of mass consumption. The purpose of expositions changed gradually from instruction in wonder to simple entertainment and buying. The Crystal palace in 1849 shows the former and the 1855 Exposition in Paris, the latter, where they put price tags on things and charged admission. The first department store opened in 1853; this changed the tone of shopping from haggling to inspecting a fixed price item.

Consumers are trained to enjoy waste, violent speeds, harsh medical treatments to extend life, and standard rations (mcRations?). The state has to try to discourage the lack of patriotism that comes from deserting from the standard needs diet. The military is actually a symptom of the orientation of the state. Health and education use a military rationale. Industrial society is constantly mobilized for emergencies, in the battles against, noneducation, poverty, diseases, terrorism. Industrial development has never been nonviolent or respectful to people.

Specialists incapacitate people's autonomy by forcing them to become consumers of care, instead of learning to care for themselves. Half of our needs are made by armed bureaucracies that have been growing since Louis IVth Empire. Industrial services see state security the generator of society's production patterns, even if it is a spin-off of military needs.

7.1.4. *Cultural Dominance: Colonialization*

Dominance is a social phenomenon that describes social relationships. Dominance in animals is related to a social hierarchy that allows the dominant animal to feed first. Dominance in plants is often related to mere numbers or the ability to grow faster and reach the light first to spread more leaves to catch light. Dominance is humans is more complex. Like wolves, human beings interact with the individuals of other species or with entire species. Like other mammals, humans change their habitats to suit themselves. Humans have modified animal and plant associations in a different way from other mammals, simplifying patterns of energy and chemical exchange and solidifying themselves at the end of many food chains as a dominant species. A dominant is a species with greater influence than any other in its biotic community, changing the lives of other species and the character of the habitat.

Human populations have increased exponentially, with billions in giant urban ecosystems. Agriculture has produced monumental yields, but only at the cost of tremendous erosion and great subsidies of fertilizers and pesticides. Dams have been built all along rivers, and riverine forests have been cut, altering rivers and fishing grounds. Changes have been made without regard to the long-term impact on the ecosystem or on its human population. We dominate entire ecosystems, starting with our own species.

7.1.4.1. Cultural Status

Like many mammals, human beings create social hierarchies, which allows some individuals to get more food and better mates. Status is also assigned according to the hierarchy. Although, in primates, the largest, fastest and usually younger males often dominate, old males can sometimes dominate with the help or permission of females who may prefer an old predictable leader to a young unpredictable one. Status has to do with standing in human society, and with appearance and ownership. Status may come from longevity, of the self or ancestors, as well as from the results of good decisions, from hunting for example, or from owning more than others, or just more things or more people. Status is a powerful human need, and may drive the growth of goods or populations. Perhaps related to population growth and size, changes in cultural status become related to equity, distribution, and dominance. As distribution becomes more unequal and as conflict occurs more between groups, dominance and slavery appear, and are both related to status.

Darwin has been criticized by Malthus for extending the popular theory of economics to the natural world. It is true that the biological considerations of economics inspired an economic description of a biological law, but Darwin enlarged and supported the metaphor. He retained the idea of hierarchy, but status became a form of fitness, specifically in birds and mammals. It can be argued that status has fitness values in human groups also. For instance, a woman is more likely to mate with a man who has higher status in the community.

Status is a social need, which is justified by a culture. Status levels in traditional society included: Nobles, commoners, and slaves. Slaves were captured or purchased. In earlier days, people were sometimes captured by enemy tribes. The return home of the captives, either through payment of ransom or owing to a retaliatory raid, was a special return. Like other property, slaves were given away as gifts. Occasionally, they were killed and eaten, for instance during the Kwakwaka'wakw cannibal dance. A commoner was simply anyone without a chief's position, potlatch position, seat, or standing place. They are not a class with a function. At times, nobles may retire from potlatch positions and become commoners. Kinship was the main determinant of status. For the Kwakiutl, the display of status validated the social system. The redistribution of food validated the cultural status of the leader.

Inequalities of status and wealth became associated with permanent settlements.

Furthermore, other social things developed such as complex division of labor, with castes and slave labor. Trade increased and competition increased. This may have had to do with resources that were abundant and could be stored, and transformed into political prestige and power. Agriculture provides more status, more wives, and more things. It allows armed struggle also. Art, in addition to luxuries and profits, was tied to status.

7.1.4.1.1. Equity & Distribution—Having More

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Inequality is more the result of differential development than of exploitation. According to K. Boulding, the greatest source of the differential is different rates of accumulation of knowledge, capital and organization; the rates are essentially internal properties of cultures. Although a minor element in terms of transfers, it is a large psychological perception, which may need to be compensated for in a global community.

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The modern market distributes some benefits to all, but its scale allows unfairness. Economics are the harmonious distribution of wealth among people. But, problems outside small-cell scales. L. Kohr points out that Marx failed to link misery to the scale of economics rather than the system. The problem is with overgrowth more than style, which is why socialism based on overgrowth looks the same as capitalism overgrown. The change in scale drove the changes, from the transition of states, from surplus distributors, to tribute-driven to commercial exchanges. There were political transitions from leaders, to chiefs, to tribute systems, and to economic and political trade systems.

7.1.4.1.2. Dominance

Strength or status can give rise to dominance. A dominant is an animal or person with greater influence in the community. Dominant behavior may be biologically-based or cultural. Dominance gives priority of access to food, sex, or space. In a majority of primates, males are not dominant over females, except where there is a large size difference. Where sizes are roughly the same and where female coalitions occur, there is not much sexual dominance. In some human groups, males may attempt to dominate females with the threat of physical violence, for instance, among the Yanomamo. Among other Amazon peoples, such as Mundurucu, it may be due to control of ritual objects and rituals, for dominating ceremonial life. In spite of the cultural forces dominant at any moment, an individual has the potential to determine a different course of action.

7.1.4.2. Colonialism

What is colonialism? Who does it, who benefits? The history of colonialism. The Phoenicians sent out colonists to found Carthage. Settlers from Carthage founded Barcelona. The Greeks made colonies in Italy, Sicily, Turkey, Libya, and Spain. Norway sent people to Iceland and Greenland, France, and Ireland. India sent colonists to Sumatra, Borneo and Java. The Inca moved villagers to Ecuador from Bolivia. Southern Indians called Tamils, crossed over to Ceylon, which was occupied by the Sinhalese. And, of course the Europeans tried to control all of their global trading by controlling the people and the resources in Africa, the Americas, Asia and the pacific.

Colonial countries introduced new ethnic rivalries wherever they took over. English imported native people from India to work sugarcane fields. By 1970, half the Fijans were Indians. Fijans tended to eat strangers and castaways, sometimes enemies from raids (and some recipes were the same as for pigs). But, only men could eat human flesh because of the strong manna.

In Tasmania, aboriginal people had woolly hair rather than curly, were shorter, had brown skin rather than the matte-black of the continental Aborigines. In technology, they had digging sticks and spears, but not boomerangs or woomera (atlatl). They understood curating fire, but could not start it. Their 12,000 year separation for any other people or culture is the longest for any people, even Rapa Nui. The English wanted to create or recreate a European world, without savages. The native peoples did not fit. All of Tasmania was first made into a prison; all the native people killed off. The culture was destroyed. The environment was destroyed. The English were not tolerant of dissent, variety or diversity. Neither seems to be the modern civilization.

The Kuna women of the San Blas islands north of Panama, wear clothing with appliquéd materials in geometric designs with real and mythical beasts and random words or letters copied from travelers. Now popular with tourists. The Kuna, who were never conquered or subdued, even now must require ships to pay homage to the chief, aboard the ship, in terms of meal or gifts. The Kuna build simple, large houses and cultivate bananas, breadfruit and calabash trees. They are the only people visited by Columbus who are still alive and living on their islands. Others were displaced or killed.

Colonial administration required central government and strong armies. The Ottoman expansion into Europe annexed one food-producing region after another. Sustainable intensive farming was abandoned as colonialism gained. There is a direct connection between colonialism and the abandonment of land, having to do with urban immigration or slavery.

7.1.5. *Cultural Dominance: Slavery*

To be enslaved means to be owned as property and divested of freedom and rights, or it means to be completely dominated. The word slave comes from the old Slavic word for the Slavic people, who were among the first slaves to be held in Europe.

Slavery is the idea that people can be held in bondage to perform work. The Greeks thought that freedom depended on some slavery. Some societies thought that their economies depended on slavery. It was actually thought that slavery improved the lives of slaves, since they were often considered to be from subhuman groups. It was also thought that it was a personal decision or personal right, although the slave might feel differently. There are of course, different kinds of slavery now. For humans, there are living slaves, but future generations might become enslaved to the decisions of their parents, especially as regards losses and debts. Animals have been enslaved. Machine slaves were the next economic boost. Finally, industrial societies have energy slaves, ten to twenty for each person. Slavery is based on a number of assumptions, such as contempt for the enslaved, or denial that there is wrong.

Different kinds of slavery can be distinguished: Opportunistic, institutional, or comprehensive. Opportunistic slavery was the result of raids or conflicts with other bands in archaic societies. Institutional slavery included labor force collection, as practiced in Egypt in 4500 YBP, or economic slavery for labor collection, as run by the British 300 years ago. Comprehensive slavery refers to the use of wage earners, animals, and energy.

7.1.5.1. Opportunistic Slavery

Many archaic cultures had slaves, who were usually the victims of conflicts between bands. In Nez Perce gatherings and celebrations, slaves were exchanged, along with furs, roots, berries, and fish. Slaves could often intermarry with their captors and acquire status; their children were almost always free. Slaves became a separate social class in some archaic societies. By 5000 YBP a stratified class society had developed in places like China—slaves at the bottom, then peasant farmers, craftsmen, then the elites of administrators, religious and military. In Assyria, slaves could not wear veils. Slaves worked everywhere in Assyrian society, for instance, even running businesses. Some people entered slavery voluntarily to pay off a debt.

7.1.5.2. Institutional Slavery

For the Tukano of Peru, the Maku group was a slave class, that is, a source of slaves. The Kwakwaka'wakw also had slaves, who were captured or purchased. Like other property, slaves were given away as gifts. Usually, they were captives kept near the door to guard the house. Occasionally, they were killed and eaten during the cannibal dance. Viking raiders and colonists owned their own land and used Irish slaves for work and for wives specifically (based on genetic evidence). As the number of slaves diminished through death or marriage, some farmers lost their land to absentee landlords, who, without ecological or personal feedback, would make poor decisions about crops and practices.

Economic slavery occurred in Mesopotamia, Slaves worked in all levels. Many were prisoners of war; some were criminals being punished; some entered slavery to pay off a debt. But, slaves could also own a business. If a slave married a free person, their children would be free. Slavery became specialized with agriculture, in China and Egypt.

In China, by 1615, slavery was hereditary, for agricultural or household slaves. Slaves reflected the stratification of society as it became more complex. Slaves in the Americas were considered to be needed because the amount of acreage increased with the discovery of new lands; the acreage and the slaves were considered necessary to develop more wealth. Slavery kept labor artificially cheap. This dampened the incentive to develop new technologies, but, new technologies eventually surfaced because they proved to be cheaper than slaves.

The appearance of mechanical devices such as the sugar mill and Eli Whitney's cotton gin helped to support the system of large plantations based on a single crop. The Industrial

Revolution after the late eighteenth century swelled the population of towns and cities and increasingly forced agriculture into greater integration with general economic and financial patterns.

Internal slavery was a feature of Europe from the Romans to Middle Ages, but disappeared when feudalism disappeared, and labor was no longer the scarce factor in production. With the opening of America, however, land opened up—or rather was claimed and conquered—faster than it could be filled with European people. Therefore, colonists tried to force native Americans into labor. Native Americans, however, were still dying from European diseases, which made them unsatisfactory as slaves. Europeans looked to another tropical continent, Africa, where the people were resistant to old World diseases. Less than thirteen years after Columbus, in 1505, African slaves were introduced into Haiti. Over 350 years, ten million more people were brought over, in a large trans-Atlantic trading circuit that involved rum, sugar, cloth, and timber as well.

In the American colonies, the independent, more or less self-sufficient family farm became the norm in the North, while the plantation, using slave labor, was dominant, although not universal, in the South. With the British, Americans, Africans, and Spanish, slaves became a commodity in a trading empire.

7.1.5.3. Comprehensive Slavery

After the enslavement of peoples, some dominant cultures turned to the enslavement of nature and then of energy. The English treated tropical lands as enemies to be defeated, then enslaved them in plantations. Their cultural attitude as conqueror of nature led them to treat biogeochemical cycles and soil requirements as temporary obstacles in a world where everything had its price.

The new economics of the industrial age depends on wage slaves, that is, people who need jobs to get necessities in urban areas. An overeducated labor pool led to secretaries and then managers, and to the fulfillment of the managerial revolution. Now, industrial society is able to use energy slaves to accomplish work. Energy, in human work equivalents, from animals, natural and fossil fuels, is used to perform work.

The concept of slavery need not be limited to plants, animals or humans. If we consider our machines as "energy slaves," then Americans each use the equivalent of fifty slaves per day. The computer is an information slave and must be the equivalent of at least three other human slaves. Slave owners love the privilege. And the exploitation of inanimate slaves is more easily justified. In fact, to some extent, the culture of arts and sciences may not be possible without machine slaves. But, at some point, slavery corrupts the owners, making them physically or mentally soft. What is the exchange for summoning these information slaves so easily? The failure to develop intellectual ingenuity? Loss of imagination? Lack of trust in intuition? Let us consider an earlier exosomatic adaptation that helped humanity. Knives permitted hunting larger game animals or deeper roots, but the long-term anatomical result was partial degeneration of the human jaw. Garrett Hardin notes that all exosomatic adaptations bring about "a corresponding degeneration in the endosomatic function," i.e., knives change the function of teeth. The species is then more vulnerable to accidents, since external adaptations, like pacemakers or artificial kidneys, become required for the health and maintenance of civilization. Perhaps writing has changed the function of human memory. Perhaps computers will change the structure of thought and maybe reflective consciousness.

7.1.5.4. A Question of Consciousness

The institutions of slavery raise questions about our relations to each other and to nature. What is our human relation to reality—slave, master, participant, or partner? Cosmology describes the place of a culture in reality. Cultures can determine inappropriate attitudes towards nature and that can result in ruin for the air and land. The worldviews of many people defined other people as nonhumans, who could therefore be improved by being allowed to work for true humans.

Although slavery is officially condemned in virtually every nation, the inappropriate use of people, animals, machines and energy continues, as a necessary part of the agricultural and industrial economies. And, it will continue to be until there is a shift in consciousness that would let us consider the ethical implications of our uses of everything and everyone, especially how these uses perpetuate patterns of domination and inequity, as well as contribute to the degradation of ecosystems and geocycles.

The ideas of dominance and slavery have been integrated into many kinds of designs, from the design of housing and chains to clothing, roads and auditoriums. Changing some of the traditional designs may reduce feelings of inequity and perhaps the actual inequity.

Religion could help control disruptive forces, especially those that result from distribution and power. Religion coerces people into a social contract. Religion and story-telling reduce the variability of individuals wants in a group. The introduction of new stories and myths, concerned with partnership and equality and with the value of other places, species and people, could change our attitudes about them into a healthier context.

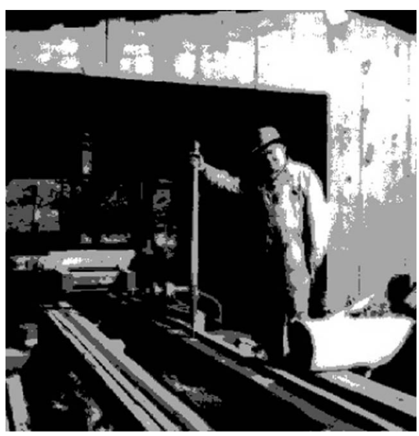


Figure 46-1. Jacob Hagen Loading logs at the Altazor Mill 1984.

7.2. *Local Solutions: Avoiding Adaptations & Traps*

Human groups have adapted to their environments, have changed them and have been changed by them. Some human groups were trapped by their environments and could not change. Sometimes the adaptations themselves can act as traps that limit human behavior. Perhaps education can be designed to afford understanding of adaptations and traps.

7.2.1. *Adaptation & Drift*

Rene Dubos suggested that humans can adapt to anything. Humans adapt rather than plan. Are we genetically hard-coded to do that? Overpopulation is adaptation to an uncertain environment (or is it an expression of expansion of all life?). Agriculture is adaptation to diminishing game and slow overpopulation; it is stable source of lower quality, lower diversity food. Irrigation is an adaptation to growing exotic crops under low moisture conditions. Permanent settlement is an adaptation to more abundant local food supplies. Large buildings and cities are an adaptation to permanence, slow overpopulation and uncertain environmental conditions, such as droughts. Coal is an adaptation to overuse of wood, oil to overuse of coal. Forest over cutting is an adaptation to environment and increased demands for houses and glass, but it changed the environment and made it more variable. Ecoforestry and conservation biology are adaptations to the overuse of ecosystems.

Our genetic make-up predisposes us to some things and pushes us in some directions. It makes limits on our plasticity. It could promote behaviors that damage the environment, and hence our long-term interests. If limited by stone-age genes, then some pro-gene behaviors may be ineffective, others effective. For example: We must have contact with natural environments where we evolved or suffer psychological and physical harm. Behavior is determined by immediate personal consequences (short-term egoism), regardless of its consequences in modern world.

Places that have been successful for a long time, or that are likely to continue to be successful, may well have another quality, which may not be immediately apparent—the places adapt easily to changing circumstances. Finally, places that are successful in the long term, and which contribute to the wider quality of life, will prove to make good use of scarce resources. They are sustainable.

Adaptation is a response to changes in the environment and the evolution of organisms. There seems to be no direction in evolution other than to live with a changing environment; genes become plans on how to live from experience; drift is selected to fit an environment that is evolving. The planet as a whole inclusive of many subsystems regulates the stability of the climate and environment. Plant diseases, plagues, floods, volcanoes cannot occur too often, or nature could not purify air and water or reseed devastated areas.

Evolution is an integrated process, partly open-ended, involving choices, and the selection of whole individuals in whole environments. The cost of evolution by selection is so heavy that most of the time most populations are not perfectly adapted to changing environment. For the evolutionary process, Varela suggests the metaphor of "bricolage," which is the putting together of parts in complicated arrays because they are possible (rather than an ideal design). He calls his alternative view evolution by natural drift.

Change is inevitable and we have to adapt to it, but we must make sure that we do not adapt to a low-level style of living, to drifting lower standards and performance, as Donella Meadows warns. We must not try to adapt, for instance, to an impoverished world without wilderness that we could preserve or keep separate. Some human systems get worse, that is, they drift to low performance. Rivers get dirtier, hospital service gets worse. Rather than adapt to these conditions, humans need to create goals and plans to avoid the drift to low performance. Similarly, our many individual enhancements to the human body, especially mechanical replacements of organs, without consideration of changed interactions or consequences may result in what William Thackera calls 'Borg drift' (from the word cyborg). Drift is a systems trap.

7.2.2. *Drifts & Traps*

Meadows calls the systems structures that produce common patterns of problematic behavior 'archetypes.' These archetypes are traps. A trap is a device for catching or holding animals (from the old English word 'to step'); it can also mean a stratagem for catching people. Many things can act as traps; many situations can act as traps. Other systems traps include: Addiction, policy resistance, arms races, and the tragedy of commons.

There are energy traps for instance. Agriculture traps energy for people, but it also an energy trap of people, because it allows a concentration of energy, that is, higher yields, but then it requires more energy be put into the system to maintain it. The system has to produce more energy than it uses to be useful. And be sustainable, with a surplus for trade. The use of energy in general creates an entropy trap, since most of the energy (84%) is wasted, and it creates disorder in the surrounding system, making it harder to get more energy.

Agriculture could be considered a population trap, also. Not being limited by having to move or carry children, also, being sedentary, farmers had more kids. More kids required more food, which could be provided by agriculture. But, because of the surplus, farmers could out-compete foragers on a smaller territory, so if agriculture collapsed they could not go back to foraging. Perhaps the trap was also a material trap. Things required storage or transportation. Storage was cheaper and easier.

There are serial traps, also. An example of a serial trap is the use of resources by a people, where the replenishment rate is constant, and the rate of use exceeds it. This trap results in ecosystem degradation that may be irreversible. Industrial strategies sometimes mistake the rate of discovery for the rate of recovery. The two are different.

The rate of population growth can act as a trap, and the shape of population pyramids can act so, since it can change the reproduction rate dramatically. There is nothing to constrain humans in their growth. We could even adapt to too many humans and too much suffering, perhaps through abstraction and art. But, art could also be survival technique. That is, it undermines the paradigm by showing the invisible effects of adaptation.

Design in west suffers from easy living and convenience, suggests Victor Papanek. He states that convenience is the enemy of excellence, fashion the enemy of integrity, and cuteness the enemy of beauty. Convenience is a trap. Can the new object, advertised as more convenient, do something more, in a cheaper cost? Is it more desirable and environmentally friendly? Papanek suggest that there are ways to question technological improvements that can lead to convenience traps: It is too small, like watches with a television screen? Is it too powerful for what it is, such as certain power tools or knife sharpeners? The fact that there are too many of them may indicate a trap—televisions, radios, and stereos. It is too much to fit with our other things. It is too complex to operate or repair, with too many buttons, switches, and options. It has been improved too much, with idiot lights and time-zone maps. It is 'state of the art,' but untested. And, finally, the package may be as or more valuable than the product, if appearance or newness is the primary selling point. We are trapped in the production-consumption-discard cycle. Conservation was a convenience during good economic times, but no one wants to really be inconvenienced. We recognize the damage, but do not want to sacrifice yet. Thus, the slaves are bought off for a fix. Ironically, our wasteful habits may force discipline on developing nations.

Language and art are also traps. Language because one is limited by words. Art because one is limited by styles or demand. If art is articulate, it may use silence; but if art eliminated all "speaking," does it not trap itself in a dumb stasis? Does it not reduce it self to one dimension? Silence is not enough to communicate. Science can act as a trap, when its logical structure limits approaches to nonhuman phenomena.

Culture can be a tool, an external set of memories and guides, but it can also function as a trap. The human culture that allowed humans to survive rapidly changing environments seems to create crises during more benign climates. In small scales, culture can be very flexible. But, with changes in scale, culture can be very inflexible and wrongheaded. Although culture is loose enough to incorporate medium-sized changes, such as automobiles, it may still be rigid enough to act as a self-perpetuating, inflexible monster when dealing with large challenges. Traditions, especially those reinforcing identity, can force people to keep to old ways that are inappropriate in new situations. For instance, the Vikings in Greenland tried to maintain a style that involved raising grasses for cows in a cooling climate, with disastrous results; they refused to learn from the Inuit style that was effective under those conditions. Culture can be a mental trap that limits choices and actions. People may become fixed in permanent roles and personalities. Even if cultural attitudes are appropriate, they can trap a people if there are no longer functional reasons for the practices. The Nembi of Papua New Guinea may be trapped in their system; making stone axes is difficult, when thousands of steel ones are available. There are other cultural traps, such as slavery, alcohol or drugs.

Humans developed as generalists, using creativity and flexibility to cope with unstable conditions following the glacial climate of the last ice age. If the future returns to the climatic variability of earlier interglacial times, this variability would impose difficult conditions on agriculture and cities, which developed in the relatively mild past 5,000 years. The most recent trends to interdependence, just-in-time supplies, and globalization are not adaptive to any instability in the system.

Global capitalism undermines traditional cultures by offering consumerism in the place of guides for behavior. Social roles seem irrelevant by comparison, if the good life can be bought without effort. Yet, it does not seem to be working in Europe and the US. Instead of being free from economic want to develop their potential as creative human beings, people are trapped in a consumer cycle. Self-actualization is postponed for self-gratification.

Capitalism is as massively adaptable as other human behaviors. Instead of being chastised for its weaknesses, it has incorporated the criticism into its advertising program. Protesters are shown drinking Pepsi. Aborigines are shown drinking Coke. The computer revolution, once thought to become the backbone of creative anarchy, is absorbed into corporate service. People become addicted to new commodities.

Addiction is a trap, since it requires higher rates to appease the need. Addiction can appear in human social systems as well, such as dependence on government subsidies or reliance on chemical fertilizers to improve crop yields. Cheating is a trap, that is avoiding the rules for personal or social gain. We are changing conditions so fast that new adaptation is necessary to fit into conditions we cause through growth and adaptability. What is the solution? Plan or adapt?

Violence might work. War has been a way to get out of traps. War can also destroy filters. But, there are other ways to change filters—by perception or thought. War can destroy cultures and ecosystems, so it may be too destructive to work as a solution.

Growth is a way to get out of some traps, but sometimes it leads to a larger trap.

Meadows notes that because of the reinforcing positive feedback loop in the market, or 'success' to the successful, for example, US automakers were reduced to third place. This is a trap also, It can be broken, in species as well as corporations, by diversifying—and how does one diversify? Find the differences in the environment through education, specifically through ecolacy. Another way is to legally level the playing field with antitrust laws. One solution to growth is mature development within limits of age and size.

Traps can be escaped by reformulating goals, or by weakening or straightening feedback loops, by adding new feedback loops, or by recognizing them or altering the structures. The way out of the trap of escalation is to avoid getting in it, refuse to compete, negotiate, or interrupt. This is where education can offer alternatives, through the filters of numeracy and literacy. The solution to cheating is to redesign rules in a direction to achieve the original purpose of the rules. In fact, design and redesign are ways to remove traps.

7.2.3. *Simple Synergetics in Practice* (Taking up the Past)

We can work toward developing synergistic linkages between the biophysical and the cultural. We need to link the best practices in synergistic ways that support social networking and the emergence of new structures. After all, we always have enough money to finance wars and buy luxuries, even if we lack enough feed the hungry or preserve rare species. Perhaps that is because of the promise of war or the necessity of luxuries.

Feedback is usually bipolar—that is, positive and negative—in natural environments, which furnish synergic and antagonistic responses to the output of any system. Positive and negative feedback are called 'closed systems' because the system is closed by the feedback loop; without such a loop, it would become an open system. By contrast, a feed-forward system is an 'open system' since it does not have any feedback loop—because it gets no information from the future, and does not rely on feedback signal to perform its function. Bipolar feedback is present in many natural and human systems.

Feedback is information directed back into system that causes a change. If there is too much positive feedback, then the system can overshoot an equilibrium. The concept of overshoot allows human consumption to increase at the same time that ecological capacity is shrinking. There is no contradiction. Both are happen.

There is no direct, immediate feedback to counter or correct overshoot. The wastes become global, that is CO_2 can leave auto exhausts despite the concentration in the atmosphere. There is feedback, but it is delayed for a long time by the size, flexibility and redundancy of the system. Meadows notes that a person who makes a decision based on feedback cannot change the behavior of the system that drove that feedback. Decisions only affect future behavior. There will always be delays, since nothing can react instantaneously.

In societies where nonaggression is conspicuous, an individual serves her own advantage as well as that of the group with the same act. Ruth Benedict used the term high synergy to describe such secure societies. The institution insures mutual advantage; the acts are mutually reinforcing. High synergy institutions transcend the polarities of selfishness and altruism. Virtue pays because the rewards for selfishness coincide with benefit for the society. The social structure of low synergy cultures insures opposition and counteraction; the advantage of one individual is a victory over another, as in a zero-sum game. Wealth may be distributed or concentrated, depending on factors, such as synergy, generosity, reciprocity, and cooperation.

7.2.4. *Emergency Designing: Starting with Urgent Needs*

What emergencies? Species and ecological communities are dying out. Millions of humans are ill, unemployed or homeless. Industrial civilization seems to be on a path to collapse. In the case of industrial nations, we have been embracing excess for many generations, so that we are crippled by stress and sickness. Is there an emergency? Certainly there is if you consider the extinction of species, a thousand-times higher than background, or the premature deaths of millions of people every years. Certainly if we consider our civilized debt-loads and how little food and fuel reserves we have, or if you look at the natural devastations from natural events and poorly planned wars. It is an emergency. Animal and bird populations have decreased 50-90 percent in the past fifty years. What if that was the human population, the GNP or Walmart income? Would that be an emergency? People are starving to death, possibly 50-60 million per year. Is that an emergency? And, it is a global emergency, caused by an emerging global system of industrial capitalism that is being adopted by most of the major cultures. Unfortunately the goals of the system are growth and profit, at the expense of the health of natural and human systems.

How should we act? Should we declare war on other people or on the environment or the planet? Usually the goal of a war is to destroy soldiers, civilians, towns, fields, resources, or all of those. Wars are more than battles and destruction of course. Mobilizing for war usually gives more power to the government, to enlist people, to create special laws for sharing or retooling industry to weapons. Maybe is we mobilized for war, but only declared our intention to destroy bad patterns of behavior: The relentless conversions of habitats, the constantly growing consumerism, our addictions to cheap fossil energy, or desires to cheat the poor for more personal gain.

Maybe war will not work. Science has not been normative enough to say what we should do. Technology is too busy growing to illuminate any one possible direction. Governments remain dedicated to preserving the status quo of greed and acquisition in unfair ways. Maybe design would work, since good design or ecological design focuses on whole projects, the entire psycho-socio-ecological network of civilization.

The nature of an emergency requires everyone to drop their normal activities and normal behaviors and to respond to a catastrophe. The catastrophe is usually quite evident, a wall of fire or a massive surge of water that will destroy or has already destroyed homes and people, as well as insects and birds, plants and animals, and their habitats. We seem reluctant to give the causes of these catastrophes the status of real emergencies, partly because the catastrophes seem like natural events, such as a warming trend, and partly because they are related to our industrial habits, which provide us with necessities, as well as with comforts and luxuries.

The planetary emergency exists due to a series of slow, long, large, invisible catastrophes that are resulting from the normal wildness and uncertainty of planetary conditions and the human modification of and interference with planetary cycles and diversity.

The problems may be regional and global, but they can be addressed on a local scale, decentral and human scale. A locality can have the authority, the power to take responsibility and make decisions, for global problems that impinge on the local. It may not solve the global problem, but it will affect it, especially if other local communities exercise their authority.

An ecological or global ecological design project could address every aspect of civilization, adding goals, resizing formal, corporate or cultural efforts to survive and prosper. Good design can make it easier to act on a local level, for instance, by providing human-powered transport for all countries. Pedal power can trump gasoline, even those that get 100 mpg. By offering simple, good, lower-carbon stoves. By combining functions to improve social use;

Papanek suggests putting washing machines (or Laundromats) in playgrounds, so mothers or father could socialize and work while watching their children. Papanek notes that the easiest way to save resources and energy, and cut waste, is to use less. Conserve. But, we can also produce designs for survival.

Are we doing enough? Only 5% of US plastics are recycled. But, plastic bags are still status quo. People cannot take an easy challenge and respond with an easy change. This is why it has to be an emergency! We have to take actions now! Coordinated, simultaneous, large-scale, drastic actions. Even a poor action would be preferred to sucking our thumbs in pretend security in our small comfort and competence zones. These zones resulted from lucky planetary and ecological accidents over a 10,000-year summer, but this time is over now. We have to be responsible for self-restraint and self-reliance, for not interfering in the developmental operation of the wild planet. We have to direct our representatives into global emergency actions, and participate ourselves.

Perhaps all we need is a diet. The essence of a diet is to restore one to health, by restricting unhealthy consumption or changing patterns of behavior. As societies and cultures may also be guilty of this kind of behavior, so they need to put themselves on a diet. Archaic and agricultural nations have been strapped by historical inequities and unfair trading. Their challenge is to avoid simply repeating the same errors and consequences in the rush to acquire minimum standards and wealth. The solutions for all nations include trying new ways of balance for self-reliance, paying attention to cultural and physical catastrophes, and striving for better equity. Because of the extent of our overuse and misuse of ecosystems, and their effects on natural processes, systems are collapsing. As the catastrophes are large, the emergency responses have to be large, also.

7.2.4.1. Solar Fire & Water

All of the energy on earth comes from the original formation of the universe, solar system, sun, and the planet, although the transformative energy of the sun directly drives most biogeochemical cycles as well as plant life. The traditional economies of animals and humans are based on solar energy and natural productivities. The earth is suitable for life because of three kinds of limits: the solar radiation that has stayed within certain limits for four billion years; the biogeochemical cycles of oxygen, carbon, nitrogen, phosphorus, sulfur, water, and other elements have stayed within certain limits; and, the constancy of the environment, which is constant enough for organic evolution, but variable enough for natural selection to be challenged.

The planet started as a mixture of chemical elements (over a hundred, including hydrogen, helium, and nitrogen) circulating over an active geology, driven by solar energy. The ecosphere acts as one system in which energy from the sun is cycled. The functioning biomass is integrated by feedback responses to extract enough energy and still maintain a balance. Most of the solar energy is used for maintenance by the biosphere. The regular effect of light, the availability of oxygen, the thickness of soil, and the area and depth of the oceans is almost a steady state (or homeorhetic state), that is, a constant pattern from the steady flow of energy.

The planet, with its temperature, tides, winds, and so on is solar driven. Life is solar-driven. Solar insolation is defined as a measure of solar radiation energy received on a given surface area in a given hour. Solar energy is not renewable for our stellar system, but it is predictable over the next several billion years at least if not longer. Solar luminosity has been increasing for the past billion or so years. That increase adds heat to the atmosphere and oceans as well as weathers rock faster, which draws more CO_2 from the atmosphere. Solar energy is the flow, while terrestrial energy is the stock. There will be less stock in the future.

The difference between them is literally astronomical. A clever civilization would focus its use on the flow.

Traditional cultures economies are based on solar energy and natural productivities. Human energy is used for building and foraging for game and plants. Fire, as the release of organically-bound energy, is used for heating and cooking. Sometimes, animals or human slaves are captured and used for work. Production is kin-oriented and reciprocal.

The laws of energy mean that solar nature is not a free commodity. The second law of thermodynamics is a limit; in all processes in which energy is changed, some of it becomes unusable, diffused and very difficult to harness. We ought to reestablish earlier energy patterns for regions, and use combined systems of wind, water, solar, organic and fossil fuels for energy. Singly, these may be inadequate, but as a mosaic they could meet decentralized needs. The energy pattern should be pieced together organically from the potentialities of a region. Technology already exists to tap the flow and it should be easy to expand. Both the location of the flow and the technology could encourage decentralization—as would an ecological agricultural base. Decentralized, less consumptive energy patterns would reduce the risks and the constant crisis of costs.

Certainly, we can use that energy for as much of our heating and movement as possible. Solar energy can be collected at any surface, the earth, clouds, kites, ocean surface, vehicles. Uses of solar include: Ovens, water, cleaning, autos, buses, trains, and ships.

James Lovelock approves of trying to use solar energy, but suggests the scale is too small. There are new projects on larger scales. Lunar Cubit is a pyramid-shaped solar power complex designed to power thousands of homes in the Abu Dhabi desert. Lunar Cubit consists of eight small glossy solar panel pyramids that surround a central large pyramid in a semi circle. The pyramids act as a lunar calendar, and the central pyramid is inversely illuminated according to the phases of the moon. By day, the pyramids function as solar energy-producing power plants. Each of the frameless solar panels is made of glass and amorphous silicon, and they're able to produce enough renewable energy to power 250 homes.

Agricultural systems are based on ecological systems that have been rearranged for human purposes (food). However, they still depend on solar energy, photosynthesis, biogeochemical cycles, stability and movement of the atmosphere, and the services of nonhuman organisms. They are subject to the laws of ecology.

By their design or lack of design, cities are already heat traps fueled by absorption and production of fossil fuel heat. Sophisticated technology can create huge savings on resources. Fuller noted that a one-quarter ton satellite outperforms the transoceanic capabilities of 175,000 tons of copper cable, although he may not have included all the ancillary costs, such as launch or recovery costs.

7.2.4.2. Designs for Distribution of Food Fuel & Materials

(Being edited)

Immense suffering and death results from the breakdown of distribution. Applying lessons from just-in-time deliveries could save lives.

7.2.4.3. Annual Holiday to Address Emergencies

Let us make it a year of celebration (Emergency), where we start no new products, no new house starts, until the old ones are renovated or resettled. No new profits for individuals or corporations (all given to the government for redistribution to the neediest. We could put off having children for a year.

Using less seems to be connected with economic health. In a dramatically changing world, with most of us fearing change, design needs flexibility with a synthetic approach. It needs to be integrated, comprehensive, and anticipatory, as Fuller and Papanek urge. We have to direct our representatives into global emergency actions, and participate ourselves. This is another function of design, to change human behavior.

7.2.5. *Straw Houses & Vernacular Architecture*

Space, as a form of expression of the field, is the whole container. Living spatially in a territory results in place making by living beings. And with investment comes attachment and commitment. Boundaries are recognized or created perceptually. The division creates an outside and an inside (here and there), as well as a belonging and an other (us and them). Place becomes known and loved, things are vernacular and local, special and soulful (literally). Identity develops and is related to the characteristics of a place. Global ideologies seem to favor the concept of space and time over the concepts of place and dwelling. The large myths of nationalism and progress of evolution and humanization, are free-floating metanarratives that can be anywhere and everywhere. The entire world is regarded as a stage for becoming rather than a network of places for being. At the global scale these myths allow people of different cultures to adopt these kinds of placeless universals.

Both trends, both processes, are products of historical change. As local peoples communicate or trade with others. The flow of cultural ideas and materials forms a global process. Elements of a culture thus get mobilized and circulate to other cultures, then selected and re-expressed in a different cultural context.

William Morris, 1861, of Morris, Marshall & Faulker & Co. to revitalize vernacular simplicity with craftsmanship. Vernacular architecture is based on knowledge of traditional materials, practices and techniques. Ivan Illich points out that the term 'vernacular' is an old technical word used for Roman law, having to do with 'free' access from a commons or free ownership, such as getting offspring from a donkey already owned. As Illich further points out, the vernacular is the opposite of a commodity, that is, something for which one has to pay. Ivan Illich uses the term vernacular to mean the inverse of a commodity. It is wood gathered by personal labor from a common; it is the donkey born from a donkey owned.

Once seen as obsolete, vernacular architecture is now the subject of serious academic study, and is increasingly considered a potential component of sustainable development for its quality of adaptation to the local environment. Bernard Rudofsky argued for the legitimacy and "hard-won knowledge" inherent in vernacular buildings, from Polish salt-caves to gigantic Syrian water wheels and Moroccan desert fortresses. Paul Oliver has argued that vernacular architecture will be necessary in the future to "ensure sustainability in both cultural and economic terms beyond the short term."

What if we tried to mass-produce basic house types, based on local vernacular designs by cultures in place, using local materials. Houses on stilts, desert houses, or Craftsman houses. This would be to make sure that people got the basics. The house could then be customized. More than individual housing it would include group housing (as in traditional long houses or malacas), group meeting housing (for education, health and governance), and community shelters.

7.2.6. *Sharing Renting & Leasing*
Victor Papanek notes that the easiest way to save resources and energy, and cut waste, is to use less—that is, to conserve. Sharing, instead of individual buying, is a good way to conserve and to make efficient use of a tool (when purchased by individuals, most tools sit idle for over 95% of their lifetime)

Sharing would alter the conditions for design, which could tailor the product for the service, not the individual. For example, a car sharing system is a solution for people that need a car only on occasion. The program Greenwheels is getting very popular in the crowded inner cites of the Netherlands, where parking space is at a premium. Anyone can use one of the cars in their neighborhood when they need it. Reservations are made with a phone call or online. The user does not need to care about maintenance, insurance, parking licenses, or road taxes. Payment is done on a monthly basis according to use.

Sharing would require a much bigger commons, but much small industry less dependent on diminishing resources. Developing nations may focus on economic growth, ignoring global problems—but, many of these could vanish with increased sharing).

Using less does not seem to be connected with economic health. Millions are unemployed and homeless. Doubtless, this is a result of a growth and throwaway economy. Local economies may become less dependent on the global, which is more self-sufficient. Build community support, maintain ecological systems. This could be an enlarged function of economics, to coordinate distribution and sharing.

How would sharing affect terrorism? Would it reduce violence and terrorism? Sharing would obligate us to consider the previous and subsequent users of the items shared. The Penan people have no word for 'thank you,' since sharing is a social obligation, not a special act. They also have six words for we, depending on the context of use.

Renting and leasing are programs for individuals to keep tools for longer times. They also have advantages to individuals, such as reducing the costs of ownership. It has been said that things enslave us, that is, trap us into working for the things themselves. Sharing, renting and leasing are actions that might let us escape the trap.

7.2.7. *Conservation of Materials & Energy*
(Being edited)
One way to conserve materials and energy is to make the product more durable by putting it in a permanent body, which may have more expensive materials but a much better design. The process part of the product can be made upgradable, with new parts, from computer chips to better motors or things. Perhaps even the frame of the product could be customizable, so that owners or users would become more attached to it.

7.3. *Local Design Solutions: City Shapes*

What is a city? Since the dawn of settled agriculture, humans have been altering the landscape to secure food, create settlements, and pursue commerce and industry. Croplands, pastures, urban and suburban areas, industrial zones, and the area taken up by roads, reservoirs, and other major infrastructure, all represent conversion of natural ecosystems. These transformations of the landscape yield most of the food, energy, water, and wealth humans need. Of the planet, humans have converted approximately 29 percent of the land area (about 3.8 billion hectares) to agriculture, roads, and urban or built-up areas. Agricultural conversion to croplands and managed pastures, alone, has affected approximately 26 percent of the land area (about 3.3 billion ha). Agriculture has displaced a third of temperate and tropical forests and a quarter of natural grasslands. Agricultural conversion is still an important pressure on natural ecosystems in many developing nations; however, in some developed nations agricultural lands themselves are being converted to urban and industrial uses.

Urban and built-up areas now occupy more than 471 million hectares (about 4 percent of land area). Well over half the world's population live in cities. Urban populations increase by almost 200,000 people daily, adding pressure to expand urban boundaries (UNEP 1999:47). Suburban sprawl magnifies the effect of urban population growth, particularly in North America and Europe. In the United States, the percentage of people living in urban areas increased 10 percent, from 65 percent of the population in 1950 to 75 percent in 1990, but the area covered by cities roughly doubled in size during the same period.

These patterns are the result of historical processes relating to the availability of land, technology, and dominance. They do not need to be preserved. New patterns are possible that respect limits, that keep populations and impacts in balance with the rest of the planet. Arcologies may be the best design.

7.3.1. *Shaping Cities*

What should cities look like? A collection of buildings? One large complete building? The mushroom of an underground network? We should not be overly concerned with the material size of a city. How much of nature is organic? 1%? How much is material and elements? Biomass is one ten billionth of the planetary mass. Most of the materials that make up a city can be neutral.

We should not be overwhelmed by having to meet limits. What is a limit? A crushing wall? Is a limit not like a grid or a poetic form? Something that has to be met yet forces or inspires creativity? The surrounding ecosystems provide constraints to the size and kind of city. The edge of the city, more than a wall, is like a membrane that allows cycles, and water, resources and people to move in and out. But, the membrane kept out exotic and dangerous animals and people and it kept the concentrated organization inside.

How is a city like an ecosystem? Does it have borders, flows and cycles? Early cities had a balance and relation with wildness and country. Now, the change in scale to empires as well as just growth of populations and cities has unbalanced this. Cities still have to follow the laws of physics, as well as the laws of chemistry, biology and ecology. Before the change in scale to cities as homes to millions, cities could waste and pollute, and the waste would be thinned out by the tides or winds. Essentially wilderness did the housekeeping and provided the sink. No longer. Cities have to embrace an industrial ecology that recycles things within.

Cities miniaturized nature. They miniaturized wildness and displayed it in parks, zoos, and even buildings. Cities, the largest of human structures, have resisted conversion to arcologies. The size and investments required for arcologies discouraged investors and builders from creating them. Is it that ecology as a science is too daunting?

What are the trade-offs of living in an arcology? People would be required to give up many of their habits and addictions, but these would be replaced with new patterns of moving and dwelling that might be much more enjoyable, much more open to a civilized conversation with others.

7.3.1.1. Reshaping Buildings

Architects have generally remained at the building-size projects. Some architects have suggested altering the design of buildings and combining uses. For example, an apartment building block typically encompasses one square hectare of land. At best, in most cases, the block is 50 percent structure, and 50 percent surrounding yard, lawn, patio, or sidewalks. This footprint has 0.5 hectare enclosed space, and 0.5 hectare open-sky space. Rooftops as designed, however, are rarely usable for additional "live loads" of constant use activity nor dead loads of landscaping and outdoor furniture. By moving to a "stepped pyramid" form, it is possible to have a footprint of 1.0 hectare of enclosed space plus nearly one hectare of open-sky space.

The stepped pyramid form, or modern ziggurat, casts minimal shadows on its own tiered plazas, and does not influence the solar access of neighboring buildings. A structure with twelve floors casts a smaller shadow profile than a six-story block building. The street-level of a pyramid would have one hectare of shops, offices or workshop businesses. The second level would have offices. The higher levels could have apartments with garden areas.

Buildings designed as boxes with "square-shoulders," reduce the open-sky area of the maximum possible solar penetration. This reduces the solar gain for patio gardens as well as reduces the possible locations for solar-power panel positions. In worst cases, blocky buildings cast shadows which not only darken the adjacent streets, but also shade lower portions of buildings nearby. Skyscrapers and high-rise buildings can put large zones in shaded darkness, especially at higher latitude locations in winter, which ensure that the buildings have to use more utilities that raise heating and lighting expenses for lower levels.

Manhattan Island has a night-time residency density of 1.5 million people. The area of the island is 67.34 square kilometers. A reasonable building density would be 45 buildings per square kilometer, assuming that 20 percent of the area would be reserved for industry and public access. Replacing blocks with pyramids, the potential population of Manhattan would be about 2.23 million people without any building being taller than six levels and no building shading any other. There would be 2,800 hectares of commercial space on the street level, ample for transportation, services, shopping markets, and workshop businesses.

7.3.1.2. Reducing Footprints of Cities

City and artificial areas should be restricted to the remaining small percentages, of the least productivity. In cases where the city area exceeded that maximum percentage, an equal area of rooftops or pavement areas would have to be dedicated to agricultural activities. Thus, there would be no limit to house density, only coverage area, and that would be directly related to natural primary productive areas.

7.3.1.3. Retrofitting to Arcologies

Arcologies are based on an optimum size, related to productivities, limits and values. Arcologies are planned so that the management of elements and order of patterns form a balanced system. Arcologies integrate farming and wilderness into the city and the city into the environment. Individual buildings could be retrofitted to be part of a single arcology. Perhaps a Buckminster Fuller geodesic dome could be erected over the parts of the city to be converted. The remainder of the city would be taken apart and recycled.

7.3.1.4. Design for Miniaturization & Intensity

The success of life depends on miniaturization, where a prodigious number of overlapping mechanisms are packed into a small space. These mechanisms persist through built-in regulation circuits, but the systems are open enough for novelty. As an emergent form of life, cities have packed patterns and increased their intensity. Arcological cities have the potential to increase it still more, while decreasing their impacts on the environment.

John and Nancy Jack Todd claim that living machines could miniaturize the production of human services, thereby letting nature develop wild systems that would provide global services. They say the designer could set the tasks for the machine and let it develop its own biotic complexity. Living machines would not need to be isolated from natural systems. However, it seems that whenever these living machines interface with living systems, there would be a potential for domination, collapse or hybridization. Such machines would fit well in the urban environment, which is already miniaturizing our relationships with nature, but not necessarily with wild systems.

The world has already been miniaturized in our imaginations, as well as by some technologies and in some urban environments. The effect of some of these technologies, such as television and movies, is that many who once accepted their lots of hunger and disease have seen western affluence and desire to share in it. Not to share equally with them now would be inhumane. Miniaturization seems to promise the intensity of ethical decisions and behaviors as well.

7.3.1.5. Design for Integration

Integration is one of the basic properties of a field. The processes of differentiation and integration, where the processes interpenetrate, run simultaneously from top and bottom, and shape a hierarchy from both sides, allow complexity to emerge. As we have seen, a city is a design that has emerged from the properties of a culture in a place, both of which are embedded in ecosystems and its enveloping field.

Many of the problems of modern urban societies, such as alienation, insecurity, and homelessness, do not occur in archaic societies. If we could recover the security and integration of these societies, with their unity of work and life and of economy and morality, we could extend economics beyond capitalism.

Global exchange, however, occurs at a different scale and a much faster tempo, so that cultural elements often sit beside one another without any kind of meaningful integration. In these cases, the scale of exchange may overwhelm a holistic culture with an assortment of materials that are personally chosen. Some items, such as blue jeans, give a superficial uniformity to all cultures. Global exchange seems to create a tight integration of economics and cultures.

However, the integration may not be coherent. Ecologists call the excessive integration of a system hypercoherence. According to Holling, a system that is too-highly connected is an accident going to happen. Rigidity increases vulnerability to change. The number and strength of all the connections is a problem if disruptions occur regularly, and they do in modern cities.

Arcological cities might be able to reduce or strengthen connections in a more flexible pattern. Of course perception is a large part of patterns. And, we perceive the direction as being towards more complexity and more integration until we have megacities in a global society, coordinated on several levels, within a more complex biosphere. An arcological pattern would allow local cities to maintain their diversity be optimally integrated into new global forms. Self-sufficient cities would allow residents to start thinking locally and acting locally, within the ecological designs of the cities and within global constraints.

Ecological design, described by Fritjof Capra, is a systems-based approach to economics integrating human activity and natural processes. Capra states that it reflects the basic principles of organization of nature that have evolved to sustain life. Ecological design has an important role in sustaining, developing, and integrating residents into broader ecological and cultural environments, shaping these environments and being shaped by them in reciprocal actions. Bricolage is a way of synthesis and a technique to integrate historical and cultural knowledge into an urban form that is an optimal fit into its place.

7.3.1.6. Advantages of an Arcology

With an arcology, the city can change its relationship with nature; an arcology is a good solution for an urban culture, as it solves the problems of waste, resource-use, scale, obsolescence, and segregation. An arcology is a monumental design, which appeals to human desires for creating monuments.

The size of an arcology would allow great diversity in retail stores and job opportunities, especially those related to running the arcology. The shape will allow optimum use of sunlight. Common areas will be designed in. Since arcologies would be highly connected, there is no reason that all of them have to be of a heroic scale. They could be mini-arcologies linked closely by rail, not totally separate but clumped in the area, like a mountain range.

The siting of an arcology, with its ability for self-sufficiency, leaves large contiguous areas of wilderness nearby; this would allow people to access wild areas, which would meet their needs for being in nature. The arcology would have a very small footprint compared to traditional cities. Although generally self-contained, an arcology could be open through local gardens and fields, which would be part of the design.

Arcologies could be a better response to drought than traditional cities. Cities have been promoted as being efficient concentrations without size limitations (by Stewart Brand and others). But, if cities are organic, then they might have organic limits to overall size and density, as do bee or termite colonies. Aggregation does enhance group survival, for instance, many bees can create more heat in a hive than an individual—but, when the hive gets too big, a young queen leaves to start a new colony.

7.3.1.7. Disadvantages of an Arcology

Being optimized for size within a place, an arcology would not be expandable, although that may not be a disadvantage. The outer or inner shape of the city might not be flexible. Like any building that relies on complex technologies, regular breakdowns are expected. How would the arcology allow people to fend for themselves in terms of warm, energy and food? If the arcology does not have enough internal or nearby external agricultural areas, then food may have to be imported.

Reliance on traditional technologies, such as concrete manufacture or energy generation from fossil fuels, might contribute to environmental problems, such as carbon dioxide release. The shape of the arcology, along with interactions, may not solve the problem of the disparities of wealth. Although the design may encourage interaction and sharing, people will always be able to choose separation. Although the design may reduce crime and violence, people will be able to choose those actions also.

Some people may suffer psychological problems from intense living in a planned environment, but perhaps no more so than in any other city. Arcologies may not be able to solve the problem of increased movements of people, who may commute regularly between other cities and nations.

7.3.2. *Wild Technology & Artificial Nature: An Arcology is a Wild City in Wild Nature*
What should cities look like? Can we place them around mountains? This would solve the problem of interior space and lighting; everyone could have a view. Arcologies complete the idea of the city and make it ecological, sustainable, frugal and exciting to live in. The pattern of an arcology is integrated into natural processes and cycles.

How big are arcological cities? How big should they be? How big is too big? How small can they be? Is there an optimum size? Is it determined by wilderness? Is the city dependent on wilderness? What does it need? What does it take? If it is dependent, how should it show that? Should wilderness dominate the city and force every design? What is wilderness? Thing, Idea, process, life? Is wilderness the center of life? Is the city? Should we withdraw human presence from wilderness?

Do cities answer as deep needs as wildness? Can we ever go back from cities or fields to wilderness and rural communities? Are cities traps? Is the city an evolutionary dead-end or horrible mistake? Created with ecological principles, cities could be the ultimate creation.

The city now provides a place of danger, for hunting and excitement. But it rests on wilderness and fields, so it is artificial excitement. Cities allowed us to be more abstract and to abstract the culture from nature to make a second nature. Our imagination took over with cities, with technology that changed cities and increased luxuries and artificial habitats. A second kind of diversity was created, of habitats and niches (for mice and rats and weeds and pigeons as well).

Arcologies have progressed from a thought experiment to experiments with specialties and specializations. An arcology creates a separate ecosystem like an episystem that participates in the cycles of nature but spins new fabrics and elements, as well as new ideas and adventures. The whole premise of arcological design is that it has to be balanced with wild ecosystems, that is, nature has to be woven in with the city or vice versa. The scales have to match. They have to be balanced. That does not mean that every part of the city has to have wild tendrils in it. We can still have solid concrete and glass. Perhaps some of the parks can be truly wild. But, evening out the whole might make it unworkable.

7.3.2.1. Nature in Cities
A construct as large as a mountain could support the vegetation of a mountain, from grasses and trees to lichens and annuals. More importantly, the vegetation would contribute to atmospheric and edaphic cycles. It would attract complements of birds, insects and animals.

7.3.2.1.1. *Forests in Cities*. Forests are wild ecosystems. To thread them throughout a city requires leaving space for spontaneous, dynamic, autopoetic changes. Trees in interior spaces could be incorporated into the structure of the arcology itself.

7.3.2.1.2. *Streams in Cities*. Wastewater could be directed into courses through small forests, grasslands or aquatic wetlands to be purified by the plants and soils. These course could look like natural streams at the middle of recycling, and enter houses and buildings as waterfalls or rivulets at the end of the process; or they could be contained in pipes for showers or toilets.

7.3.2.1.3. *Agriculture in Cities*. The top of the arcology, or the tops of buildings offer potential surfaces for growing crops, as do balconies, windows, community gardens, or the sides of some buildings or the front of an apse. Providing enough area to feed the entire city might be an engineering challenge. Many foods can be grown in vats or hydroponically, but these areas would not require a large footprint, as would grains or fruit trees.

Vertical agriculture could offer some extra space, even potentially enough to feed the entire population, especially on exterior surfaces. However, to create entire floors or moving conveyer belts of surface might require extra technology and energy.

7.3.2.1.4. *Recreation in Cities.* Arcologies could offer virtually every kind of recreation found in any kind of habitat, although most likely on a smaller scale. For instance cross-country skiing might be quite limited. Many other activities, from climbing and swimming to running or golf, could be accommodated. Of course, special urban forms of recreation, such as free-racing or basketball, would be natural in such a large building. Even exploring would be stimulating, especially in the service or manufacturing areas.

7.3.2.1.5. *Wildness in Cities*. Like any human aggregation, an arcology would attract wildness in the form of commensurates, such as rats or cockroaches. Bacteria and viruses are always part of any concentration. On a more formal level, we would use wild processes to help create an open ecology that would connect the city with its proximate environment.

7.3.2.1.6. *Participation in Building*. Participatory architecture can be one of those processes that allows citizen participation in the design of their communities. An open ended participatory design process can lead to a great diversity of all forms being used in the architecture, also more diverse pattern this may result in more diverse patterns of social interactions, such as nurseries located near administrative offices or a bar located near a work area. The network of working and living can become much more dense if it includes pedestrian paths gardens and public spaces. Within each building walls and floors could be movable so that people could customize their own living or working spaces. As part of the participatory process that workers and builders can be simply given design principles and constraints rather than complete final absolute blueprints.

7.3.2.2. Cities in Nature

Every city, including an arcology, exists in a natural and wild context, depending on the services of the environment for resources. The siting of a city would be much more important in a cell-phoned, internetted world. Not less important because of technology, but more important. For instance, there would not be the requirement or reason to have the city on a fertile grassland or wetland, or on a shore or river. Cities could be located in geologically stable areas, to minimize the natural threats of floods, earthquakes, firestorms, or volcanic eruptions. Cities could be located at equidistant nodes for trade or communication, according to size or requirements.

7.3.2.2.1. Forbidden Places

There should be forbidden places for cities. Many of these have been too obvious for millennia. We should not build on flood plains, even if we could create a floating city. Although perhaps some classic cities such as Venice or New Orleans, could be saved with surrounding dikes or higher technology possibilities. Cities could be kept off tectonic faultlines, and off fertile grasslands and prairies, which could be restored or used for natural restorative agriculture. New locations could be dictated by new transport corridors, especially new kinds of rail or maglev lines, but not necessarily places that required river or ocean transport.

7.3.2.2.2. Patterns of Arcologies

Using theories of central places and networking, arcologies could provide a planned solution to population areas. They could replace failing cities in dangerous areas. Arcologies could also be raised in deserts; their internal closure would permit enough water efficiency and cooling to make their survival in rough climates practical. In some cases, for example parts of the Sahara or central Australia, an arcology could be the center of restoration for part of the desert, starting with the reforestation of the fringes of the arcology (and there are already examples of restoration in the Sahara, using less sophisticated techniques). Arcologies could also be built in mountainous areas or rocky shores, if they were stable enough.

7.3.3. *Virtual Arcologies*

We have games, such as Sim City, which are as interesting as Doom or Killer. We could have games that would be as adventurous as any without killing half the population of a virtual space. There are mystery games, such as Myst, that are as challenging as the high-body-count alternatives.

Games where people could model buildings or ecosystems would be far more complex than simple either-or destruction games. Construction and creativity can form character as fit for living in society as the games of destruction and degradation can. Biologically, games, and play, in general, prepare people for the skills they need to live in society.

Play is the method of learning for most juvenile animals and a means of enjoyment for many adult animals. For humans, play is imaginative experience, entered into freely. Much human activity is play, in place in a community. Even science and philosophy are forms of play, attempts to solve the puzzles of existence. Play was thought of as an outlet of "surplus energy," but later definitions enlarged its importance in learning and information gathering.

For Frederich Schiller, play is activity for its own sake, where the drives of emotion and reason are harmonized. The state of play is whole and simultaneous. It unifies permanence and transition, chaos and order, duty and selfishness. The object of the senses is life, the object of reason is form, and the object of play is living form—called beauty in the widest sense. Aesthetic play, like physical play, requires order and control. The rich flowering of human nature is possible only when the constraints of need are replaced by leisure and abundance.

On the other hand, perhaps we should use the violent games to settle real cultural and social differences that seem insoluble through anything but war. Perhaps we could have the rich leaders of countries play for their lives rather than the lives of their fellow residents.

People are mostly born indoors and live indoors now. The virtual possibilities of the web may increase the possibilities sofa and virtual work and bus virtual migration to two virtual kinds of labor. It's possible that status will be increased depending on those identities in the virtual world rather than those in the real world such as citizenship.

With expanding computer capabilities, virtual worlds can be created that can embody many of the values of the material world. The generation of these worlds would require fewer resources than if the activities had occurred in physical space. The only problem is that it takes a lot of energy and space to create those virtual worlds. We can think perhaps of the virtual world as a model of reality but not having the origins of reality the simulations become the basis where economic needs are met that is, where are the tangible material products no longer become necessary for some of those needs I would suggest that those needs are more like Maslow's hierarchy needs. Obviously the lower needs, such as food or herb comfort could not be met in by virtualization.

Obviously virtual worlds are going to change the way homes and workspaces, transportation systems, and electronic communications will be reorganized. There will be new patterns processes and relationships in response to what we face. Alan that you need to expand on these to point out what could possibly go wrong and how the hell these sites and things will be different. For instance what if the virtual world collapses of like any kind of Bronze

Age culture?

Some abstract architecture is nondimensional, existing only on paper or computer data files. Is it fantasy-driven virtual reality. Arcologies would be dramatic, unusual structures that support a different way of life. They are naturally interesting to writers of speculative fiction. The first mention of an arcological structure might be in H. G. Wells's *When the Sleeper Wakes*, published in 1899. A more in-depth description of arcology's design principles can be found in "The Last Redoubt" from *The Night Land* by William Hope Hodgson, first published in 1912. In it Hodgson envisions structures complete with a full artificial ecology, agriculture, and public transport by mobile roadways.

An arcology is also depicted in the 1968 futuristic novel *The World Inside*, by Robert Silverberg, where in the year 2381 the human race lives in 1000 stories high towers, providing all necessary to the society (nutrition, energy, entertainment, jobs, etc.). These buildings seem like a mutation between a building and a living organism nourishing and sheltering this futuristic dystopian society.

J.G. Ballard wrote a dystopian take on a self contained building which is much like an arcology in his 1975 novel *High Rise*.

Another depiction can be found in William Gibson's 1986 novel *Count Zero*. The structure "Fiddler's Green" from George A. Romero's 2005 film *Land of the Dead* might be an arcology. Larry Niven and Jerry Pournelle's novel *Oath of Fealty* features an arcology.

Arcologies also appear in video games, such as SimCity 2000, Escape Velocity Nova, Deus Ex: Invisible War, Call to Power II, Shadowrun, and Mass Effect

There have been some interesting suggestions for arcologies on the SimCity blogs. Arcology design could benefit from harnessing the science fiction imagination displayed on the internet.

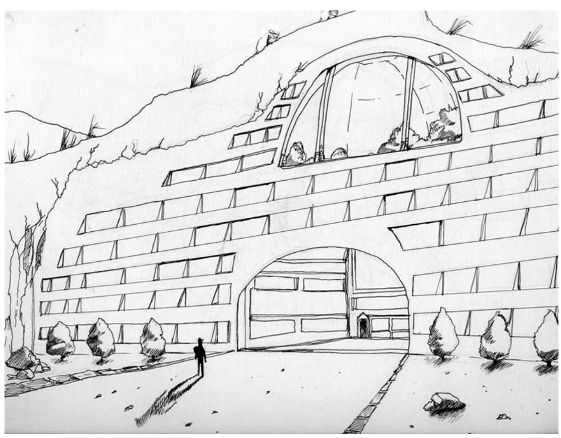


Figure 4214-1. Palouse Hills arcology (in *Redesigning the Planet: Regions*)

7.3.4. *Oregon Tree Arcology*

Oregon has some unique and eclectic tree houses. An arcology based on a tree form, however, might be a different beast, so to speak. In order to be large enough to house hundreds or thousands of people, it would have to be a much larger structure, much larger than any single tree.

Being in a forest, the arcology could be connected to other trees by walkways. Some walkways would be rope or wooden. The lower level of the arcology would have an external spiral stair around the arcology, perhaps up to seventy feet.

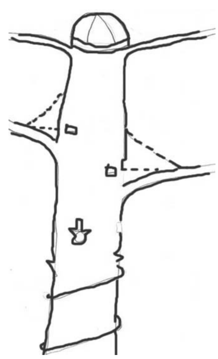
Being in the valley, the arcology would be connected to other small communities by the current road system and by the utilities grid. Although much of its energy could be self-generated, it would still be connected to the infrastructure of southwest Oregon.

7.3.4.1. Description & Design of a Tree Arcology

Such a structure could be based on an arrangement of trees, that would form the frame for the structure, which could be extended and covered with living bark, complete with a phloem and xylem system of nourishment. It could be of a large circumference, as long as the 'post' trees were living and the roots connected them, although even at 400 feet tall and with a diameter of 30 feet, it would be within the upper biological range of a large fir or pine (a preferred 50 foot diameter would be larger than a fir, but within the diameter of other trees). Like a tree, everything inside it would be essentially nonliving. Like a tree, it would thrive in a forest. And. Like a tree it would have a limited lifetime.

The normal shape of a mature fir, after the leader has stopped growing, is an open top, with large branches that are favored as platforms by large birds such as vultures or eagles. This structure would have a geodesic dome on top, above the top branches. Lower branches would support openings or porches for the arcology. There would be sufficient openings on the side for light, although light wells could be tubed down from the dome. Some of the branches would hold solar collectors. Many branches, and the bark system, would serve to collect water.

The arcology is designed for 200-350 people, which is the size of a typical small community in that area. The area offers modern connections to sophisticated utilities and larger urban areas, from Ashland to Portland.



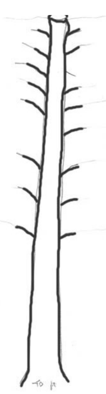


Figure 7341-1. Tree Arcology detail with dome, & to scale

7.3.4.1.1. Site

The forest is located in the geologically complex and deeply broken Klamath Mountain physiographic province of southwestern Oregon. The province is composed of four belts of island arc-related volcanic and sedimentary rock, intrusive rock, and ultramarine assemblages. Mountain crests are comprised of steeply folded and faulted pre-Tertiary strata, which vary in elevation from 600 to 1200 meters. The region is set apart from the rest of Southern Oregon by a boundary separating its pre-Tertiary rocks, probably the oldest in Oregon, from rock formations outside the area. Most of the area is decomposed granite or schist.

The forest is situated primarily in the valley floor at an elevation of about 1500 feet. Of the surrounding lands, federal forest is located primarily along the ridges at an elevation of about 2000 ft. and private lands are just upslope. A state road, which connects to Interstate 5 after 2 miles, abuts the southeast corner of the property.

The Umpqua interior valley is a relatively warm, dry region with a Mediterranean climate. In the rain shadow of the Klamath Mountains, the Umpqua valley has hot, dry summers, and mild, wet winters, although potential evapotranspiration in the summer exceeds moisture buildup in winter. Average annual temperature is 54 degrees F. (Average January, 40, average July 69). Average annual precipitation is 31.5 inches (US Weather Bureau, 1965). Precipitation (as rain or snow) is intercepted by the forest canopy. Surface water is held by forest floor structure, including duff and debris, before entering the ground water stream. Some of the water may be held in an aquifer. Much of it is channeled into a local creek that forms part of the local watershed.

Soils in the mountains belong in a widespread great group, Haplohumults (reddish brown lateritic soils). The parent materials include sedimentary and basic igneous rocks. The soils are moderately deep (335 feet to bedrock) and possess a silty loam or silty clay loam A horizon underlain by a silty clay B horizon. Scattered upland areas of peridotite or serpentine bedrock have reddish-colored soils classed as Hapludalfs (gray-brown podzolic) or Xerochrepts (Regosols), which are considered unproductive, with very shallow and stony profiles.

Nearly pure stands of Douglas-fir continue south from their northern limit on Vancouver Island through the Klamath range. This forest is a meeting place and transition zone between the drier Mediterranean-type climate to the south, characterized by the Pine/Oak/Incense Cedar ecosystem, and the moister temperate rainforest to the north, characterized by the Douglas Fir/Grand Fir/Western Hemlock ecosystem.

Placed in a bottomland, it would reach to the height of trees on the upslopes of the hills and mountains, so it would not seem to be too much out of scale. There are few, if any, trees over 300 feet tall.

7.3.4.1.2. Populations

(Being edited) The city is designed for a large human population that would be surrounded by wild plants and animals within the building, as well as by domesticated annuals and plants. The outer environment would not be available for agriculture or gardens, although it could offer limited cold weather recreation. The numerous research stations could be better supported from the arcology, which would reduce separate efforts to stock the sites from home nations.

7.3.4.1.2.1. Plant & Animal Populations

The Western Hemlock (*Tsuga heterophylla*) forest zone is regularly dominated by the Douglas-fir (*Pseudotsuga menziesii*) subclimax. The oak woodland of the Umpqua valley has a well-developed canopy of Douglas-fir, ponderosa pine and incense-cedar; this woodland ranges from open savannas with grass understories to dense forest stands with an abundance of conifer associates. The vegetational mosaic can be characterized as “Interior Valley” or typologically as a pine-oak-Douglas-fir zone. The mosaic includes oak woodlands, coniferous forests, grasslands, chaparral (sclerophyllous shrub communities), and riparian forests—all considered semi-natural rather than mature communities, due to human activities. The "mixed-evergreen" occurs usually above 800 feet elevation.

Mixed stands of deciduous oaks and the evergreen Arbutus are conspicuous. Douglas-fir is common. Important shrubs are Ceanothus, especially on east and southeast slopes. Northeastern slopes and more mesic sites have open stands of Douglas-fir, Ponderosa pine, and incense-cedar, with a well-developed lower canopy of Oregon white oak. Typical understory species include Pacific poison oak, low dogbane, honeysuckle, balsamroot, fescues, lupines, brodiaea, and ground cone.

In coniferous forests, which tend to be in the uplands, Douglas-fir is considered most common, although Ponderosa pine and incense-cedar are conspicuous. Associated hardwoods include bigleaf maple, madrone, and oaks.

Some grassland or prairie communities may be mature sites on some soils or xeric sites. Others appear to be successional, maintained by fire and human activities. Some interior valley zones, dominated by soft brome, dogtail, and ryegrass, are invaded by sweetbriar rose and poison oak. Chaparral in interior valleys is dominated by buckbrush and manzanita, with other species present: Deerbrush, poison oak, dogwood, tanoak. Riparian habitats have a typical hardwood component, such as black cottonwood, willow, bigleaf maple, and alder.

Wildlife is a prime indicator of a healthy, fully functioning forest in their roles as seed and spore dispersal agents, herbivory checks (from rodents to beetles), the health of soil fauna and flora, and the health of stream and aquatic habitat. Arboreal mammals, including squirrels, porcupines, red tree voles, martens, fishers, chipmunks, forest deer mice and woodrats, are a keystone species guild. They all depend on trees in some important ways, and they are either the main or supplemental food for forest predators, including most raptors. Many tree-dependent mammals depend on an adequate supply of quality understory plants for survival. The forest, of course, is more than the trees. Porcupines depend on understory herbs and shrubs as well as the inner bark of trees. The northern flying squirrel eats truffles (fruiting bodies of mycorrhizal fungi) and passes spores in feces. Mycorrhizal fungi form a symbiotic relationship with trees by attaching themselves to the roots and greatly increase the uptake of nutrients and water, and by providing a large measure of resistance to disease.

Deer and elk are present, but not usually seen because their prime browse plants have been shaded out of the forest. Mountain lions, black bears, and coyotes have been sighted regularly. Some species of frogs and salamanders are locally extinct. More animals live in a mixed hardwood/conifer forest than in one dominated only by conifers. And, more are attracted to riparian zones near streams. At least fifty bird species are associated with mature or old growth pine woodland alone in southwestern Oregon (there should have over one hundred bird species as residents or winter/summer visitors). Few bat species remain of the thirteen species known in southwestern Oregon. Plants and animals are monitored annually.

The entire arcology structure would be one community. It would host many of the fungi and insects that are normally partners with trees. Lichens for instance would grow on the bark, but could be used to color interior walls naturally.

7.3.4.1.2.2. Human Population

The valley served historically as the meeting ground of the Umpqua Indians, who burned uphill to select desired plants, such as mushrooms and willow. The forest of the was initially high-graded in the early 1900s, when a railroad spur was constructed. Some streams were mined for gold. The area was then clearcut and burned starting in the late 1930s. One tree, 66" in diameter and 280 years old, indicates that there were fires every 50-80 years in some parts of the valley. Partial logging occurred until the 1950s. Some people ran cattle in the cleared areas. The current condition of the forest is largely a consequence of past clearcutting, cattle grazing and fire suppression practices which resulted in an even-aged, simplified, overstocked forest with high fire hazard.

Although endemic peoples may have numbered a thousand or two, but immigrants swelled it to over 18,000 in Umpqua County by 2009. Population growth rates have slowed since the 1980s, although there is movement to the cities and to come rural areas.

Placed between two larger cities of Roseburg and Medford, and several small towns (dominated by logging mills), the arcology would have a population of 225-300 residents.

Soleri notes that the intensity of life in an arcology could be overwhelming with the sheer human magnitude, but that this possibility is diminished by the design of neighborhoods and in this case the relatively small size of the arcology. The size would be large enough, however, to offer minimum diversity and specialization.

7.3.4.1.3. Spaces

At 400 feet tall and a diameter of 50 feet, the arcology could be divided into 42 stories, and each story would have an approximate area of 1960 square feet. With a population of 200, each resident would have 484 square feet (or at 250, 308 ft^2 See Table 73413-1).

Over 90 percent of interior space is housing—this is an unusually high percentage in an arcology, but due to its small size as well as its forest location and design, much less space is needed for food, parks, and commercial and public space, much of which would be provided outside. About 4 percent is set aside for public and commercial space; the top dome would be used for gatherings and meetings, perhaps set up as a theater, while two floors would be set aside for a restaurant and general store.

Table 73413-1. Division of Space in Tree Arcology

Spaces	*Area (in square feet)*	*Percentage*
Living space	77,000 sq. ft.	90.5%
Public/commercial space	3500	4.1%
Civic functions		
Commercial		
Public circulation services	1500	1.8%
Utility		
Paths/stairs/elevators		
Food-growing space	2000	2.4%
Parks/wild	1000	1.2%
Total Area	85,000	100%

About 1% is reserved for administrative or civic use. Green space for food growing and parks covers 3.6% of the total area, or two floors on the lower levels. Another floor would be dedicated to school. Less than 2% serves as public circulation services. An additional 4000 ft^2 is contained underground, and allocated for research, education and computer recreation.

The percentage set aside for parks is much lower than for most cities (good cities usually set aside 10-15% of their area) because of its forest location, which provides ample opportunities for walking and meditating. Deciding how much area for food-growing is difficult, as most cities trade and import their food, much of which, like wheat, corn, melons, or tomatoes, require large areas; however, for external greenhouses, hydroponics, small truck gardens, or wild nontimber products, such as mushrooms and raspberries, the surrounding area should provide. Eighteen percent should be enough.

The figure for circulation is a rough guess. Using alternative technologies, perhaps 1-5% of the area is needed for electricity generation, much of which would be the surfaces of the external structure.

In a modern city such as Los Angeles, 59 percent of the ground area is dedicated to streets and parking (other cities such as Detroit, Chicago and Dallas use 48-41 percent). By comparison, traditional walking cities were always more compact; the arcology simply eliminates cars, trucks, buses, and trains. However, walking paths, sidewalks, as well as elevators are expected to take up only 1% of the total area. Most of the entire population of the arcology would be expected to commute to local jobs, although a decent number could work inside with service jobs. That would require an onsite parking lot of some kind, depending on public transportation or private busing, although the arcology could be reached by a 2-3 mile light rail and parking areas could be located near I5.

Civic functions would also be relatively dense and so require less space over shorter times. This would be for public meetings, city meetings, celebrations—but it would also be for heroic meetings or presentations, so the spaces would need to be larger and more dramatic, but still less than 4% of the area.

7.3.4.2. External Description

A suitable configuration of trees would have to be located. There are several sites in Douglas or Umpqua County Oregon where Douglas fir trees of about the same age grow in a rough circle. However, the age and size of the trees may be younger than desired. Douglas fir has grown in recent times to over 400 feet tall per individual, often with large diameters and great age. Most of these trees, have been harvested before the 1950s.

Old trees, from 120-200 feet tall would be selected and modified. The trees and branches would provide regularly spaced scaffolds for building. A curved framework would be built between the eight trees (possibly 12), which would be the basic load-bearing members. The bark would be peeled off of approximately two-thirds of the diameter and attached to the new framework. Xylem and phloem tubes would have to reattached between the roots and the bark, either with transplanted tubes or artificial ones of nylon or plastic.

The framework could be made of carbon nanotubes or of a wood and metal structure, which would support the living cambium and bark on its outside. The frame would likely have to be extended by as much as 200 feet upward to achieve the design height.

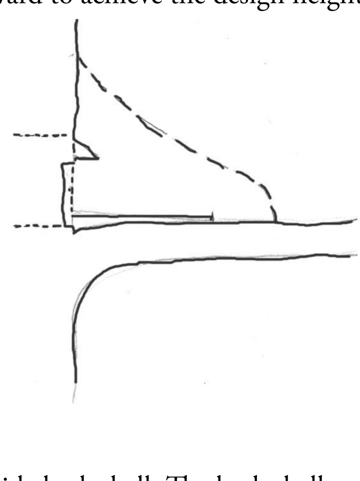


Figure 73413-1. Tree Arcology Mid-level

7.3.4.2.1. Building process

The building would be assembled from the outside bark shell. The bark shell would be supported by an industrial foam material that would allow attachment of the bark on the outside and shaping of walls on the inside. It would also be assembled from the bottom up, as joists of wood or carbon fiber were inserted for each floor.

7.3.4.2.2. Surface sheeting

Coverage by living bark would replace the need for a metal structure or for paints or external treatments. A possible alternative to bark would be the gardening method of pleaching, which is a method of weaving together tree branches to form living archways, lattices, or screens. This method might work better if self-grafting trees, such as Live Oak were to be members of the load-bearing structure. The branches could be woven to form a lattice frame for walls. Another alternative method would be to weave a layer of vines on the outside of unfinished walls. As we know, with climate change, vines are outcompeting many trees.

Regardless of which method was used, there would be opportunities for aerophytes and lichens to live on the surface. Depending on the method, the plywood scaffolding could be retained or removed, depending on the durability of the bark, branches or vines.

Upper windows could be primarily bioplastic windows that accept growth of the structure and the manage flows across the wall section to assure that the interior remains dry. Lower, larger windows could be of standard glass or 'Superglass Quad' windows would reduce the energy costs. The super-insulated windows would consist of two standard glass panels, separated by two tough plastic sheets known as 'heat mirrors.' These four layers would create three spaces that were filled with krypton gas, which would prevent the formation of condensation on the glass and heat loss to the outside. The windows would have a thermal insulation rating equivalent to a wall insulated with fiberglass bats (with an R-value of about 2.6), although they would weigh more. Inside surface sheeting could be plywood or plaster.

7.3.4.2.3. Membrane qualities

Having a living membrane would allow natural processes to continue. The local ecosystem would also continue as birds and beetles, fungus and bacteria, would live in the bark. The building would be a functioning ecosystem. This might make it more difficult to filter pests from the inside of the arcology; one option might be to open it more for bats and birds to control insects. Glass or plastic windows would be placed so that very living unit would have 2-5 entry points of access to the outside. The central light shaft from the geodesic dome at the top would allow interior light also. One important way to reduce heat loss is to build extremely well insulated structures. The use of commercially available insulting materials like the Thermalkool radiant barrier (which is paper thin and is rated R52) and other materials like mylar would help greatly. Using these materials in alternating layers with air pockets between them may let the walls be rated at over R300.

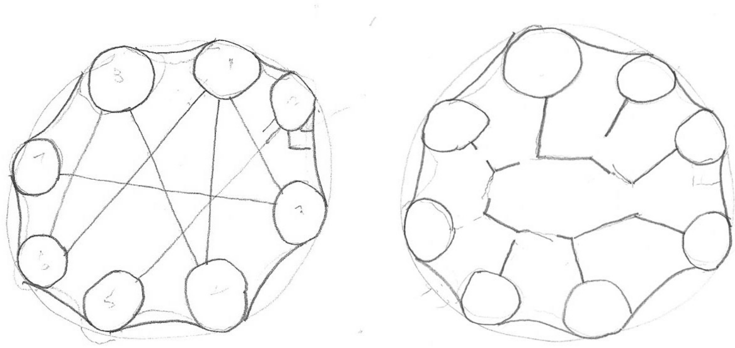


Figure 73423-1. Joist plan / Floor plan.

7.3.4.3. Internal Structure
The interior of the building would, like a tree that it resembles, be nonliving structure. Wood would be dried; other materials, such as foam or steel would be nonreactive.

7.3.4.3.1. Support Structure
An intricate pattern of joists between the eight tree columns would support each floor. No one joist would need to be longer than 50 feet; many would only need to be 20 feet or less. Some branches could serve as joists. The external branches would support a series of porches and entry ways.

The porches would have extendable and removable screen vanes covered with a solar-collecting 'paint.' These would also serve to limit the number of insects and birds entering the interior through each door.

A circular spiral wooden walkway would extend from the ground for the first four stories. It would have railings.

7.3.4.3.2. Modular units
Although most of the living units, as collections of rooms, could be standard shapes, and hence, modular, hexagonal or pentagonal shapes, many could be customized into rounded shapes or even rectangular rooms. For instance, a typical floor layout for residential areas might have seven rooms, a public or garden area and a common entry way from the elevator and outer door. The seven rooms could form two to four apartments.

7.3.4.3.3. Floors wide
Each floor would have an entry area, with an elevator and outside door. The door would lead to a balcony, which may be isolated or connected to others by an external stair case.

7.3.4.4. Areas
Although the tree arcology would be relatively small, with only 200-250 residents, it would still be divided into functional areas, including private homes with common areas for growing some foods or having plantings, gardens or small recreation areas, as well as neighborhood configurations, public areas, such as neighborhood stores, educational areas, such as schools or training, and work areas, for appropriate kinds of production.

7.3.4.4.1. *Neighborhoods & Homes.* Home size is expected to be on the European or Chinese model in terms of space, although the spaces would be very efficient. We know from studies of prisoners and animals, that crowding produces stress. To avoid the reactions of crowding, we need to design for varieties of spaces. Good designs can change behavior. Open neighborhood or public areas would meet the need for large open spaces.

Individual homes could display several kinds of wall and floor coverings. There would be minimal space for storage, so residents would be encouraged to share some kinds of tools or appliances. Frugality in clothing and possessions would be encouraged.

7.3.4.4.2. *Neighborhood public areas.* Public areas in neighborhoods would include entry ways, and common areas, which could be used for meetings or recreation on a small scale.

7.3.4.4.3. *Neighborhood stores*. One small general stores, perhaps only a 1000 square feet, would provide daily basic needs for some clothing, adhesives, food, paper, and other supplies. So, much material would have to be gotten externally, from local or regional towns or cities.

7.3.4.4.4. *City public*. The top dome could be used for private or public meetings for all the residents. In terms of scale of human groups 200-250 is larger than an immediate family (1-15) or a set of friends (30-150), but smaller than a community (1500), village (15,000) or small city (150,000). The number is small enough for decision-making as a direct democracy. But, the arcology is obviously going to be part of the larger community and economy, where much of one's identity and meaning is determined.

The arcology would require more participation. Furthermore, the design of public areas would contribute to a more democratic style. It would be a governable size, with clearly defined boundaries. The arcology would specifically work to maintain a framework to represent the people, as well as the other beings in the ecological system, by reemphasizing the goals. Efficiency is less important than participation in good judgments.

The arcology would be a limited size, dedicated to protecting desired ways of life, while leveling extremes of wealth and paying all ecological and economic costs in its boundaries (see section 6.8.3.2. in *Redesigning Regions in the Planet*).

7.3.4.4.5. *City Large stores & factories*. There would not be adequate room for large stores or factories. Other needs would have to be met through the regional network, either with other communities or larger regional centers in cities, such as Eugene or Roseburg.

Production would be limited in scale to that which could be supported within the arcology. Thus, computer work or some service functions, such as art, advertising or sales, could easily fit in the physical structure. Larger production, especially requiring assembly lines or factory processes, such as the production of light rail cars, would not be supported.

7.3.4.4.6. *Food growing*. Food growing would be limited by the scale of the arcology. This size would easily allow growing or herbs, flowers, certain fruit trees, and small truck gardens. Thus tomatoes and carrots might be grown easily, but not fields of corn or wheat.

External land would be required for food. Nut crops and tree crops could form a permanent, important agriculture. Truck gardens would work, but food such as wheat or beans would have to be traded for.

7.3.4.4.7. *Recycling and Waste*. Sewage would be treated with the living machines as envisioned by John and Nancy Todd, and based on many of their suggested principles; these treatment machines would have to be integrated in the outskirts of the arcology. The foundation of such a machine is microbial communities. But, the machine would also be a photosynthetic community, and a linked ecosystem with a variety of pulsed exchanges and nutrient reservoirs. They note that the system should have steep gradients for higher efficiencies of operation (for example large differences in pHs).

7.3.4.5. Infrastructures

Infrastructure, for daily operations and services, but also for emergencies, would be required. For instance, the arcology should have a small medical clinic, but may not be able to support cancer research or a hospital offering specialized operations.

The operation of the arcology would initially be managed by a special manager. In a similar way, the minimal services would be provided by certified individuals. This would be for food and materials, as well as medical and educational services.

Water would be collected by the structure itself, from precipitation and interception, then funneled down to storage areas. Grey water could be used for flushing and irrigating. Water might have to be rationed at times, depending on the efficiency and speed of recycling.

Emergency services would be provided by one or two specialists, given the conditions and isolation of the arcology. Transportation is an important part of any city. Due to its unique setting, no private automobiles would fit in the arcology. Inside the building, travelers, residents, employees, and visitors would shift to local elevators. These would primarily operate within public spaces throughout the interior. Service transportation is provided between floors by elevators. Large goods, furniture and appliances would be limited. Pedestrian movement outside the arcology is aided by walking and bicycles. Automobiles would be the most likely forms of transport within the region, unless public transportation or private kinds of sharing were encouraged.

7.3.4.5.1. *Horizontal Movement.* Horizontal travel would be within a floor or from the floor to the porches on limbs. It would be limited by the width of the structure.

7.3.4.5.2. *Vertical Movement.* The lower stairways would allow easy climbing on the lower levels. There would be one elevator running the entire height of the 'tree.' The elevator would be large enough for people and freight. It would be powered by electricity but capture energy on its descent through a hybrid system of batteries. Vertical movement could also provide exterior and interior vistas, as well as provide paths for air and light.

7.3.4.5.3. *Utility cores & Air/water systems.* Utility cores are concentrated on one side of the structure. This includes air and water systems. This arrangement would violate most local ordinances requiring electrical outlets every six linear feet or so. It would also force clustering of pipes for kitchens, baths, and laundries. Sewage could be treated surrounding the structure, using 'living machines' to recycle the water. The systems would also produce some plants and fish that might be edible.

7.3.4.5.4. *Energy Generation.* Primary generation of electricity would be from solar collectors. Secondary generation would come from collectors on wind generators and gravity devices. Water flowing down the outside or inside could power blades. Some generation might be produced by other chemical or mechanical processes, such as hydrogen. Human body heat could be a significant source of heat.

7.3.4.5.5. *External Grid.* The regional western grid, much of it from water power, would be available for peak times for the arcology.

Figure 73455-1. Valley location by highway and stream

7.3.4.6. Context

The arcology would exist in the context of a pattern of western urbanization, connected or surrounded by rural communities. Traditionally, in this area, communities formed in the bottom lands between the ranges. Unlike much of the United states, ranges in this area run north-south and east-west, giving the land a character of isolated valleys.

7.3.4.6.1. *Cultural.* Although the cultures of first nations are still evident, the modern industrial culture has dominated the area for over a hundred years. Although native peoples are once again training their people in their cultural ways and languages, most native peoples are tied into the modern grid though forms of trade, work or gambling. The shape and reputation of the arcology may attract people with similar philosophical and cultural beliefs, such that they may be considered more traditionally conservative.

7.3.4.6.2. *Transportation regional*. Regional transportation is dominated by a north-south highway (Interstate 5), with a few north-south feeder roads and several east-west roads. Due to the terrain, only a few roads go east to the center of the state or west to the Pacific coast.

7.3.4.6.3. *Wilderness location*. There are many state parks, as well as federal lands. The BLM owns great acreages on both sides of the coast range of mountains.

7.3.4.6.4. *Communications*. Communications networks are sophisticated. Cell phone coverage is almost complete, as is electricity. Almost any area has access to satellite communications.

7.3.4.6.5. *Resources*. Western Oregon is relatively rich in resources, especially biotic ones. Stone and rock (mica, quartz) can be found for building. An assortment of minerals can be found: Chromium (in Chromite), gold, copper, rare earths, platinum, nickel, zinc, cobalt, and coal. There are other energy sources: Wind energy and solar energy.

The land has heavy vegetation with wild animals; some areas have grasses for grazing some domestic animals. Many soils are rich with good decay and organic materials. Trees have significant wood biomass, with boughs, ferns and other plants. Diversity is considered a genetic resource.

7.3.4.7. Discussion of a Tree Arcology

An arcology of this size might be regarded as a play thing. But, it would be relatively inexpensive to build and test. It could be scaled up in several ways, although not likely by height.

There are concerns: The building time is expected to be much longer, since parts of the structure would have to grow together. Furthermore, the maintenance of the structure would require a larger knowledge base, especially to operate and direct growth processes, waste and pest management, and repair. Ecosystems are more complex than from buildings. Cost is a concern although the materials costs should be less than with traditional methods. The construction time to achieve a working functioning home might be significantly longer.

But, there are also advantages: A more sustainable value might be achieved through a linking with biological time and value. Recognizing the adaptive, renewal, cooperative, evolutionary, and longevity characteristics of the home, we might ignore the incessant desire for speed, newness and low artificial costs. The design of the arcology links people into the support matrix.

Counterintuitively, greater attention is given to the role of technology, inorganic or biological. Technology can be used to expand or contract resources. Technologies have the capability to minimize the use of resources. Breeding, fertilizer, pesticides, and modern equipment have certainly increased agricultural production, but the negative impacts of genetic loss, soil degradation, erosion, and pollution decrease actual and potential productivity. When all factors are combined, and total energy cost is compared with energy production, it is better to use more traditional and labor-intensive methods (Wittbecker, 1983).

There should be a proper mix of handicraft labor, intermediate technology, and heavy industry. The root problem is how to live with technology in a mature manner. We need an ecological awareness at all levels, a humane, existential ecology, where humans are part of the system and aware of it. But that may not be enough; we may have to legislate limits or induce adherence with economic incentives, if awareness and reasoning are not enough.

The goal of planning is community success and personal happiness, based on self-reliance in food and shelter, self-sufficiency in agriculture, and self-limitation in size and desires. If human patterns were based on mature ecosystems, civilization would be far more complex;

human values would allow for the welfare of humans, animals, plants, and land. We have to be wise enough to be disciplined, to leave wilderness for other beings, and yet to make good places for ourselves.

There are long-term benefits to a living structure. Contact with wild nature has been shown to increase human health and happiness. A living structure would make so many of the connections visible, which support the human endeavor.

7.3.4.8. Conclusion: Containment & Principles

This arcology would provide a test for small arcologies. In the Oregon area, it might be useful as a model for intentional communities. It would also serve as a test bed for creating hybrid systems or 'machines for living.'

The arcology would have a built-in waste disposal through natural forest processes, based on microbial and photosynthetic communities. It would provide more reservoirs for nutrients and wastes, and channels for exchanges with external flows of air, water and nutrients.

The city has been the most active and dynamic outlet of human life. Soleri refers to the city of the future as an arcology to remind us that a well-built city is always ecological architecture. But, for him it is also the fundamental instrument in the transformation of matter into spirit. The arcology would create a synergy between habitat and nature, body and spirit, and work and leisure. It would generate the urban effect more intensely, which would energize the inhabitants.

The arcology would be a self-contained habitat of much reduced size, with access to the surrounding domestic lands and wilderness. Not only a recognition of interdependency with the local environment, but participation in it. As a single structure, it would integrate the fundamental components of life—dwelling, eating, learning, working—into a frugal form, while accepting a certain amount of ambiguity and disorder. It would be a laboratory for doing and learning, tested through experience, and tempered by the opportunity to fail.

The principles of an arcology, from using marginal land and imploding spread to habitat density to internalizing and miniaturizing the urban effect and linking the habitat, energy and environment, serve as a model for a stable, exciting construct. The creation of a small, biotic arcology as a community of like-minded residents is an important experimental step to converting the spread of urban growth into intense, rational settlements.

7.3.5. *The Floating City of Venice Florida*

By Courtney Beasley & Heather Ryder

The water levels along the coast of Florida are rising, as the glaciers and ice melt at the poles. Possibly before 2030 those cities developed on Florida's lower-level coastlines will be the ones greatly afflicted by rising seal levels. Our focus is on Venice Florida, which is one of the cities that will be affected by these rising water conditions. Similar to the legend of the lost city of Atlantis and to Venice Italy itself, rising sea levels will cause the entire area of Venice to flood, submerging the city completely underwater. A new city will be built as a solution to preserve the history and culture of Venice, Florida. It will be developed over the surface of the water, right above the original location of what was Venice. The city will be named New Venice.

Figure 7350-1. Land view of New Venice arcology

7.3.5.1. Introduction

The high temperature of the atmosphere melts glaciers and expands the waters of the ocean. The melting ice makes the surface of the water darker. The darker surfaces reflect the heat back into the atmosphere. It is these high temperatures that are causing the rise of the sea level. Expanding the waters and melting glaciers and portions of Antarctica and Greenland. The flooding that will result will affect many cities, mostly those near or below the current sea level. One such place is Venice a city in the state of Florida. By 2030, or earlier, it may be completely submerged.

To preserve the city of Venice, after the devastating effects of rising sea levels, we propose to rebuild it as a floating arcology. A new city structure will be built capable of housing up to 25,000 people. This design will be developed as a floating structure and anchored on the surface of the water just of the coast of Florida. As a replacement, the town will exist in the exact location of its predecessor. However, New Venice will not be an exact copy of the old Venice. This aquatic town will maintain the natural beauty and aesthetic of Old Venice by using concrete styled buildings painted in soft pastels. At the same time New Venice will still offer a new ideal style of living to its citizens and tourists.

The town's compact size was chosen as being ideal for inhabitants for protection against various climate changes and oceanic weather conditions like heavy rains, strong winds, storms, high humidity, and seasonal tornados and hurricanes. The compact size of the city is also a way to offer to its citizens another level of protection, normally the ones present in most cities. Such Crimes as theft, vandalism, and possible murder that is likely to happen with in the city. The small shape of the structure allows for a strong cluster of police force that has the ability to cover more ground.

The compact design also eliminates the use of personal transportation in th form of automobiles; this is safer for people and the environment. Instead the people of Florida will be able to enjoy the use of new Venice's efficient rail system. The transportation is continuous, running throughout the entirety of the town until late into the evening. Designated stops will be easily available and they will be scattered throughout the city. Local boat rides and tunnel ways will connect the citizens of New Venice to the shores of Florida from its semipermanent, but changeable, anchorage. This will allow easy travel to and from the state and the city.

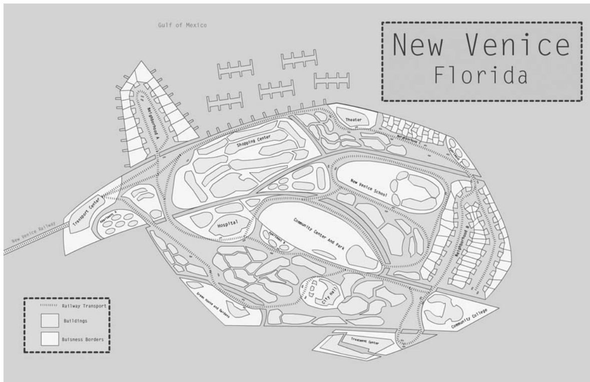


Figure 7351-1. Map of New Venice with Canals

With New Venice our objective was to build an city structure to replace a town that no longer existed because of global warming and as a sample arcology in general for inhabiting on the planet. With this city we would like to build a place that is safe for dwellers but also self sufficient when it comes to the usage of power and by being able to reuse waste. But being functional is just one step in invisioning the structure that is New Venice. The west coast of Florida is very artistically driven. That feeling is what New Venice strives for. This feeling that will exist in everything from the layout to the building. It was all considered conceptually and how these new designs could and would enfluence New Vencie artistically. All these efforts are in hopes that New Venice will be a staple in preserving a culture that will be decimated by global conditions.

7.3.5.2. Methods

Rebuilding Venice into a new city was only a fraction of our goal. To truly preserve the culture of Venice and subsequently that of Florida as well, a lot of emphasis was placed on the actual design of the city. This design would have to be functional as a sustainable living community by allowing for a residential, commercial, and agricultural type businesses and buildings. But also the city needed to be as environmentally sound as possible.

We searched online for other examples of on the water arcologies, video games, and some movies like the matrix, for references. Evenutally we realized that we wanted to do something with a tropic or sea life base. While browsing the web for aquatic life references we came across some interesting shark photos. Knowing that Venice itself is known for ancient sharks teeth, we knew that we had a theme. So we looked into how we could incorporate an artistic approach for the city using sharks as a design. In the end, a fish-like shape we thought worked better for the city as its overall base as seen from sky level, as fish are more pleasant to look at than a shark.

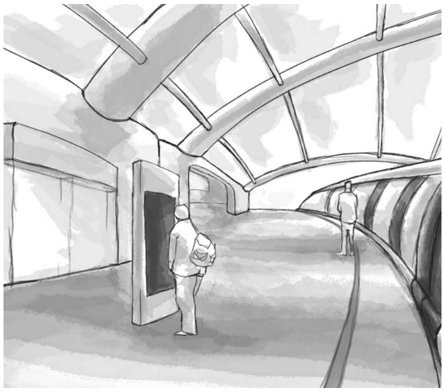


Figure 7352-1. Rail stop

Traveling to Venice for a day and looking on the internet allowed us to take in the architecture of Venice. We realized that a lot of the buildings being designed in Venice had a certain look to them. This meant that a lot of the conceptual ideas and designs we came up with would have to fit in with this very distinct aesthetic. We were also thinking along the lines that marketing and tourism would be a possible source of income for the structure. So we needed something to draw in the crowd. The idea of using a themed design was thought of. We believe it is an ideal way to bring in said tourist and to also reinforce the artistic culture that is present in Venice. The theme for our design allows us to form a series of very unique buildings, streets levels, and transportaion systems.

A lot of emphasis was placed on our designs being simple but functional, conceptually themed but still staying close to Florida's already existing styles, and for them to be economically safe and environmentally friendly. So to reinforce our idea a few building were designed and developed as a sample. They are to show what everyone can expect by living within the city. As stated above we thought a themed city design would be ideal for bringing in tourists but also appealing to those people already inhabiting the structure. The theme is aquatic in nature with an emphasis on fish or coastal species. Our reasoning is that the original Venice was considered a small fishing community. It offered much in the way of fishing and relaxing through city wide activities, historic trails, and locations (beaches) along its coastline. By imploring these ideas of the original Venice we tried to capture that sense of community with our new city. By dividing the city into residental and commerical and adopting the same street names from the original city.

The general idea is that most cities themselves are extremely wasteful and a hazard to the environments they reside in. We used books from the campus library and sources from the internet to help us develop New Venice into a town that is as efficient and eco-friendly as possible. We looked at other examples of developing arcologies for answers on how they managed to build a green city. These similar ideas and their functions were then used as a basis for own designs, functionality of the our city, vehicles, and established enterprises. By using their already developed ideas, we were able to understand and apply them to our structure with some tweaks for general design purposes and functionality for this particular type of city. The use of power plants to supply energy throughout the city may be necessary. Having a hydrophonic green house to supply the structure with its vegetation is a good idea; it would be similar to the the McMurdo station built for the United States Antarctic program.

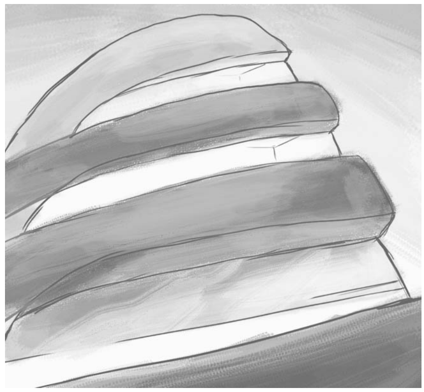


Figure 7352-1. Residence building

7.3.5.3. The Design

From the beginning we knew we had to develop our ideas for New Venice to be as environmentally sound as possible. But at the same time sturdy enough that it could resist the harshness of the weather that can become a problem on the water. This meant that New Venice would have to be anchored to the spot of its location. So, New Venice is stationed three miles off the west coast of Florida. Utilizing Soleri's human beehive concept the structure of New Venice will stand at about 4-5 stories tall. Below its surface are another 2-3 stories. They are developed for underwater living areas, escape bunkers, and also for the aquarium. The total length of of the city would be no more then 500 feet long, with roughly 700,000 square feet of space. All designed to house up to a total of 25,000 people. Each section within the city has a specific percentage of space divided to be as convenient for citizens as possible.

Table 7353-1. Space given to each section of the City of New Venice

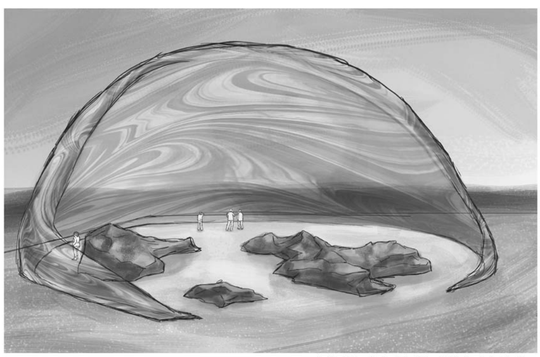
Residence	*Business*	*Entertainment*	*Transportation*
40%	30%	20%	10%
~280,000 sq ft	~210,000 sq ft	~140,000 sq ft	~70,0000 sq ft

Since the city is not particularily large, we looked into ways that people could be transported around quickly without the need to use cars. We decided that a continuous rail system would best to serve our purpose. This rail system would be magnetic and structured similar to the bullet trains (Shinkansen) in Japan. The magnetics of our train system and much of the power throughout the city will be powered by water pumping through designated power plants underneath the city. The water that powers the city will flow from the surrounding ocean and also through the various cannals the run throughout the city. However, the canals will serve as an alternative transportation route via boat within the city.

The actual construction or main hull of New Venice would be built using steel. With most of the buildings made with concrete. The glass used on the exterior of the structure would have to be hardened and designed to protect against windstorms and impacts from various debris. The type of glass would have to be a type of impact safe glass, which consisits of a stong laminated interlayer of glass that is bonded between two panes of heat-strengthed glass. However the lamination wanted for this project can not directly reflect the surface of the water, as this is bad for the wildlife, since wildlife preceives the windows to actually be the surface of the water.

We studied ways to supply food to the people settled on New Venice. The McMurdo station as part of the United States Antarctic Program uses a hydrophonic green house to grow all of their fruits and vegetables. We also looked at the work of Bill Toone, who is the leader of a conservation group in San Diego called Escondido. He has developed a scaleable green house system that uses both aquaphonics and hydrophonics. In tanks he raised fish that live and reproduce. These fish then create waste that becomes nutrition for the plants that grow among the fish. The water is filtered and recycled back into the tank. It is this idea that we applied to our own green house. But the green house is not the only source for food. Fishing along the banks of the city will provide people with their own food and also serves as another way to gain an income for the city, by catching and selling outside of the structure.

The housing apartments (or condos) will be designed to fit comfortably up to 2 people. The size is generally 900-2000 sq ft. With some districts specifically designed to house up to 4 people. Our reasoning is that when touring Venice we recognized that it mostly a senior citzen living area. A life style that we do not believe will change much in the future. The interior of these complexes will feature the use 75%-100% of recycled glass for the tileing, counter tops, and the flooring. The complexes will use low-flow shower heads and toilets. Apartment ceilings would have sensor lights installed in them that turn the lights off when no motion is present in a room. The use of solar panels on some commercial buildings will be used to provide energy and power. The main purpose for this whole process is to promote construction that supports the conservation of energy, water, and building materials. And, to stress to the citizens the idea of how they themselves can help to sustain the city by preserving energy by using less lights during the day, and by changing their living habits to support an eco-friendly community.



Heather Ryder, Venice Under Water (2081). New Venice Florida

Figure 7353-1. Entertainment under a dome near New Venice

7.3.5.4. Attractions

Once the construction of New Venice is complete, our citizens will be able to enjoy the rich and relaxing accommodations we have to offer. The 5-mile radius allows for easy travel throughout the city. And its 3-mile distance from the coast of Florida offers a wonderful and exotic backdrop from any location within the city. If one were to tire from the day to day bussle of a city floating out on the water, then the bridge that leads into the city is always connected to the main coast of Florida. Travel between our city and Florida is safe, fast, and easy.

Once inside New Venice there is an abundance of activities to participate in. Our mulipurpose theatre is the number one source of entertainment when it comes to watching plays, viewing movies, and participating in concerts. Our art center is wonderful for recreation and physical fitness. Have an appointment to make, out on the streets of New Venice?

Well, New Venice has got you covered. We have two various ways for people to travel to their destinations. Our state of the art rail way will get you there in no time. This railway uses magnetics to travel along its terminal that stretches across the entire scope of New Venice. Miss your ride the first time around? No problem. Our rail system is continuous and runs throughout the day. It is only at night that it takes a shorter route and stops at desginated stops to conserve energy. If you would like to travel and have more time on your hands, you could take a trip down the canals on one of manned ferry boats.

At New Venice we have plenty of activites available to all. From festivals to fishing. There are plenty of places with in and around New Venice where one can go to enjoy a peaceful and tranquil day. This activity is not only a great way to relax but it is also an excellent way for one to catch their dinner for the evening. Interested in even more fish. The New Venice Aquarium is just the place to go. A trip that anyone can enjoy no matter what their age is. The aquarium is nestled on the 2-3 level below the city, directily in the water. It allows you to take in the grand scope that is the ocean while also serving as a reminder to the past. Directly below New Venice slowly being turned into a new bed of coral are the old ruins of Venice, Florida. This small aquarium allows us to look back into the past but it also reinforces the idea of recycling, because people can look out into the water and watch as nature recycles and rebuilds to make itself a better home.

If you are interested in how new Venice is able to supply food to its citizens, you can take a trip over to the greenhouse. Our greenhouse is open to the public. It is an ideal site for educational trips from the schools or for any one with general curiosity. The greenhouse operates on a two way system when it comes to suppling food. It serves as a habitat for the fish that reside there and use the vegetation for food and shelter. And it is also a way to cultivate food, and supply it fresh to the market. To the citizens, the greenhouse is a great lesson in understanding the functions of a give and take balance that make up the foundation of a sustainable ecosytem. This idea would hopefully integrate inself into the minds of the citizens and push them forward in a way that allows them to help sustain New Venice as a eco-friendly and self-suffient city.

7.3.5.5. Discussion & Conclusion

Floating cities have been proposed since the early days of science fiction. Recently, there was a proposal to float New Orleans as a response to hurricances and water surges. The Seasteading Institute in San Francisco has made plans for the construction of a homestead on the Pacific Ocean. It would be expandable, such that modular neighborhoods could be added later. A prototype might be based on an oil-drilling platform, although not fixed in place and using suspension bridge technology to expand space. Another engineer suggests it might resemble a cruise ship. They suggest that the city might not only operate differently, but might be a natural form to experiment with new political systems.

The Belgian architect Vincent Callebaut created a design for 'The Lilypad,' a floating ecopolis for climate refugees. Based on the structure of a lily pad, but at 250 times the scale and made of polyester fibers coated in titanium dioxide, the city would have 50,000 residents with a complement of biodiversity in a half aquatic, half terrestrial city. The city would have three mountain regions with buildings and streets, and a central lagoon as ballast (and also allow marinas).

Arcologies similar to New Venice could house the displacement of millions of people as a result of global climate change. Not only is the Gulf coast of American nations threatened by these changes, but the low-lying islands in the Pacific, parts of India and Southeast Asia, and the Low Countries in Europe are likely to lose dry territories.

Overall our vision for New Venice is to build a community that is both safe and compact. A structure that remembers the past and is built for starting a new future. A construction designed for recreational pleasure and for environmental exploration. And, a new home for a generation that has learned to live in harmony with natural communities.

The buildings are designed to be simple, functional, and conceptually different at the same time. To express this idea, all buildings are designed using simple shapes that resemble aquatic environments and species. Theoretically we tried to push for a compound that was environmentally friendly. To do this we thought of using recycled materials such as glass when ever possible. Physically we had no way to apply these theories and ideas. But it is our hope that given time and more study, our ideas for New Venice will be able to be developed.

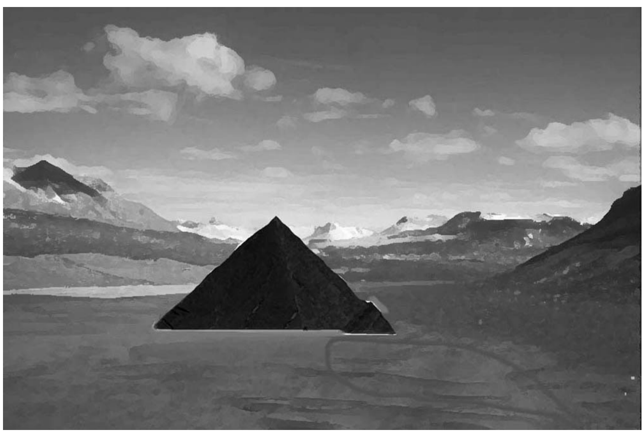


Figure 7311-2. Antarctica World Pyramid arcology (in *Redesigning the Planet*)

7.3.6. ***Mumbai Arcology: A Shellarcology***

The Mumbai Arcology would be a shell for 600,000 slum dwellers to inhabit, located in the Western Ghats, or the Sahyadri Mountains. This mountain range is along the western side of India, on the western edge of the Deccan Plateau, separating it from a narrow coastal plain along the Arabian Sea. The hills are a faulted plateau of the Deccan Flats, a giant bed of basalt covering much of India from a massive series of volcanic eruptions about 65 million years ago. The hills are a catchment area for a complex of river systems. The majority of streams have been dammed for lakes and reservoirs.

7.3.6.1. General description of Arcology

The arcology would require an internal floor area of 50 million square feet and a volume of 500 million cubic feet. The footprint would be relatively small at 2.5 million square feet (58 acres or 24 hectares), with 20 stories, 10 of which would be underground in the basalt, 4 within the profile of the ground and six above the surrounding hills. The grassland is deep loess soils on a basaltic base, developing in a modified Mediterranean climate. In essence the entire arcology would be shaped like a loess hill, with a smooth rise from the southwest to the northeast, where the slope would be steeper. Much of the surface would be planted in native grasses. The density would be 862 people per acre (2083 per hectare). The overall height would only be 120 feet (37 meters), well within the variations of the topographic elevations.

Figure 7361-1. Site of Mumbai Shell Arcology (current slum)

7.3.6.1.1. Site

The Greater Mumbai area rests on the Deccan basalt flows, which poured out between the late Cretaceous and early Eocene times. The basalt flows are horizontally bedded with certain extrusive and intrusive mafic types and with rich fossil-bearing sediments that make it less uniform than the Deccan basalt in general. Geographically, Greater Mumbai is an island outside the mainland of Kokan in Maharashtra separated from the mainland by a narrow Creek and a wider Bay. The city covers the original island group of Mumbai, so it is surrounded on three sides by the seas: by the Arabian Sea to the west and the south, the Harbour Bay and the Thane Creek in the east.

Its height is hardly 10 to 15 meters above sea level. At some places the height is just above the sea level. Part of Mumbai City district is a reclaimed land on Arabian Sea coast. Mumbai City is one of the first four metropolitan areas in India.

The climate is generally humid and tropical, although frosts occur in some locations. The area has high rainfall from the westerly monsoons. The area was occupied by tribal groups until the British cleared large area for agricultural and timber plantations. Coffee and tea are grown in the area. The soils in the city are sandy, surrounded by alluvial/loamy soils.

Mumbai Island has ridges along its western and eastern side. The city of Mumbai is built on the central low-lying part of the island. The western ridge comprises stratified ash beds overlain by hard, massive, andesitic lava flows, both formations showing gentle tilt towards the west. The stratified ashes, which display variegated colors and variable textures, attain a total thickness of about 135 feet (45 meters).

7.3.6.1.2. Populations

In the Paleolithic, fishing villages formed on the small islands in the area, where marshes and mangrove forests were drained by streams. Much later, the area hosted trade between China and Africa. The city of Bombay was founded by Portuguese and British colonists in the 1600s (the name was changed to Mumbai in 1995). After the British leased the islands, they drained and filled in the marshes, building bridges and railway lines, and attracting migrants from across India. After independence in 1947, the population expanded exponentially. Modern commerce and technology sectors have replaced the recent heavy industries, and the size of the city has expanded. Although troubled with overpopulation, crime and pollution, Mumbai offers a higher quality of life and a rich culture in a modern economy and large urban infrastructure.

The arcology is designed for a large human population that would be surrounded by wild plants and animals within the building, as well as by domesticated annuals and plants—all within an urban context.

7.3.6.1.2.1. Human Population

Although the arcology is designed for 250,000-300,000 people, because it is offered as a shell for slum-dwellers in an area, and it is not controlled by the government, the actual population may range from 100,00 to 600,000. Perhaps as much as 10 percent of the population would be transient or temporary. A large permanent population would be expected due to the opportunity to create home-based businesses.

7.3.6.1.2.2. Animal & Plant Populations

The arcology would be in the middle of one of 10 identified diversity 'hotspots.' The area has over 5000 species of flowering plants, 139 mammal species, 508 bird species and 179 amphibian species—of which 325 may be threatened. The nation has established parks and biosphere reserves. Fragile ecosystems are protected from mining and hydroelectric projects.

Wild animals and plants would colonize parts of the arcology without human assistance. Domestic animals and plants would be added for food, medicinal, aesthetic and companionship purposes.

7.3.6.1.3. Spaces

The Mumbai Shell Arcology would offer generous spaces for public activities as well as parks and food growing areas. These might be contracted or expanded as the population changes. Each floor would be open as people moved into the structure, having only regularly-spaced light and utility wells.

Table 73613-1. Division of Space

Spaces	*Area (in square feet)*	*Percentage*
Living space	180,000,000 sq. ft.	30%
Public/commercial space	108,000,000	18%
Civic functions		
Commercial		
Public circulation services	100,000,000	16%
Utility		
Paths/rails		
Food-growing space	105,000,000	18%
Parks/wild	107,000,000	18%
Total Area	600,000,000	100%

The percentage set aside for parks is higher than for most cities (good cities usually set aside 10-15% of their area). Deciding how much area for food-growing is difficult, as most cities trade and import their food, much of which, like wheat, corn, melons, or tomatoes, require large areas; however, for greenhouse, hydroponic, or small truck gardens, eighteen percent should be enough.

The figure for circulation services is a hybrid figure, since many utilities would be contained or underground. Using alternative technologies, perhaps 1-5% of the area is needed for electricity generation, much of which would be the surfaces of other structures.

In an industrial city such as Los Angeles, 59 percent of the ground area is dedicated to streets and parking (other cities such as Detroit, Chicago and Dallas use 48-41 percent). By comparison, traditional walking cities were always more compact; the arcology simply eliminates cars, trucks, buses, and trains. However, walking paths, sidewalks, as well as light rail and escalators are expected to take up 5-8% of the total area.

Areas set aside for civic and commercial functions are relatively generous. Most of the entire population of the arcology, as well as external workers or visitors would be 'housed' in these areas for 8-11 hours per day. Assuming that each business had 3-9 employees, perhaps as little as 3-5% of the area would be reserved for commercial enterprise.

Civic functions would also be relatively dense and so require less space over shorter times. This would be for public meetings, city meetings, celebrations—but it would also be for heroic meetings or presentations, so the spaces would need to be larger and more dramatic, perhaps 4-10% of the area.

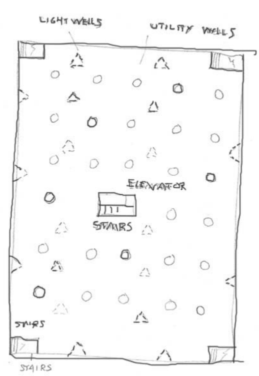


Figure 73613-1. Detail of a middle floor showing columns

7.3.6.2. External

Most construction in Mumbai is masonry, although perhaps 10 percent is reinforced concrete. And, 60 percent are nonengineered structures, mostly walls and covered porches.

The building would be oriented on a northwest-southeast axis. Large trees would be planted on the southeast and southwest sides. The structure would be a cube about 500 feet tall, with columns of balconies.

This building would be pre-stressed, low-carbon concrete, sheeted in clay brick, made locally. Glass windows and doors would be triple-glazed, but capable of being opened. A limited number of fixed windows would be shaded externally. Wooden doors would be insulated. Natural ventilation would be favored.

The building is thermally massive, with reinforced concrete construction (not a glass-curtain wall) with cavity brick infill walls, plastered inside and out, with hollow concrete blocks. Vermiculite could be used in places as an insulating material. External surfaces would be white or light brown; some surfaces might have a china mosaic finish in bright colors.

It would be a low-energy building with passive features and low-energy strategies. Climate-responsive techniques, such as orientation, shading devices, wall-window ratio, integrated daylight, and partial air-conditioning would be favored (Screw and centrifugal chillers) and air would move as a result of the chimney effect.

The roof would be sod, planted in native herbs, flowers and trees. The roof would have a large temple with gardens and a large paved (grasses over block) meeting square surrounding it. It would be connected to exits by numerous paths. The roof could also provide extensive shading.

7.2.6.2.1. Building process

Building would begin, after planning and design participation, with the excavation. Floors would be made of low carbon concrete supported by concrete columns. The external walls would be built next of clay brick. Utility shafts would be added every 100 feet and designed for access and connection on every side. Light wells would also be placed alternately every 100 feet.

Concrete is a versatile and stable building material and the second most widely used resource in the world (after water). Concrete can produce a lot of carbon during its manufacture. One of the most important factors is that cement, the main energy-intensive binding component of concrete, is made from crushed Limestone, one of the most common minerals found. Limestone is generally be harvested and processed locally, which reduces transportation costs. Alternatively, cement could be made wholly or partially from waste products from other production processes such as fly ash (waste from electricity generation), silica or slag (waste from steel manufacture), which could reduce its carbon footprint by 80 percent.

Despite its carbon costs, concrete has many advantages over wood or plastics. For instance, it is durable, and sustainable design and green building emphasize long-term solutions and products over cheap, short-term products that generate waste. Concrete can last for many times longer than conventional building materials, such as wood or drywall. It is resistant to insect activity, rot, rust, and fire. Concrete also forms airtight seals, which minimize drafts and reduce air-conditioning costs. Although concrete is naturally light-colored and can reflect light and heat, it will also take colors so its dark surfaces would absorb heat. Concrete acts as a natural insulator and retains heat, which is useful in cold climates. It can absorb warmth from the sun and keep the heat inside.

The goals of sustainable design and green building are to reduce the negative impact of human actions by reducing, reusing and recycling. The use of fly ash or slag in place of cement results in a low-carbon, intensive concrete often used in Britain and Ireland.

On a global scale, concrete is the most commonly used material for building infrastructure. The manufacture of 1.5 billion tons of cement generates approximately 5% of global carbon emissions. Low-carbon concrete (LCC) could save over a billion tons of CO_2 emissions, billions of tons of quarrying, and thousands of years of electricity use. Like normal concrete, LCC offers fire resistance, sound and noise insulation, thermal mass, ease of construction, and availability. LCC, however, is stronger, more durable, and lighter in color than normal concrete. LCC can last twice as long in aggressive environments, such as those found on farms, in marine environments or under harsh climates. LCC shows greatly improved strength after fire, which can reduce the strength. Acids such as those found in farms and wastewater treatment plants cause deterioration of concrete. Previously developed sites may contain contaminants in the soil and ground water, which attack concrete, causing expansion and cracking that lead to accelerated deterioration. LCC improves the chemistry and reduces the porosity of the concrete, protecting it from sulphates. Salts on roads and in marine environments penetrate concrete, attacking the steel reinforcement and causing it to expand. This causes the surrounding concrete to crack, requiring repair and, ultimately replacement. Cracking and voids will lead to significant damage in your concrete. LCC has less cracking because of its chemistry, and has a much reduced void ratio than normal concrete

The use of heavyweight construction materials with high thermal mass can reduce total heating and cooling requirements. Dense, cast concrete has the highest conductivity and heat capacity after water, higher than granite, block or clay, and much higher than plaster, timber, carpet, or fiberglass.

7.3.6.2.2. Surface sheeting & Membrane Qualities

The clay brick external walls would have window openings every 20 feet on all four sides of the building. Large balconies with exterior doors would be placed every 100 feet. The doors and window would allow breezes and views.

The concrete would be covered with thin plastic sheets from recycled materials. The north face of the building would have many larger glass windows. The very large windows would be—not standard glass, which would drain the building of heat—but new ‘Superglass Quad’ windows would reduce the energy costs. The super-insulated windows would consist of two standard glass panels, separated by two tough plastic sheets known as ‘heat mirrors.’ These four layers would create three spaces that were filled with krypton gas, which would prevent the formation of condensation on the glass and heat loss to the outside. Altogether, the windows would have a thermal insulation rating equivalent to a wall insulated with fiberglass bats (with an R-value of about 2.6). Even with windows and doors, the building should be very cool in the hot season.

The underground membrane would be impermeable, so that water could be collected and stored before it reached the local aquifer. The faces of the building would allow exchanges of air and organisms through doors and windows. It would be a relatively open system, especially for bacteria and insects.

One important way to reduce heat loss is to build extremely well insulated structures. The use of commercially available insulting materials like the Thermalkool radiant barrier (which is paper thin and is rated R52) and other materials like Mylar would help greatly. Using these materials in alternating layers with air pockets between them may let the walls be rated at over R300 at less than one foot thick (a typical American home uses fiberglass insulation rated about R30).

7.3.6.3. Internal Structure of Mumbai

The footprint of the arcology would be a rectangle. The front entrance would have a high-columned setback. Except for the utility shafts and light wells, no interior walls would be constructed before occupancy. The occupants would determine their own configurations.

An arcology is a natural place to experiment with a new generation of products, for instance, tools that promote greater autonomy and decentralization, as well as better and smaller communication devices, which is already a trend in technology. Alternative energy sources could be used to power longer-lasting, higher-quality appliances and motors, built with benign manufacturing systems in an industrial ecology. The arcology itself would be a multiple-use building, which would be assembled from mass-produced, modular housing and basic paths and an automated rail system, using recycled or biodegradable materials.

The structure would have 100 central light wells, which would be fed by the thousands of light tubes interspersed with the native grasses. Utility shafts would be placed through the vertical solid interior support walls.

7.3.6.3.1. *Support Structures*. The support columns would be load bearing and noncustomizable. Floors would be low-carbon concrete. Outer walls would be local brick.

7.3.6.3.2. *Modular units.* Plans for some basic three-room modular units would be offered. Many resources, from brick to recycled metals and wood, would be made available.

7.3.6.4. Areas

In most proposed arcologies, the areas are zoned according to use, and this is reflected by room-size, utility density and other design features. However, in the Mumbai shell arcology, the structure provides minimal protection and basic utilities and materials. Special areas for stores or factories might be pre-wired for capacity, but not delineated with walls or larger corridors. Essentially, the structure is prepared to be designed by the occupants themselves. Special areas for energy generation would not be necessary, since the use of micro-generators and collectors would fit on the roof and external walls.

7.3.6.4.1. Neighborhoods & Homes. Home size would likely be limited by cultural standards as well as the availability of building and finishing materials. A significant area of every floor, perhaps even 100 percent of some, would end up as private homes.

7.3.6.4.2. *Neighborhood public areas*. Neighborhood public areas might be suggested by the absence of utility shafts. Public areas would be sized according to the floor population, such that there would be a public area for every 250 people.

7.3.6.4.3. *Neighborhood stores*. Certain areas of each floor may have enhanced utility shafts, to power additional lights, refrigerating or power equipment. It is expected that each floor might host 10-12 stores.

7.3.6.4.4. *City public areas*. The top central dome would be set aside as a religious area. Since only the shell and floors, with utility access would be finished, the new residents would be free to shape the interior according to their needs, including public areas for meeting or gathering for specific purposes, such as celebrations of announcements.

Traditional Indian government in this area was small village within an empire. When the Europeans settled the area, they brought their centralized, representational government. The original goal of the American republic, according to Jefferson, was to make each person a participant in the everyday affairs of government.

The arcology would require more participation, which would be expected to mirror the self-organization of the previous slum. Furthermore, the design of public areas would contribute to a more democratic style. It would be a governable size, with clearly defined boundaries. The arcology would specifically work to maintain a framework to represent the people, as well as the other beings in the ecological system, by reemphasizing the goals. Efficiency is less important than participation in good judgments.

The arcology would be a limited size from a calculate optimum, dedicated to protecting desired ways of life, while leveling extremes of wealth and paying all ecological and economic costs (see section 6.8.3.2. in *Redesigning Regions in the Planet*).

7.3.6.4.5. *City Large Stores & Factories*. It is expected that people will create large stores to provide food and materials to others, and that other people will create relatively large businesses to produce other items for use or trade. Such large, relatively energy-intensive businesses would be anticipated.

7.3.6.4.6. *Food Growing*. There are virtually no agriculture or food growing areas in the Mumbai City district. Food is imported from other parts of India by truck, airplane and ship. Some areas would be established in the arcology, with soil and plumbing.

Information on food growing would be available, and it is likely that many families would establish small gardens for their own use for food, as light wells and external windows should provide adequate light. Therefore, it is likely that some food will be grown inside, in greenhouses, either in soil media or hydroponically. Some areas may have tree or root crops. Individual homes may also plant herb or limited gardens.

A possible vertical farm on the east side of the building could create 'closed loop agricultural' ecosystems, where nearly every aspect of the farming process is recycled and re-used, especially water and nutrients. This and some horizontal farm areas would solve the problem of inadequate expanses of fertile farmland nearby. The vertical farm could offer a solution in the form of a complete self-sufficient ecosystem that covers everything from food production to waste management.

7.3.6.4.7. *Recycling & Waste*. Local sewage was previously dumped untreated into the water system. In the arcology, each floor would have basic plumbed tanks and some internal sewage would be treated with the living machines as envisioned by John and Nancy Todd, and based on many of their suggested principles. The foundation of such a machine is microbial communities within a photosynthetic community, and a linked ecosystem with a variety of pulsed exchanges and nutrient reservoirs. The system could have steep gradients for higher efficiencies of operation (for example large differences in pHs).

7.3.6.4.8. *Missing Areas*: Roads & Parking. Roads are missing internally because there are no trucks or cars. Pedestrian paths are wide enough to handle carts and a few powered carts or bicycles, which would be used for deliveries of large items such as furniture, appliances, and large packages (food, clothing, or supplies). Large shipments to the arcology could be by train or truck with access from main highways.

7.3.6.5. *Infrastructures of Mumbai*

The structure would require initial large quantities of electricity and water for operation. Construction material would be available as collected or 'harvested' from other construction sites. Initially, 'seed' stores on every floor could provide food and material for the first generation of residents. Medical services could be provided in the same way at the beginning.

Emergency services would be provided by the surrounding urban area. Places in Mumbai are susceptible to cyclones and landslides. The city would be responsible for planning for disaster mitigation and preparedness. The arcology would be another unit in the governmental network.

Transportation is an important part of any city. Due to its unique setting, no private automobiles would be allowed in the arcology.

The main terminal on the southwest side of the structure would connect the arcology to the local port. Maglev lines would take travelers from the port and from the main station to local stations within the building. Inside the building, travelers, residents, employees, and visitors would shift from mass transit to local paths, rails or elevators. These would primarily operate within public spaces throughout the interior. Within vertical neighborhoods, vertical circulation would be enhanced by extensive use of stairs and several large elevators. Pedestrian movement is aided by a small rail system on each floor. Service transportation is provided between floors and in construction yards, warehouses and distribution depots. Freight elevators handle construction materials and large goods or appliances.

7.3.6.5.1. *Horizontal Movement.* Horizontal travel paths would form through self-organization during the occupation of the structure. A special grid for a rail on every floor would be marked as a suggestion, but not built or reinforced with special materials.

7.3.6.5.2. Vertical Movement. Vertical movement could be accommodated by 4 elevators per floor, located near the corners of the structure. Stairways would also be located near the corners. With external windows, the stairways could also allow more light and air circulation.

7.3.6.5.3. *Utility cores*. The utility cores would be bunched for easy access and maintenance. Airflow and controlled temperature are handled by interior ventilation systems using the Chimney effect (hot air rises).

7.3.6.5.4. *Energy Generation*. A number of micro wind and solar generators on the roof and external walls would allow people to supplement purchased grid energy. Some built-in features of the building itself, from generators from falling water and excess heat (body and thermal), would supplement grid energy. In general, the thermal mass and airflow design of the structure would allow significant conservation of energy, lowering the requirements from the regional grid.

Services, such as electricity and water, would radiate out from a central core. Most residential areas would be intermingled with small businesses and recreation. Light and possibly some heavy manufacturing would be confined to lower levels (in spite of the cultural influence of science fiction stories about underground manufacturing).

Some built-in features of the building itself, from generators from falling water and excess rising heat (body and thermal), would supplement grid energy. In general, the thermal mass and airflow design of the structure would allow significant conservation of energy, lowering the requirements from fossil fuels.

The design of the structure puts an emphasis on the pedestrian, saving the fossil fuels that would normally power automobiles. The three-dimensional, multiuse design puts the pedestrian within walking distance of most functions, allowing residents to live, work and learn in a densely-packed, lively space. Close access to some natural environments would give residents limited recreational opportunities without personal vehicles. Food production in the greenhouses would save fuel by eliminating much trucking of food to the city.

Alternative sources of energy production for the reduced needs of the residents include solar panels with photovoltaic cells on the external glass, which could occupy 500,000 square feet and produce 10 megawatts of low voltage electricity per hour for use in low voltage lighting throughout the building.

External windmills also located to the east of the arcology could produce 10 megawatts of electricity every hour of the operation. A field of solar power generators, 3000 Genset hydrogen conversion units near the south face could take advantage of even low light to produce 100 megawatts of electricity per hour, the bulk of the household electrical needs in the arcology.

The structures ventilation system takes full advantage of both rising warm air and sinking cool air, the chimney effect.

7.3.6.5.5. *External grid*. The electricity requirements are currently provided by the Tata Hydroelectric System, through various distribution agencies. The arcology might depend on the grid at first, and at peak periods of demand after its own electricity generation is working.

7.3.6.6. *Context*

Almost 80 percent of the city is dedicated to habitation. Most of the remainder is wired and plumbed as industrial areas. The city has numerous administrative units and fire brigades. Water is supplied from two rivers in the Greater Mumbai area, Dahiser and Mithi Rivers, through three dams. Some solid waste could be taken to three dumping sites. The city has a diverse base of industries, including engineering, printing, garments, textiles, plastics, and chemical (41 industries and tank farms), with of course many hazardous materials, from chlorine to propylane and styrene.

A modern transportation grid, with new highways, has already been established. It could remain with emphasis on mass transport.

7.3.6.6.1. *Cultural*. Mumbai City was one of the first four urban areas in India. There are many religious centers in the city proper, including churches, temples, and mosques. There are also parks and stadia, where large numbers of people can congregate.

The arcology would provide a physical center for slum dwellers in unauthorized slums. It would also provide minimum service for healthy existence. The large dedicated area on the top floor could host temples and meeting areas.

7.3.6.6.2. *Transportation regional*. Mumbai is an international seaport and airport of national and international importance. It is connected to other parts of India by Express Highways and Central and Western railways. The waterways have various ferry services.

7.3.6.6.4. Wilderness location. Forest cover in the urban area is negligible. There are significant forest and wilderness areas far to the east of Mumbai. Some areas to the east, at the site of the old slum, could be restored to forest and exploited for some timber and non-timber products.

7.3.6.6.5. *Communications*. The Public Information System (PIS) demands that people are kept aware and informed of the entire cycle of disaster management from the stage of risk assessment. A lot of community education, awareness building, and plan dissemination and preparedness exercises has to precede in the arcology if a meaningful PIS is made operational.

This can be ensured by upgrading the present communication system with a more efficient wireless system. The wireless system should be full duplex and also enable communication with different line departments.

7.3.6.7. *Discussion & Justification*

The authorized and unauthorized slum colonies (2335 in 1985) of Mumbai contain over 70 percent of the population. All the slums are vulnerable to fires, floods, cyclones and many health hazards. Slums are located on hilltops, slopes, low-lying areas, coastal areas, along highways and railways, water mains, and in industrial zones. The city attempts to provide electricity, water and toilets to the authorized colonies. Land ownership is problematic.

Mumbai has a self-organizing slum of over 600,000 people. The slum has some positive attributes, such as being climate-adapted, very mixed use, and walkable. Social cohesiveness makes some slums livable. Some people have accumulated forms of wealth. Many people in slums have color TVs, radios, cell phones, and possibly a washing machine or motorcycle as well. Slums dwellers do not pay taxes or get permits, but some charge others rent. They sell things and services. When slums are in proximity to rich neighborhoods, supply and demand seems to work for maids, drivers, gardeners, and guards. Even in slums, cities allow new forms of income generation. This is not surprising, since cities spawned specialists. The density allows cities, even slum cities, to provide more efficient services like education, sanitation and power. More than anything, every slum needs water, sanitation, and electricity; garbage is often recycled internally.

If the arcology becomes anything like the existing slum in organization, then most areas would be mixed-use, with work areas near living areas. Because cell phones allow such flexibility and connectivity, the infrastructure may not have to be as formal.

Greater attention is given to the human scale in an Arcology. Pedestrian distances are measured by walks and in minutes. Other wheeled vehicles, such as bicycles or battery-powered carts, could be available for delivery or even recreation.

Greater attention is also given to the role of technology. Technology can be used to expand or contract resources. Technologies have the capability to minimize the use of resources, but they also have negative effects. Breeding, fertilizer, pesticides, and modern equipment have certainly increased agricultural production, but the negative impacts of genetic loss, soil degradation, erosion, and pollution decrease actual and potential productivity. When all factors are combined, and total energy cost is compared with energy production, the result is disappointing and does not compare well with traditional methods, using draft animals and human labor (Wittbecker, 1983). This should not be a problem in the arcology, as slum work is generally labor-intensive and efficient.

There should be a proper mix of handicraft labor, intermediate technology, and heavy industry. The root problem is how to live with technology in a mature manner. The arcology will need an ecological awareness at all levels, a humane, existential ecology, where humans are part of the system and aware of it. But that may not be enough; the arcology dwellers might have to legislate limits or induce adherence with economic incentives, if awareness and reasoning are not enough.

The Mumbai Arcology (similar in size to Paolo Soleri's Babel IID, which was designed for 550,000 residents) would be located on a high flat site, with access to roads and railways. It would provide a roof and outer walls, floors, and utilities that would be metered for each floor. Arcologies could offer more security through tenure as well as basic services. The informal economy is very large scale. The basic building would channel resourcefulness into building the rest of the arcology.

This kind of Shellarcology might work in other slums, including West Point in Liberia, Mathare in Kenya, Borde de Vias Colony in Mexico City, Rio de Janeiro Brasil, Istanbul Turkey, Port au Prince Haiti, and Kibera Nairobi Kenya. Haiti would also be a promising place to start, due to the long combination of circumstances, from dictatorial rule to deforestation and earthquakes, which have impoverished the nation.

Crime might be a problem. It might be necessary to train people to create their own law or rule enforcement, since state personnel might not fit or be welcome.

An arcology is an example of heroic architecture, large size combined with high intensity. Yet, some architects, designers and thinkers, such as Victor Papanek, have noted that large-scale increases the likelihood of failure. Does this mean that an arcology this size will necessarily fail? Possibly not. On the scale of traditional cities, it is not large. In the tradition of buildings, it is large, but it is not as complex as a large machine. Although it is complex, it does not rely on complex nests of machines. In fact, it uses many simple designs and principles, such as the chimney effect or termite mound model, to avoid having to control complete processes from rising air and heat to falling water. Furthermore, the intentional, conscious design of the arcology would give it many advantages over a traditional city of the same size (and it would be far smaller than megacities such as Mexico City or Tokyo).

Mike Davis credits some religious groups, such as Populist Islam and Pentacostal Christianity for helping slums to organize. These groups can become the informal governments of slums, providing legal aid, medicine, and help with funerals, or other social services. This would likely happen in the Mumbai Arcology, helped by ethnic uniformity and three major established religions, Hinduism, Islam, and Christianity.

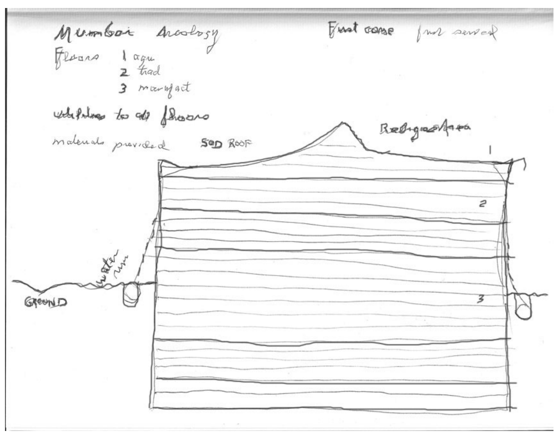


Figure 7367-1. East Elevation of Mumbai Arcology

7.3.6.8. *Conclusion for Mumbai Arcology*

Mumbai Arcology would essentially be a beginner's kit to an arcology. Residents would be provided with minimum services and legal security, and even with informal ownership.

The Mumbai Arcology would have to be presented and supported at three levels: First, central government departments, multilateral aid agencies, state level officials; second, municipal and district authorities, government departments, corporate sector, and NGOs; and third, mass media. The arcology might need to be explained to its dwellers and neighbors through well-designed and focused awareness programs. The plan for this arcology would be disseminated by the Municipal Commissioner, as well as through awareness programs organized by various agencies and NGOs using suitable public awareness material to be distributed to the public. Media would be extensively used for public awareness programs through newspapers, television, local cable networks, radio, written materials, such as newspapers and pamphlets, and educational institutions.

The Mumbai arcology would be a self-contained habitat of reduced size, with access to the surrounding wilderness. As a single structure, it would integrate the fundamental components of life—dwelling, eating, learning, working—into a frugal form, while accepting a certain amount of ambiguity and disorder. It would be a laboratory for doing and learning, tested through experience, and tempered by the opportunity to fail.

The city has been the most active and dynamic outlet of human life developed. Soleri refers to the city of the future as an arcology to remind us that a well-built city is always ecological architecture. But, for him it is also the fundamental instrument in the transformation of matter into spirit. The arcology would create a synergy between habitat and nature, body and spirit, and work and leisure. It would generate the urban effect more intensely, which should energize the inhabitants.

The principles of an arcology, from using marginal land and imploding spread to habitat density to internalizing and miniaturizing the urban effect and linking the habitat, energy and environment, serve as a model for a stable, exciting construct. The creation of a frame for an arcology in a dense slum area would be a good test to see if the self-organization abilities of people, if provided with a basic shell offering basic services, could create a comfortable, attractive, working city.

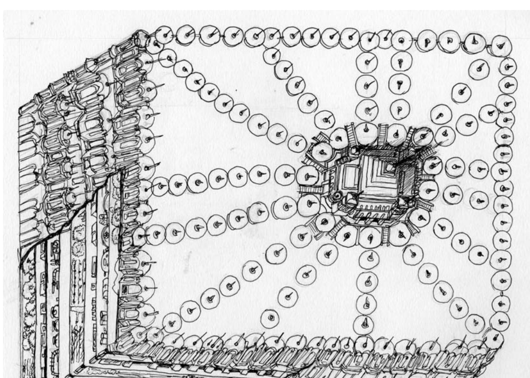


Figure 7368-1. Wedding cake angle of Mumbai Arcology

7.4. *The Lean Linear City — Arterial Arcology*

By Paolo Soleri

GREEN = LEAN

Lean urbanization as the coherent alternative to materialism, hyper-consumption, and exurban sprawl.

For this occasion, we would like to present a retrospective that frames, so to speak, the recent work. This will show the coherent thread of development for forty years along the concept of leanness—a thread that is now emerging in the conscience of the western world under the banner of the "green movement."

7.4.1. *Hyper-Consumption and Exurban Sprawl*

Civilization and culture beg for excellence and sophistication. Under the demand for such critical and creational conditions, the city and only the city delivers. Therefore the self-aware organism needs to carry on with his intent (volition) and its indispensable twin, binding (*rilegare*), by means of the city. Life is in the thick of things, nature shows; let's find human coherence in this fact. History suggests that only the city does that.

Yet we are now in the desertifying process of imprisoning ourselves in a limitless hermitage composed of segregational exurban developments. As of now that is fatal for the noble (if obscure and hidden) potential of mankind. Fatal because the industrial, technological, speculative mainstream of our materialist impulse is irresistible, a tsunami-like tidal wave that will be acted out by a tsunami of the unhinged mind. The size of it will depend on the number of nations conquered by materialism. In the coming generations, China and India, totaling 2.5 billion people, are in the throes of traumatic transformation. Latin America and the Pacific nations are also in the same pursuit of swelling industriousness at all cost.

The diffusion of well-being through industrialization has led to relentless hyper-consumption by Homo rapax, never accepting limitations of any kind. "The sky is the limit" is a mantra of Wall Street, not suffering any call for a human condition best suited to produce a culture of excellence, one not limited to the privileged. History suggests that the privileged eventually lose the nimbleness necessary for searching out the novel and the noble. The arthritis of the "establishment" is a well-known malady. The false dynamism of the very rich is evidenced by the almost exclusive dedication to becoming richer even when philanthropy is the best way to consolidate a dynasty while assuaging consciences.

Our dumpsites, offal of Homo rapax, are mastodonic embodiments of materialism's tangible "entropy." To take the clutter out of our domestic landscape is a great gesture. The market is the producer of clutter and there lies the dilemma of labor, productivity, wealth, ethics and environmental well being, to achieve the balance and sophistication of a great culture, the discrimination, the refinement, the excellence that is a prodder of evolution: the sensitization of matter, i.e., space geometries of greater and greater volitional and religious intensity, bathed in grace: the Love Project.

The societal cluttering is inevitably developing from our domestic clutter, the frenzy of Homo faber. The landscapes we produce and maintain in exurbia are well cared-for mediocrity. This is nothing to sneer at, as a well cared-for mediocrity can often enable surges of self-awareness, breaking through to new levels of self-awareness that redeem the mediocrity that preceded them. The brain suffers from a similar cluttering as the avalanche of information that computer technology delivers can easily produce the desolate, verbose stage of fragile and disconnected landscape of cyberspace, the cluttering of the brain.

The new agencies determining the new urban patterns are

(1) the exponential and unstoppable growth of consumption; and
(2) the exponential growth of demand for indispensable logistics (traffic, in a plain but momentous word).

The irresistibility of both seems to burden everyone's lives with a powerful dose of fate, as if we are doomed to hyper-consumption and doomed to drive ourselves into oblivion. Both of these are caused willy-nilly by each of us. It matters little that some of us do not "comply"; the drift is there and it appears unstoppable, i.e., "fatal".

To pursue materialism is to indulge our dependence-addiction to the objects that Homo habilis – Homo faber feverishly constructs, at the expense of the truer potential pursuit of the transcendence of Homo nobilis. We must remember that man's history is a sequence of transcendences on the part of an originally weak species.

The rules of the jungle hold at all levels of life; the fittest survive. But according to this criterion, the logistics of contemporary industrialized man are not "fit". Improving and maintaining are the modes by which what is dysfunctional is modified, made sufficiently appealing to satisfy the conservative side of Homo habilis. This is what I call a "better kind of wrongness." The inadequate logistical reticulum of our industrialized nation can be reformed and made to serve for a while longer, becoming a classical instance of a better kind of wrongness.

As graphics, models, and computer images show, many dimensions of life and needs must be considered, including the hard core of energy use and the logistical necessities of our times. What remains central is the urban imperative. It is urban because life itself is an "urbanizing" of events, albeit one that we now almost absent-mindedly scatter here and there across the flat land of post-urban sprawl.

The largest sector of infrastructure needing reformulation is the one dealing with logistics and its far-reaching presence in all aspects of life. Logistics are servo-systems intimately connected with the life systems in which they travel, distributing and retrieving. Life depends on logistics: a living cell is an extraordinary set of micro-logistics, a mega city is an extraordinary set of macro-logistics (the delivery and disposal on which life depends).

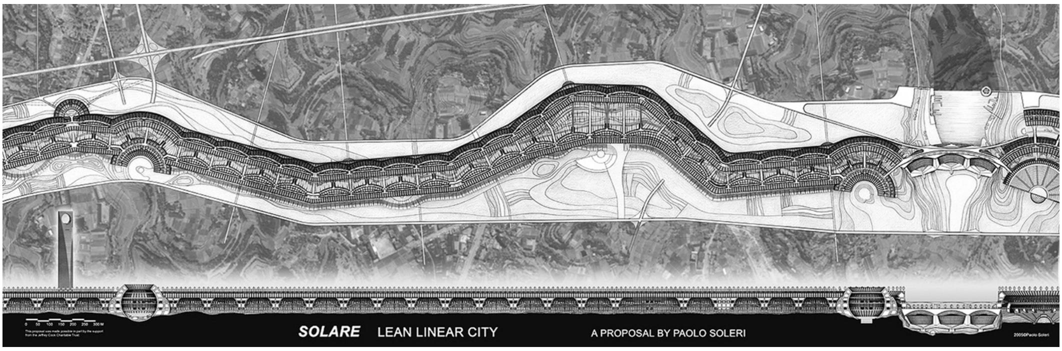


Figure 741-1. The LEAN LINEAR CITY - ARTERIAL ARCOLOGY, proposed by Paolo Soleri, is a suggestion that may trigger a positive change in how we develop the human habitat in harmony with the environment. Paolo Soleri first introduced this design in Arcology Theory during a conference at FALA 2005 in Macau, China. FALA stands for The Forum of Asia's Leading Architects. Soleri proposed the Lean Linear City for development of a habitat that may respond to some of the critical situations now taking form in China. (Image: Cosanti Foundation)

7.4.2. *Logistical Reformulation: The Lean Alternative*

The only genuine alternative is total reformulation, wherein the existing system is reformulated rather than reformed. The radicalism of reformulation proposes a graduality: Laboratory-like institutes working on the urban problem step-by-step would not only plan but also produce testing grounds for a non-segregational attack that the problem demands. Recognizing that it is impossible to simulate the logistical sophistication that organisms (vegetal, animal, fungal) have opportunistically devised in pursuit of survival and reproduction, we must try to understand and emulate some of their ways.

Figure 742-1. The LEAN LINEAR CITY - ARTERIAL ARCOLOGY proposes a continuous urban ribbon of twenty or more stories high, extending for many kilometers. The Lean Linear City dances through and along the sedimentary edges defined by the natural history of wet and dry alternate conditions. The system winds around the topography of the region chosen for this project. It is designed to intercept wind patterns of the region and to be sensitized to the sun's radiation, both photovoltaic and with greenhouses. (3D rendering: YoungSoo Kim)

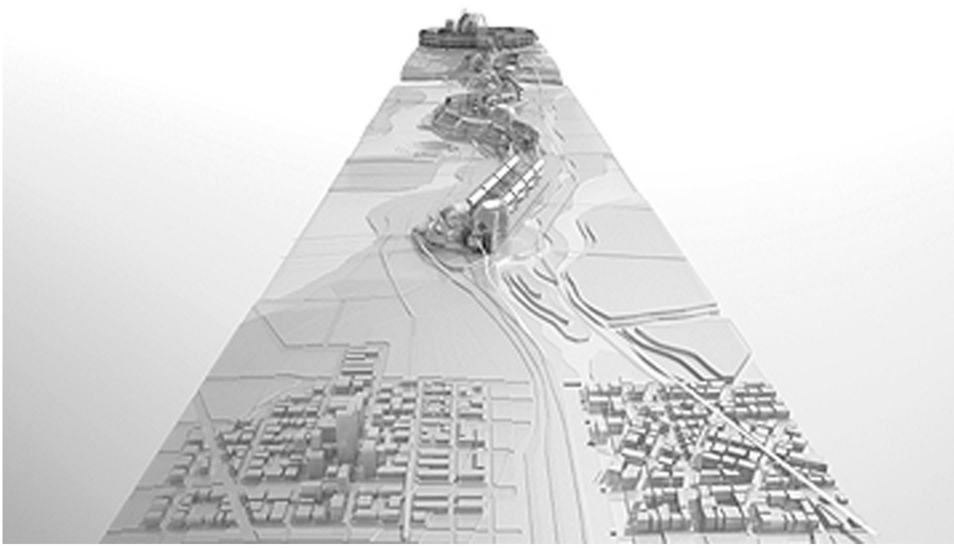


Figure 742-2. LEAN LINEAR CITY is a complimentary piece to the existing cities in need of urban growth and re-development, In the arterial arcology, five minutes on the train plus a five-minute walk takes you where you choose or need to be (daily cycles). In five minutes on the train you could traverse ten “mini provinces” (modules), each with its own distinct flavor, akin to New York’s ethnic neighborhoods. (3D rendering: Youngsoo Kim)

Two factors are cardinal for organisms:

(1) extraordinary use of space, which I call the Urban Effect, the multilayered interacting of highly discriminatory performances, the gist of a rich life

(2) a stringent economy of means and the indispensable synergistic coming and going of information and knowledge.

Those logistical sophistications have achieved a record of efficiency unequaled by human culture and civilization, the assets of a “fortunate” persona, us all.

The notion of mass transit was disposed of by the fraudulent intervention of personal transport by the automobile industries. From then on things became surreally worse. The car is the cause and the consequence of the city’s breakdown and the unavoidable materialism of suburbia and exurbia.

We need to marginalize the automobile. The national gallop into materialism finds in them, exurbia and the automobile, the market bonanza and the consequent hyper-consumption that every American is blessed by.

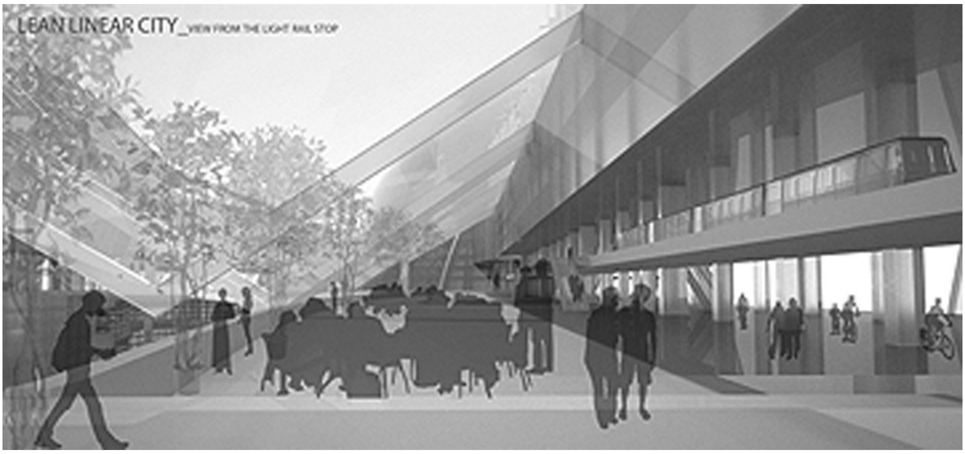


Figure 742-3. Public accessibility at multiple levels encourages walking, as well as cycling and the use of other low impact transport mechanisms. Sustainable mobility should address less polluting and healthier lifestyles for citizens. (3D rendering - Youngsoo Kim)

The continental hermitage defined by the exurban landscape—one house or mansion per breaking-up family—requires a logistical landscape horrendously wasteful, expensive, and brutally anti-environment, the nemesis of "greenness".

The logistical infrastructure now in disrepair is obsolete anyhow. We need seriously a conceptual reformulation of the whole system along realistic guidelines, not awkwardly fighting the ever increasing crowding of roads, highways and parking areas, but by reformulating the damaging patterns of our communities, of our anti cultural, anti environmental, anti-social endless and mediocre expanses of one- to two-story homes.

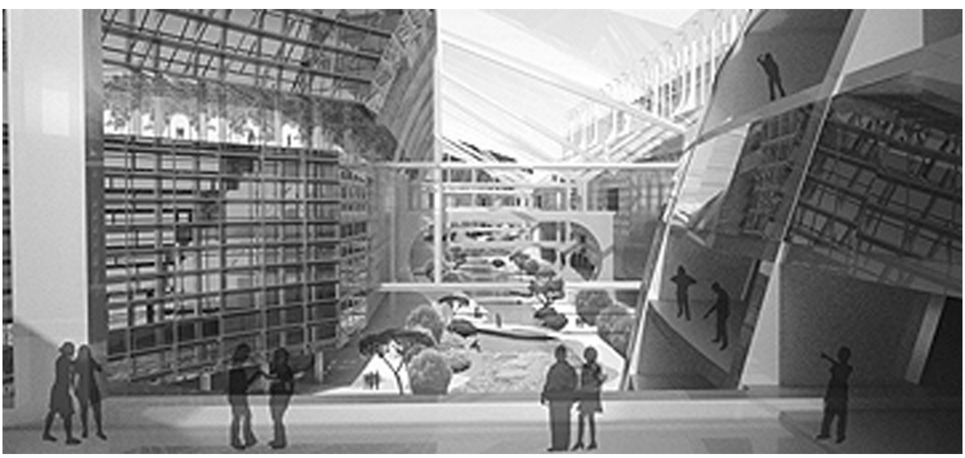


Figure 742-4. Each module accommodates about 1500 residents, and spaces for commercial, industrial, institutional, cultural, recreational and health maintenance activities. (3D rendering - Youngsoo Kim)

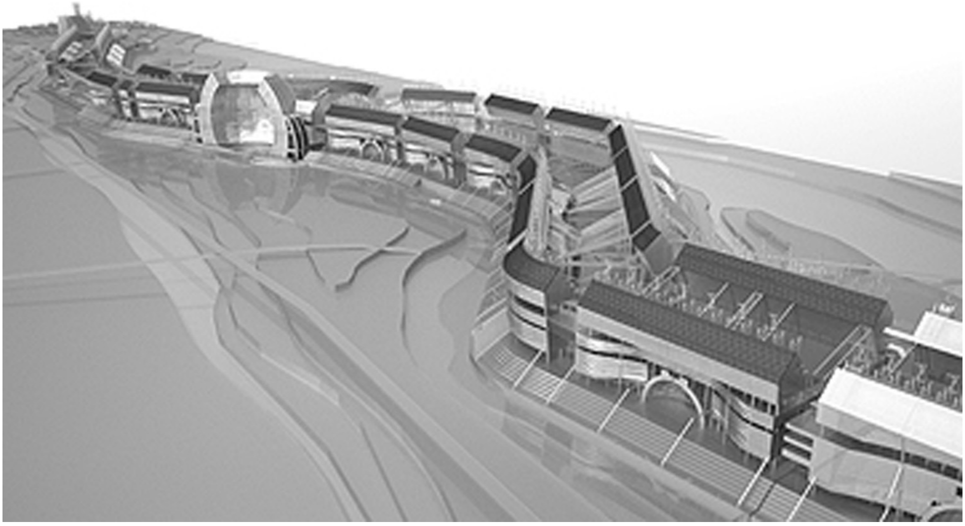


Figure 742-5. LEAN LINEAR CITY will be connected to even larger nodes, like the NUDGING SPACE Arcology. (3D rendering: Youngsoo Kim)

This seems to be a case where what is to be recommended is not reform; what is indispensable is reformulation. The infrastructural degradation can be halted if the logistical system is reformulated.

This entails the reformulation of the human landscape now given to the not too slow encroachment on the land by the habitat we have chosen as our dream on earth: the endless hermitages of suburbia and exurbia. The quest for leanness is an inverse image of the universal hermitage! Our infrastructures seem to reflect the incoherence of materialism's slogan, "If you can get away with it, do it", regardless of the health of society, since its goal is wealth instead of worth.

The moment is critical because the converging of our intense industriousness (of Homo faber, Homo habilis), now spreading to China, India, Latin America, etc., is the law of the jungle successfully applied to the post-jungle world by opportunistic man (Homo rapax).

The political unrest, the environmental crises, the inequity that seem impossible to eradicate—this convergence shouts "materialism now, materialism forever". But being "green" and the pursuit of materialism are antithetical.

The Lean Alternative is an attempt to reformulate the materialistic tide into a considered balance, where Production-Consumption-Worth form a balancing act, a graceful trinity working on the basis and inspiration of knowledge, learning, and transcendence. The industriousness of Homo faber exemplified in the Industrial Revolution has produced the magic of materialism unlimited. We are taken by it because one dimension of man is Homo opportunis, signifying the transposition of the "law of the jungle" — effective, innocent, and ethically mute. In the human field, "If you can get away with it, go at it" is the maxim of busy-body man, Homo faber.

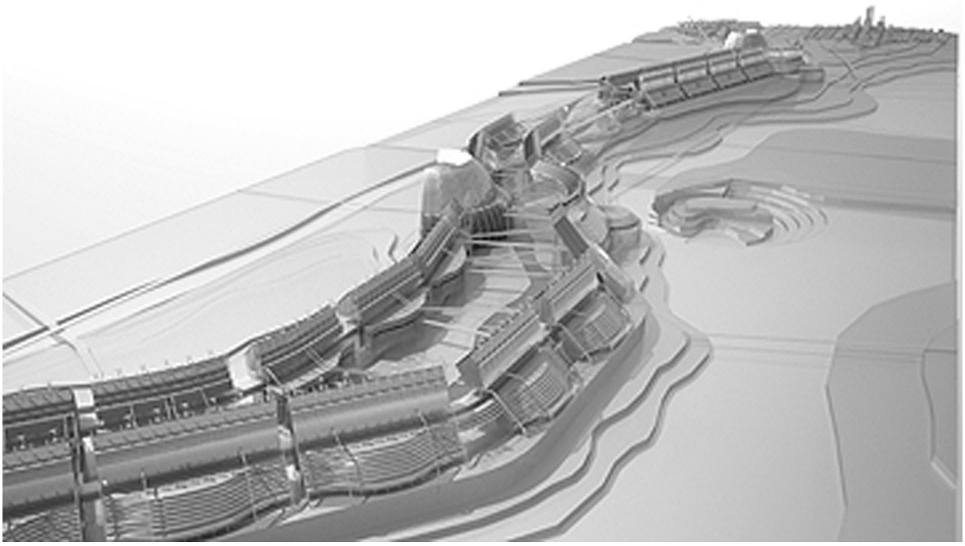


Figure 742-6. Two main parallel structures are built of modules measuring 150 meters (500 feet) in length. A climate-controlled volume constitutes the inner park defined by the two structures. (3D rendering: Youngsoo Kim)

7.4.3. *Arcologies and the Lean Linear City*

My career as an architect-planner under the influence of the Lean Alternative has proposed the development of urban systems I have called "arcologies". These are lean three-dimensional structures analogous to the structures of organisms and hyper- organisms.

Figure 743-1. Even though a single module of the Arterial Arcology (2,000 residents) is a relatively modest urban enterprise, a fully developed Lean Linear City (tens or hundreds of kilometers), in addition to its planning, would be able to employ a very, very large, skilled, and varied labor pool for many years. (3D rendering - Youngsoo Kim)

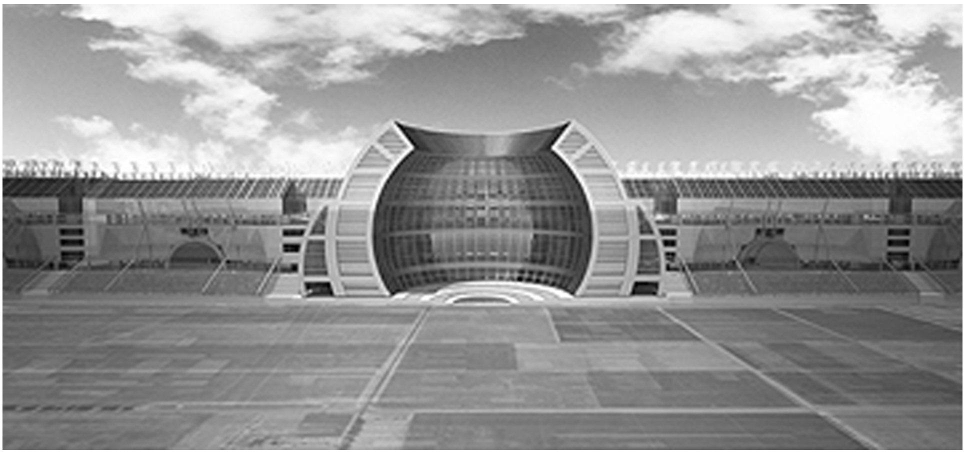


Figure 743-2. LEAN LINEAR CITY is an integral part of proposed 'ecological' communities forming urban nodes along the way. (3D rendering: Youngsoo Kim)

A self-sustaining "confederation" of organisms, such as those of termites, ants and bees, are successful proto-consciousness systems, though deprived of the self-creative élan of cities. Both unaware insect "cities" and human cities are codified by similar rules: Bonding (*rilegare*) and intent (volition).

Figure 743-3. Each module could define its proper characteristics: products, facilities, ethnicities, health, technologies, fashion, cuisine, and conviviality aligned sequentially along regional and continental routes. (3D rendering - Youngsoo Kim)

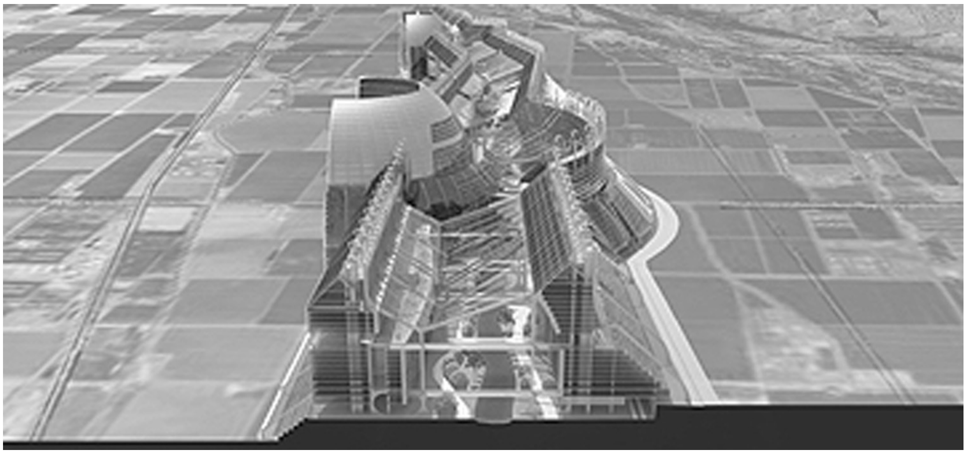


Figure 743-4. The most promising effect of the arterial arcology is a network of logistically distributed habitats capable, in time, of cleansing the land by substantially reducing an enormous fossil fuel dependence, thus restoring ecosystems and enriching the life of the countryside now under the threat of endless sprawl (the City of Phoenix Syndrome). (3D rendering - Youngsoo Kim)

Parallel to arcologies, I have developed the Lean Linear City, an elongation of the arcology principle intended to perform well with respect to the main logistical reticulum now so indispensable to urban life.

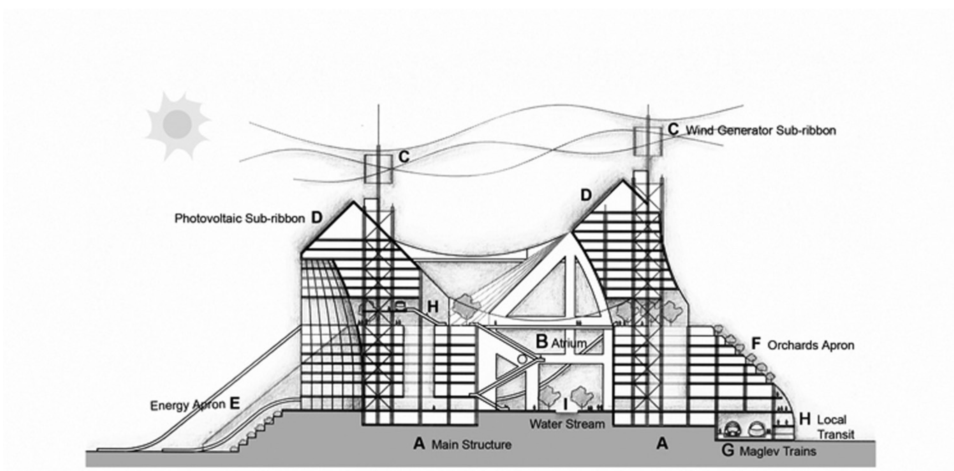


Figure 743-5. Depending on regional climatic and topographical conditions, the Lean Linear City - Arterial Arcology introduces alternative energy production options: continuous arrays of photovoltaic modules harvesting solar energy and a series of windmills capturing wind energy. (Image credit: Cosanti Foundation)

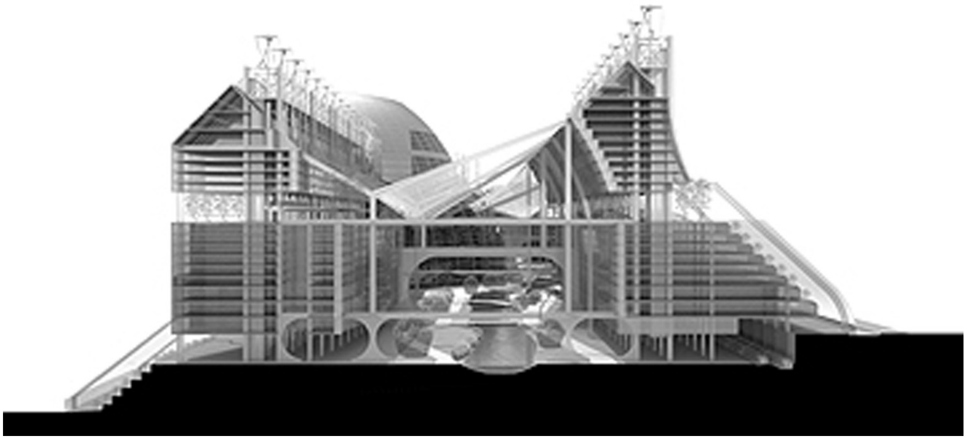


Figure 743-6. LEAN LINEAR CITY. Passive solar features such as glazed atrium spaces add to the energy efficiency of the building. (3D rendering - Youngsoo Kim)

The 'Lean Linear City — Arterial Arcology' is the study of an urban environs along main logistical systems existent or anticipated. The main promise of leanness consists in an unflagging thrust toward a re-coordination of cultures within and along intense broad-ranging experiences available, as history tells us, in and only in urban coordinations.

As we are definers of spaces and are defined by space, the natural environs and the man-made environs, the Lean Linear City is a conjecture willing to test and improve a different geometry of space.

It might turn out that the alignment of habitat has to be parallel to the logistical grids serving it. That requires urban ribbons of modest width incorporating parallel roads, bicycle pathways, public transit services, and stations for local, regional, continental trains.

Transversal to the urban ribbon, the servo-systems complete the logistical grid. In a matter of a few minutes the pedestrian can reach most of the locations in his or her daily routine. In a matter of a few more minutes walking, bicycling, or using public conveyors, he or she can reach the adjacent "town", or urban module, to the left or the right.

As indicated in the cross-section diagram of the Lean Linear City, most of the locomotion would be sheltered by greenhouse or parasol but not separated from the open air, the indoor-outdoor alternatives of the "Central Park."

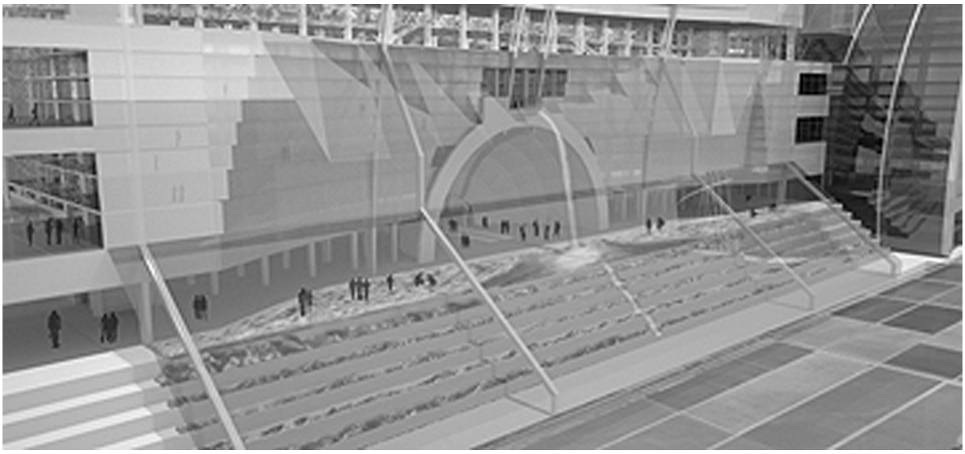


Figure 743-7. LEAN LINEAR CITY. Passive solar features such as attached greenhouses (Energy Apron) contribute to the energy efficiency of the building. (3D rendering: Youngsoo Kim)

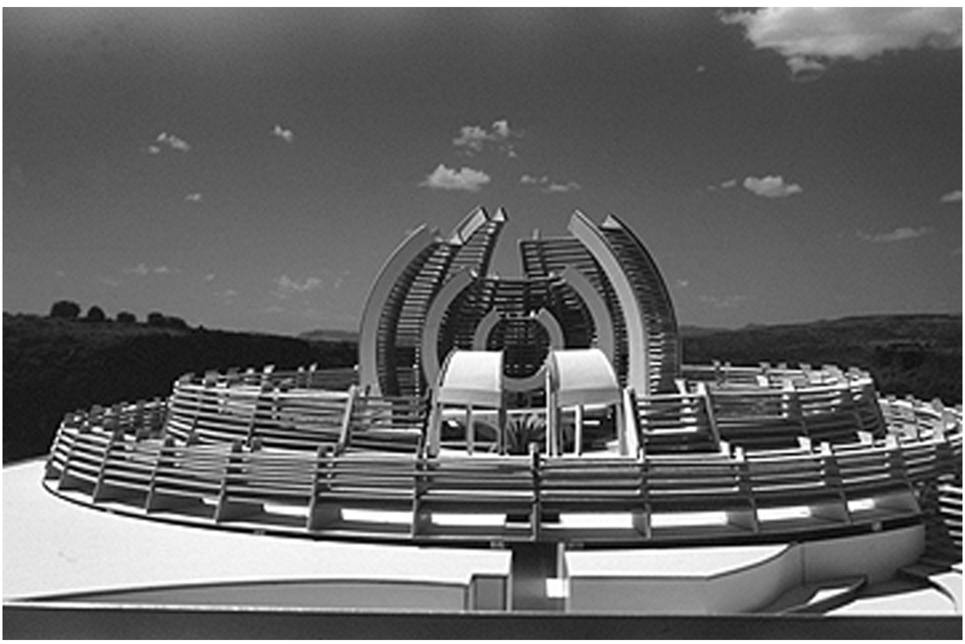


Figure 743-8. (photo credit: Tomiaki Tamura)

The LEAN LINEAR CITY is designed in conjunction with larger nodes, like the NUDGING SPACE Arcology.

Figure 743-9. (3D rendering: Youngsoo Kim)

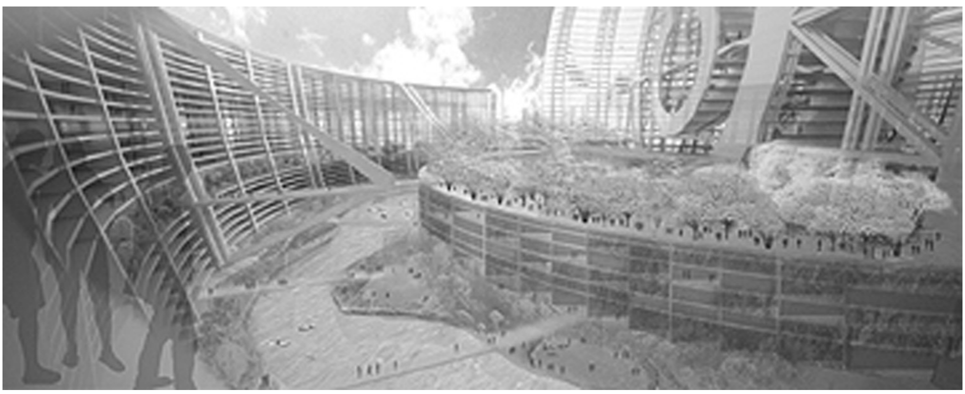


Figure 743-10. Within the NUDGING SPACE Arcology the psychosomatic side of the design is revealed by the influence the curved space has on our relationship with things and people. The Apsedra encourages conviviality by offering a focusing convergence (its center of centers) where awareness and dialoging are enhanced. (3D rendering: Youngsoo Kim)

Now that we are beginning to realize that our species is still evolving genetically while evolving culturally, it becomes more and more important to examine the past, where we slowly altered the species both genetically and culturally. It is an exhilarating and frightening imprint that is in us, quite indelible and quite challenging. The answer may have to be found in the structure of reality: self-generating and self-creating.

7.5. *Leaping to Sustainable Cities in China*

By John B. Cobb, Jr.

All over the world, forests are disappearing and agricultural lands are eroding. Aquifers are being exhausted. Fish stocks are diminishing. Land, water, and air are being poisoned. Many species of living things are disappearing. The planet is getting warmer, resulting in increasing storms and changes in rainfall. Those who study natural resources and the condition of the earth issue warning after warning. They tell us that some time ago humanity crossed the line into unsustainable living. Catastrophes loom ahead and some time will surprise us in the present.

However, governments look elsewhere for guidance—primarily to economists. Economic theory has no place for resource limits. It assumes infinite supplies. Of course, economists do not mean that there is an infinite amount of any one resource, like petroleum in the Earth. What they mean is that as one natural resource is exhausted, technology can provide us with replacements. Obviously, this is often true. If the only shortage were petroleum, as it grows more expensive, replacements would, undoubtedly, be found for its multiple uses. The transition would be difficult for many people, but if the economy is was sufficiently healthy, economists assume society as a whole would do well.

We have, therefore, two views of sustainability in our society. One view calls us to find ways to live within the context given us by nature, destroying as little as possible. In this view human life adjusts to its natural context. It seeks ways to improve its condition that also benefit its natural environment. We will call this the ecological understanding of sustainability.

The other view is of sustainable growth. It calls for continuing increase of economic activity, accepting the losses to the natural world that such growth entails. It is believed that this growth will be sustainable as long as there are sufficient economic resources to fund the technological research and development needed to transform the natural environment so that it will meet human needs. I will call this the economistic understanding of sustainability.

This economistic vision suggests not only that we can substitute new resources for those that are exhausted, but also that we can deal technologically with more fundamental scarcities. The world is losing good soil, and water for irrigation grows scarce. Accepting this as inevitable, technologists can engineer new types of plants that will grow in bad soil and with less water. As oceans become poisoned, technologists will create fish that can survive these poisons. Even human beings may have to be genetically altered to cope with a more poisonous environment.

Economists long resisted taking global warming seriously. Now that some of them do so, they tend to regard the results of global warming as inevitable, and they once again turn to technology to solve the problem. If ocean levels rise, people will either build dikes along extensive coastlines or learn to use the remaining land more efficiently. If the Gulf Stream ceases to warm Europe, technology will provide Europeans with new crops to grow in a colder climate. New species of animals will be bio-engineered to replace the ones that cannot adjust to climatic changes.

The economistic notion of sustainable growth can appeal to much supportive evidence. It has kept us going through many changes in our natural environment. A good example is found in the field of insect pests and insecticides. Modern agriculture growth has been achieved by monocultures that are vulnerable to insect pests. Hence, they have required heavy use of insecticides. Insecticides kill most of the pests, but a few survive. These reproduce rapidly. New insecticides are required to kill the new insects. Thus far technology has stayed ahead of insect mutation. The same story can be repeated with respect to herbicides.

These poisons also kill many of the organisms that naturally contribute to the fertility of the land. Accordingly, there is need for more and more artificial fertilizer. This has also been supplied in sufficient quantity to sustain and increase production.

At present, most of this is based on petroleum. Petroleum production globally is at or near its historic peak, and it will soon begin to decline in both quality and quantity. Technology will be called upon to develop substitutes. No doubt it will have some success. Some of this will be by introducing genetic changes that make plants more resistant to particular pests. Some of it will be by finding other ways to manufacture insecticides and herbicides.

Advocates of sustainable growth based on technological innovations are confident that technology will always stay ahead of changing threats. However, this makes the production of food more and more dependent not only on ever new technology but also on the social order that allows the technology to be quickly available wherever it is needed. Further, these problems must be solved by technology at the same time as the problems brought about by global warming, shortages of fresh water, and loss of top soil confront the world. In the past, advances along one line have often made problems of other sorts worse. For example, the Green Revolution required increased inputs of water and fertilizer in order to achieve its increased production. It also made grains more vulnerable to pests and diseases. The technological mindset has always focused on particular problems in some abstraction from the broader picture. To follow the economistic vision of sustainable growth, we must now be confident that in the future technological solutions to diverse problems will be brilliantly integrated.

My own judgment is that the economistic vision of sustainable growth is an illusion and a profoundly dangerous one. The longer we operate on this basis, the more the world is impoverished and the more precarious the human situation becomes. For thousands of years healthy soils carefully tended by individual farmers have produced crops for the families that grew them, with some surplus for others. This has been a relatively sustainable system. The more we continue to husband the soil, maintain supplies of freshwater, slow climate change, and use organic methods to control insects and weeds, the more sustainable our agriculture will be. Thus sustainability is approached, not by shifting from peasant farming to agribusiness monoculture, with ever greater applications of artificial fertilizer, insecticides, and herbicides, but by renewing reliance on nature and on human labor. This is the ecological vision of sustainability.

I do not want to leave the impression that in the ecological vision there is opposition to technological advances. The world urgently needs technological advances that lead toward sustainability. Peasant farmers need technological advances that improve their crops, enable them to survive droughts, and improve the quality of their homes. Society needs technological advances that will most efficiently bring agricultural products to local markets and preserve them while in storage. Rural society needs technological advances that will reduce the incidence of disease and bring basic medical care to all. As families and friends are separated from one another, improved technological means for communication among them are highly valued. The technology of recycling and other uses of waste products is important. There is much more to be said.

Needless to say, I understand sustainable urbanization in ecological, not economistic, terms. From this point of view, any social order that exhausts the resources on which it depends is unsustainable. Any social order that pollutes its environment is unsustainable. The present global order is unsustainable on both counts. In many ways U. S. society leads the way toward more and more unsustainable resource use. A major problem in China is that it follows too much the American lead.

II

But what I am calling ecological sustainability is not simply a matter of the relation of human beings to their natural environment. There are also political, social, and economic considerations that interrelate with concerns about nature. A society in which government lacks legitimacy and the basic support of the people is unsustainable. It may sustain itself for a while by sheer force and terror, but this cannot last.

A society in which most of the needs of the citizens are not met by the structures of the society itself is unsustainable. For example, if families and local communities fail to care for the children and to raise them to be constructive and productive members of the society, the society cannot long endure. Governments cannot take the place of families and local communities. U.S. society shows signs of unsustainability in this respect, as family breakdown and economic pressures block the transmission of values from one generation to another and damage the psychic health of children. I hope we are not exporting this social breakdown to China.

A society that cannot provide its members an opportunity to support themselves cannot survive. The present global economy is actually increasing the number of persons who are excluded from economic activity within the official economy. The underground economy, partly criminal, partly simply extra-legal, is growing in much of the world. The official economy is dividing people more and more sharply into the rich and the poor within countries and between them. These trends are unsustainable.

My reflection about sustainable urbanization in China is in the context of these multiple concerns. But why direct special attention to urbanization in China? My reason for special concern about this is that it is now occurring, and is likely to continue occurring, at a scale and tempo never before seen in human history. This is partly because of China's vast population, and partly because of the unprecedented speed of social and economic change in China. It is my assumption that if present trends continue, hundreds of millions of now rural people will have to be urbanized in a decade or two.

Consider, for example, what will be required if 300 million people move from the countryside to cities. Already, the rural population dropped from 74% to 53% between 1990 and 2009, as over 215 million people moved to cities. This new movement would mean that China would have to build thirty cities of ten million each or three hundred of one million or three thousand of one hundred thousand. My judgment is that the larger number of smaller cities is far preferable. Moving from a peasant farm to a city of 100,000 people fifty miles away would be less disruptive of human life and family connections than the alternatives. But planning and building three thousand cities will prove a daunting or horrendous task!

III

If Chinese cities continue to follow today's models, the unsustainability of global practices will come vividly into view all too soon. Indeed, I think it is already manifest.

I will cite only one factor in unsustainability. I have commented on the importance at this point in history of avoiding a shift to petroleum-based agriculture. Thus far, China's urban development has shared the global dependence on petroleum. China's increased demand for oil has been cited as one reason for the current spike in oil prices. If order is restored in Iraq and production there greatly increased, the price may come down somewhat. But it is public knowledge that oil is being pumped from the ground far faster than new oilfields are being discovered. Within a few years, global production will probably peak, if it has not already done so. Even if production continues to rise longer than expected, it will not rise as fast as demand based on current practices and accelerated Chinese development of the current type. Normal market pricing will lead to a further rise in oil prices. It is safe to say that, whatever happens in the short term, oil will be much more expensive ten years from now. It will be still more costly twenty years from now.

Economists assure us that as the market signals scarcity, technology will make more and more efficient use of the resource. Technology will also develop alternatives. No doubt this is true. If oil were the only resource destined to become scarce, the world could make a transition to other sources of energy. However, the more rapid the transition, the more difficult it will be. Chinese cities now being built to operate on oil will pay a high price for this choice. The price signals should already warn even economistic thinkers that continuing to build cities to operate on oil is a serious mistake.

China as a whole will pay a high price for continuing to plan on the basis of an oil economy politically as well as economically. The United States intends to control global oil production. It does so in part so as to maintain its own economy and postpone the pain of the inevitable adjustments to come. It does so also in order to secure its global hegemony. If China depends radically on oil, and the United States controls the global oil supply, China will no longer be a truly independent nation. I am distressed by this prospect as an American. I would expect Chinese to be more distressed, although they seem to be securing oil and other resources through agreements and aid.

What is the alternative? It is complex and difficult, but not impossible. Of course, it includes efficient use of oil and development of alternatives. But these technological approaches can only go so far. Much more important is to avoid not only the development of an oil-based agriculture but also the construction of cities dependent on oil.

Improved agricultural practices that remain labor-intensive and produce food organically, combined with prices for agricultural products that make possible a good living for peasant farmers, will slow the depopulation of the countryside. This could reduce the number and size of the cities that must be built, whereas following the economistically driven mandates of the World Trade Organization will accelerate the exodus from the countryside while making agriculture less and less sustainable. Maintaining stable communities by improving the existing system of agriculture instead of replacing it with “modern” systems could also support the social sustainability that is eroded by rapid mass migration.

My first recommendation, therefore, is to improve life in the countryside and refuse to move from peasant production to agribusiness. However, much of the countryside is overpopulated, and there will be, and should be, continuing urbanization. This urbanization has a better chance of being sustainable, and of being a part of a sustainable China, if the flow of population from rural to urban contexts is slowed. China had started a program from the 1990s to encourage migration to the more remote areas, especially the Xinjiang and Tibet (Xizang) provinces.

Increased urbanization will take two forms. No doubt much of it will be the expansion of present cities. How that occurs is very important. But because I think the cities of China are already too large, I would encourage aiming primarily to build new cities rather than to enlarge the present ones. I have already indicated that I believe that a larger number of smaller cities will prove more sustainable than a smaller number of larger ones.

In any case, a discussion of sustainable urbanization should consider both how to make present cities less unsustainable and how to build new cities that are, from the beginning, genuinely sustainable.

I am particularly interested in the possibility that China, facing this enormous challenge, will experiment radically with a different type of city. For decades I have believed that the most original and important vision of what cities could be and should be is that of Paolo Soleri. He has presented his vision, and specifically his vision for China elsewhere, so I will not repeat what he has said. If somewhere in China he is given the opportunity to build a small city, I believe this may be a turning point in the quest for a sustainable world.

This is not only because Soleri points in the direction of cities that are energy self-sufficient, producing few poisonous wastes or greenhouse gases. It is also because his cities will take much less land away from agricultural purposes. Further, they will encourage new forms of human community as traditional patterns of community based on the extended family decline. They will make possible new experiments in economic organization that guarantee to all some participation in the economic life of the city. They can reduce the hardships of poverty by making all the facilities of the city available readily to all its inhabitants. And they will make possible new forms of local self-government.

I do not want to be misunderstood. Neither Soleri nor I believe that the architectural form will solve all problems. What is needed is to get the best thinkers about community, economics, and politics to help in planning. Ideally, several experiments should be developed soon to learn from mistakes and provide stimulus to others. Perhaps the genuinely sustainable new cities that would emerge in China would be quite different from any of the designs proposed thus far by Soleri. That would be fine. The enormous value of his work is that it points forward to an entirely different conception of what cities can and should be. This is certainly an area in which China could lead the world into a new and far more promising age.

IV

Whatever breakthroughs of this kind occur, China must still deal with the problems of its present, huge and numerous, currently not sustainable, cities. This comment is not a criticism of China. Chinese cities are no less sustainable, I assume, than European and American ones. Bill Rees has led the way in showing that the ecological footprints of cities are enormous and still growing. Modern cities developed originally when most of the world's population still lived in the countryside and could provide the goods needed by the cities. Natural resources such as wood, then coal and then oil were abundant. Pollution was a local rather than a global problem. But the relationship to the environment has now changed. This urban civilization of the petroleum age is now unsustainable.

I have given special attention to the use of oil since the petroleum age is coming to an end. Existing cities cannot abruptly free themselves from dependence on oil. They can however reduce their use of oil both by reducing their need for importing energy and by substituting other forms. Both procedures are needed, but since there are problems with all forms of imported energy, the former procedure is the most important. Technological improvements can greatly reduce the amount of energy needed to generate a particular amount of light or motion. They can also make it possible to capture solar energy, including its passive form, for more and more purposes.

We now have many examples of buildings that require virtually no energy other than the heat from the sun in order to remain comfortable all year long. I am sure that Chinese architects are fully aware of this and are making use of many of the innovations that make it possible. I am also quite sure that much more could be done.

I am impressed, for example, by the work of David Orr at Oberlin College in Ohio.

He has erected a building that produces more energy that it consumes and that is designed to require minimum-cost maintenance indefinitely. Amory Lovins has constructed a building at 7000 feet in the Colorado Rockies that houses both his home and extensive office space. It is extremely well insulated and arranged to capture sunlight, and as a result it is heated entirely by passive solar energy.

Similar strategies for solar energy and transportation are being considered. The policy in China should be that all new buildings should be self-sufficient in heating and cooling, as well as extremely frugal in their use of imported electricity. San Francisco recently made a city-wide effort to turn the sunlight falling on its buildings into electricity. Examples of this kind can be studied and, when appropriate, emulated.

Transporting people from home to work is another major drain on the energy supplies of a city. Not long ago, much of that transportation was by bicycle. Cities should be sure that they do not allow new developments to make it more difficult to return to bicycles as the major means of transportation. In general everything should be done to discourage the ownership and use of private automobiles. Good public transportation helps. Many European cities exclude private motor transportation from the central city. Locating residences near places of work is helpful. Suburban sprawl of the sort so widespread in the United States should be prevented.

The implementation of all these policies depends on technological developments as well as on political will. In the appropriation of technology, one important policy should be leapfrogging. Alongside all of the destructive aspects of contemporary technologically driven society, there are also genuine advances that enable goals to be accomplished with far less use of natural resources. Cell phones, for example, whatever their problems, may make it possible to have the advantages of the telephone without the huge infrastructures that have been needed for this kind of communication in the past (except for the towers everywhere—maybe they could be combined with solar or wind machines). Buildings that are self-sufficient in energy production are also an example of leapfrogging over intermediate stages.

A massive example of leapfrogging is provided by the arcologies of which I have been speaking. There are trends in the development of urban centers that now move in the direction of arcologies. But there is no need to evolve gradually in that direction through steps that are extremely consumptive of resources. By leapfrogging over these steps, China can take the lead. Between cell phones and arcologies there are many more examples to be considered.

One might consider that certain proposals for urban economies are also a form of leapfrogging. There are excellent ideas that have been proposed and then quashed in the West by those persons of wealth whose interests they would have threatened. These stand a much better chance of serious consideration and implementation in China.

V

Whether or not cities are built as arcologies, they are more sustainable if, together with their rural surroundings, they are relatively self-sufficient. One reason I support experimentation with arcologies is that they are more likely to have this character of sustainability, but I will set that point aside for now. To put the matter negatively, the more the healthy survival of a city depends on long supply lines and on decisions made by people at a distance who have no interest in the well being of the city, the more precarious is the future of that city.

This illustrates the fact that, especially in recent decades, we have been constructing a more and more unsustainable world. The world economy has been reordered so that goods are produced thousands of miles from where they are consumed. Instead of planning agriculture so that local people can be fed, huge monocultural plantations produce for export.

The economistic commitment to growth has supported this development. It may be that moves of these kinds lead to the most rapid economic growth, although I am not sure that statistics bear this out. But, many of us do not believe that what is called economic growth consistently benefits human beings. This growth is usually measured by Gross Domestic Product, which can, and often does, rise, while the actual living conditions of most people deteriorate. There are several reasons for this.

First, GDP is indifferent to the distribution of the income it measures. The policies employed to increase GDP are often based on the theory that wealth accumulated by the richest trickles down to the poor so that all benefit. These policies lead to the increase of the gap between rich and poor. Such "trickle down" as may take place rarely reaches the poorest segment of society. Furthermore, concentration of wealth is typically accompanied by concentration of power, and much of this wealth and power is in the hands of foreigners who do not care what happens to local people.

Second, the GDP is unaffected by environmental deterioration. Indeed, there is a direct relation between the rise of GDP and the decline of the environment. First, extra costs incurred because of environmental decline are added to GDP. For example, if water must be transported farther and new facilities for its purification are required, the cost of all of this adds to GDP. Second, there is an obvious correlation of increased consumption and reduced resources on the one side and increased pollution on the other. Again, nothing is subtracted from the GDP because of the loss of natural capital.

Third, the policies designed to speed economic growth as measured by GDP almost always prove destructive of human communities. People are separated from the means of production and from one another. The quality of family life declines. But healthy community is essential to sustainability. It is a profound mistake to adopt policies oriented primarily to "economic growth" as that is measured today.

Common sense tells us that real "growth" must be understood in quite different ways. The question is whether the changes in the economy actually benefit the people with special attention to the poorest and most vulnerable. The question is whether the society that develops is sustainable. The goal should instead be that kind of growth that leads to sustainable communities. One characteristic of sustainable communities is meeting the basic needs of all its members.

This global economy is not sustainable, and the more China buys into it, the less sustainable the economy of China becomes. If new cities are built primarily to produce goods for distant countries, they will be unsustainable and contribute to the unsustainability of the whole society. If they produce primarily to meet their own needs they will be far more sustainable.

The goal of complete self-sufficiency, on the other hand, is undesirable. Trade can and should play an important, although minor, role. It should be such that the people of the city could survive without misery if the trade were ended. In other words, their basic needs should be supplied apart from trade. In that case trade can add to the enjoyment of life without threatening its sustainability.

Trade with the countryside and with neighboring cities should be favored over trade with distant place. Whereas a single city provides a sufficient market to stimulate competition in the production of clothing, sports equipment, household goods, and office supplies, its demand for elevators would not suffice for a healthy market. It may be inefficient for each city to manufacture its own elevators, or if it did so, the market would not support more than a single company. Monopoly has many negative consequences, and has to be controlled carefully by government. But the results for manufacturing of bureaucratic control are often negative. If several cities manufactured elevators, it would be important that the manufacturers competed with one another without the assurance that they would be excessively favored by the city in which they were located.

One advantage of relatively self-sufficient cities is that they could make decisions about wages and working conditions without fear that these would put their businesses at a disadvantage in competition with businesses elsewhere that paid lower wages and had worse working conditions. Goods coming from such places should pay a tax that would at least compensate for this difference. Of course, it is now very difficult to control the movement of goods into and out of a city. With an arcology it would be easier.

VI

Let me summarize some of my basic convictions about sustainable urbanization for China.

1. In an uncertain future, a city together with its surrounding countryside will be more sustainable if it is relatively self-sufficient. That means that it is capable of meeting its basic needs. That does not preclude trade with other cities and even more distant places, but the local region should not be dependent on that trade for survival.
2. Both the city and the countryside should be self-sufficient in the production of the energy they need to function.
3. Smaller cities can achieve these goals better than huge ones. Arcologies could do so best of all.
4. Cities together with their countryside should adopt new technologies that leapfrog over wasteful ones still characteristic of much of the West.
5. Cities together with their countryside should experiment with political and economic systems that allow maximum participation in local self-government of the people.
6. To achieve genuine sustainability, cities and their countryside should foster community among their people, such that none are excluded from participation and from having their basic needs met.

The Chinese government could create an experiment of an arcology as a solution to deal with urban immigration. It would be the first time a national government directed cities into a rational configuration.

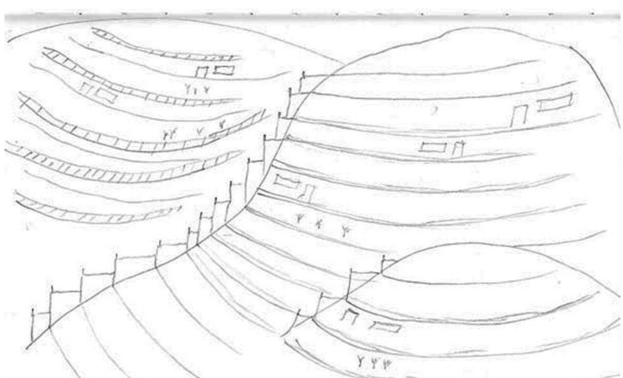


Figure 750-1. Drawing of Chinese Rice Terrace arcology (in *Redesigning the Planet: Regions*).

7.6. *Local Design Factors: Ecological Economics*

The formal study of how people use their surroundings is economics (from the Greek words meaning 'law of the house'—house is used as a metaphor for human society and nature). The word has come to mean the management of resources to supply human needs. It is basically concerned with sharing resources to meet physical needs of a people.

Although economics is a social science that studies human behavior, it considers itself a positive science. As a social science, economics addresses human problems. The acknowledged fundamental problem of economics is the contradiction between scarce resources and unlimited human wants. The kinds of resources and the possibilities of using them in production are considered in the scope of economics, as are the role of the government, business cycles, monetary details and policy, stabilization and growth, international trade, consumer behavior, production costs, pricing, and resource markets.

7.6.1. *Holeconomics & Ecological Economics*

John Stuart Mill wrote that beyond the progressive state lies the stationary state; each advance is to approach it. A stationary economy is not synonymous with a stagnant economy; there is always room for developing and increasing the scope of economic culture. It could be highly sophisticated, dynamic, and imaginative. Mill said: "It is scarcely necessary to remark that a stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever for all kinds of mental culture and moral and social progress; as much room for improving the art of living and more likelihood of its being improved." Mill's vision of a stable state was a response to the goal of an industrial society. Technological progress would abridge labor, not necessarily increase production. In a state of equity, persons would have room for solitude and leisure development. But Mill's idea was anthropocentric—"man" was not bound to protect nature.

7.6.1.1. Holeconomics (Steady State Economics)

Herman Daly concludes that the steady state economy is both necessary and desirable. He notes that in the definition of economics, as the study of the allocation of scarce means among competing ends, the entire ends-means spectrum is not considered. Only intermediate ends or means are considered, not ultimate ones. He anchors the ultimate means in physics and ultimate ends in religion. Economics falsely concludes that the middle ranges represent the entire spectrum. In another computer model, Laszlo's scenario calls for an across board reduction in population, investment, and resource usage, to create a steady state with the present disparities maintained.

Development calls for a social and educational organization, more than technological style. Styles of technology must be determined by culture and context. Such development requires a local authority working with suitable economic and ecological conditions. No authority can be affective without the participation of the populace. To stop growth, a strict regulation of the productive system is needed. States should be able to control which products are made, and with which technology. Practical implications of the steady state are that nonrenewable resources will be conserved as much as possible, by recycling, while erosion, depletion and pollution are minimized; energy sources may be greatly decentralized and diverse. Using a field concept for development emphasizes the dynamic transformation of the domain, rather than its structure as an individual. Selective advantage or cost benefit become adjectives or afterthoughts to the domain.

Jane Jacobs, in *The Nature of Economies*, argued that the same principles underlie both ecosystems and economies: "development and co-development through differentiations and their combinations; expansion through diverse, multiple uses of energy; and self-maintenance through self-refueling." The Nature of Economies, also in Platonic dialogue form, is based on the premise that "human beings exist wholly within nature as part of the natural order in every respect." Jacobs' characters then discuss the four methods by which "dynamically stable systems" may evade collapse: Bifurcations; positive-feedback loops; negative-feedback controls; and emergency adaptations. Their conversations also cover the "double nature of fitness for survival," traits to avoid destroying one's own habitat as well as success in competition to feed and breed, and unpredictability, including the butterfly effect characterized in terms of multiplicity of variables as well as disproportionally of response to cause, and self-organization where "a system can be making itself up as it goes along."

7.6.1.1.1. Holeconomic Wealth

Economists try to bronze the economy in its current structure, but it is a changing system. Since it is changing, strategies that are appropriate at one stage are totally inappropriate at another. This is the remorseless working of tragedy. Any lasting economy must have a dynamic approach. Wealth must be renewable.

There are two roads to wealth: producing a bigger pie (supply) or reducing each portion (demand). This assumes that wealth is defined as supply divided as demand. If supply is limited then wealth can still be increased two ways: reduce expectations of individuals or reduce the number of individuals. Supply may be mostly material things, but not status, for instance; demand has the more psychological dimension. Therefore, wealth will always have a psychological dimension.

For this reason, Gregory Bateson thought that economics may be founded on a fallacy. Economists cannot account for intransitive preference: where a is preferable to b, b to c, but c is preferable to a; as in Money being preferable to resources and resources being preferable to wilderness but wilderness is preferable to money. Preference curves in economics should not intersect.

An individual's perception of environment is a semantic map that forms the context for decision making by delimiting possible acts. People respond to felt needs; economic growth occurs when these psychological needs are stimulated and satisfied. As soon as people think that they need clean air, like snowmobiles, these demands can be met somehow.

Rich sensory experiences can be derived from direct contact with nature, but economists and planners rarely mention these values. Light, wind, dirt, plants, and birds, all perform during a walk, but not with the same meaning as crops or dogs, which is for their utility—they just are. People do not live without these things. All values are based on a healthy ecology. It must be kept healthy; arable land must be limited, and mineral exploitation must be limited.

The Gross National Product (GNP) is the money value of the final goods and services produced by the economy. It includes all the goods and the bads. That is, it is a measure of throughput, the flows rather than the capital stock of wealth. Meadows suggest that capital stock could be maintained with the lowest possible throughput. That would require redoing the economy and its technologies and making them more efficient. The trap is seeking the wrong goal. The way out of the trap is identifying goals that reflect the real wealth, then focusing on result not effort.

7.6.1.1.4. Holeconomic Goals

What are our economic goals: Market leadership or development for all of humanity? Subsidizing corporations does not seem to be a good way to achieve the latter, especially when corporate profit grows even when standards of living drop. Regarding consumption levels, how much is enough? When does consumption stop adding to satisfaction? How necessary are Chilean grapes or New Zealand kiwi to healthy consumption in another nation? By matching consumption to ecological limits, the way is open for more psychological measures of wealth.

An economics based on ecological understanding would have many different assumptions. For instance, the capital of an ecosystem would be its physical environment and its gross primary productivity; interest would be the net ecosystem productivity. The production percentage would be the amount necessary to keep the ecosystem healthy. Cultural capital would be the wealth of human knowledge about environments, and cultural interest would be experimentation.

7.6.1.1.4.1. *Expanding Capital.* Traditional economics has a three-capital model of human wealth: Land, labor, and manufactures. Clearly, this is not adequate; each kind of capital should be expanded. Land is the entire ecological system, complete with other species and biogeochemical cycles, preserves, as well as agricultural areas, resources, and artificial modifications like dams. Labor depends on the traditional capital of a culture, the beliefs and myths and rules for behaving, the institutions. Manufactures depend on culture, and land (resources), and on technology as well.

Modern economies, embracing the metaphor "nature is capital," draw on the accumulated "capital" of ecosystems for production. By ignoring the real cost of the capital, as well as the costs of natural services, such as nutrient recycling, soil building, and atmospheric renewal, these economics create a temporary wealth. Decisions regarding resources are made on short-term economic grounds and lead to material shortages and environmental degradation.

Economics must internalize all costs for product cycles, from agriculture to manufacturing. This means finding the real costs first, starting with environmental degradation, lost employment, increased health care, tax credits, and defense. The real costs of energy usually far exceed what users directly pay for nuclear, coal, oil, or gas. When workman's compensation premiums are paid at a rate determined by a company's accident experience, then the cost of an unsafe operation is already a recognized direct cost of doing business. These external costs can be internalized directly with taxes, especially one on carbon-containing fuels. Another possible tax could be an anticipatory tax for degradation. This would encourage more efficient use of sources and development of more cost-effective technologies. For agriculture, this means reducing waste and pollution, and emphasizing diversity and disease-resistance instead of gross yield.

7.6.1.1.4.2. *Diversifying Institutions.* The simplest economic transactions occurred between individuals who gathered food or made tools and then traded with other individuals. With the increase in specialization and complexitycame individual traders, then guilds, and finally corporations.

Corporations were formed with the historical promise of providing social services to the national states that chartered them. In the name of secure trade they often explored territories and guarded resources with private armies. Unfortunately, as private good became identified with public good, corporations became less concerned with social service and more concerned with greater profit through greater technology.

As legal entities, corporations have formal expectations that have become imperatives: Profit, for instance. According to Milton Friedman, the only social responsibility of a corporation is to make money, by striving after profit as an efficient agent of production—although Friedman admits that the corporation should conform to the rules and norms of society. Other imperatives, equally important if less touted, are constant growth, aggressive competition, objective, i.e., amoral, decision-making, efficient exploitation of resources, and the quantification of values. Unfortunately, as an entity with limited responsibilities, these imperatives tend to dehumanize workers and consumers, homogenize people and cultures as markets, foster no commitment to place, and interfere in natural processes. Corporate forms, with their characteristics of simplification, naiveté, homogeneity, and incompleteness, turn wild landscapes into "flatscapes," where variety disappears and significance is ignored for the comfortable standards of meaningless continuity.

Corporations, as economic institutions, do have many kinds of responsibilities: ecological, social, community, political, and individual. The first responsibility is to discharge its specific function. Then, it has a responsibility for its impacts; this is one of the oldest principles of law. The institution has a duty, and self-interest, to discharge its function with a minimum of negative impacts. Profit making is a necessary part of business, but not the sole reason for business. The best business serves public goods as well as private interests. Environmental and social problems should get as much attention as profitability, because they are as much a part of the process as sales, finance, and production.

Corporate law holds that management must act in the economic interests of shareholders. Communities could change that law to start to control corporations. The corporation is a noncorporeal entity, but because it is a fictitious person, speech in the form of advertising is protected under the First Amendment. So, corporate speech has little in the way of regulation. Therefore, it may be necessary to regulate corporate speech under a new amendment. Corporations sponsor wonderful shows on nature as a resource, so we become attuned to corporate interpretations and objectives. We need to be more attentive to their real objectives.

We need different kinds of regulations for corporations, ones that limit destructive activities to environment and workers, and ones that encourage responsibility to nature and community. This may require changes in economic organization and legal institutionalization. Corporations should be anchored in the community. Although they must not act beyond their competence, a larger community responsibility is merely expanded self-interest. They need to build concern and responsibility for the common good into their vision, values, and behavior. Common good does not emerge automatically from conflicting interests.

The corporation is defined as a collective citizen—we need to enforce the duties of one. How can we make the corporation accountable to the community? The problems of corporations are structural, inherent in the forms and rules by which the entities operate. Corporations increase their power because of our failure to grasp their nature. We could restructure the market to favor long-term investment over speculative profit. To give back to the community, we could require a percentage of new stock offerings go to the government for the public. The state grants the charter to a corporation; the state could revoke the charter to protect the interests of the state (as citizens). Corporations have many human rights but few human responsibilities. Even when their actions cause death, the corporation cannot be jailed or executed. Perhaps we should change that law also and be willing to disband it.

7.6.1.1.4.3. *Emphasizing Development of Wealth Over Growth*. Powerful images can influence cultures over centuries. The principle of plenitude, restated in Christian terms, presents that an intelligible creator gave an earth of unlimited bounty to humanity for its use. This principle seemed to be confirmed in the Renaissance with the discovery of the richness of heaven, microscopic life, and unexplored continents. Many modern political ideologies and economic systems have been shaped by the principle of endless wealth. Adam Smith calculated that the real price of anything was just the toil acquiring it. This image is dangerous because it ignores the evidences of the limits of the earth.

Economics has always been concerned with measuring wealth. Wealth once meant tangible things, land, ships, houses; then labor and production; but now it has come to mean negotiable symbols such as cash and stocks or unlimited information. Yet, no single description is adequate.

It is said we are in an information age, that information is the ultimate resource, and that land and resources are less. But information without 'form' is nothing (in-ation?). Information only lets us use resources and land more efficiently. The basis of wealth for a longtime will be land. Even more so now because we do not know its complete value, as many native peoples have found out when oil or pharmaceutical plants were discovered on their lands—as a source of information.

Economics is distorted when reduced to quantity and technique; there is always a psychological and ethical dimension to be accounted for—motives, values, needs, aspirations. Economics needs to be restructured to take this consciousness into account. The assessment of personal or cultural wealth, for instance, is mostly psychological; wealth may be measured by how many valuables one has, which may be physical, like feathers or salmon or gold or land, or by how much status, which may be behavioral, as enjoying deference or a good reputation.

Pitirim Sorokin indicated that the wealth of an area was a function of its physical attributes and its culture. In fact, the attributes are only possibilities until appropriate cultural perceptions and technologies exist. The redefinition of wealth in an ecological framework would increase human enrichment and natural preservation.

Economics tends to devalue many things. Our economy is crippled by the unspoken principle of immediate interest maximization. We allow economics to discount the future value of benefits. That also means that our children's and grandchildren's lives are worth less than ours—are they really? A common strategy in Rome was to defer the true costs of government by debasing the currency. The cost was shifted to the indefinite future. We have been doing the same, but the future is becoming more definite and vulnerable to collapse.

Ecological and economic processes and values are often the same. Benefits can be assessed in a common metric. The GNP is an inadequate way to measure well being. It measures only increases in spending. The International Standard of Economic Welfare (ISEW), developed by Herman Daly and J.B. Cobb Jr, expands consideration to literacy and longevity as well. More is needed, however, to measure wealth and happiness in addition to general welfare. The measure needs to be expanded to include more of the human growth needs recognized by the psychologist Abraham Maslow. It also needs to recognize an expanded definition of the self, to include the ultrahuman beings who support us.

We make trade-offs in social systems without assigning dollar values. We could do that with ecosystems. The valuation could be scientific or be based on human labor. New values of natural resources, such as option value, are being recognized now by economists. Option value reserves a resource for future use or for existence value (paying for something to exist that will not be used).

One thing business can do is put a price on nature, but, let us make it a real price, reflecting the real cost of replacement. Let us base the cost on human labor and technology, so that one gallon of oil is worth a million dollars, as Buckminster Fuller once calculated. Let us make all those prices high, too high rather than too low.

Nothing is value-free—not technology, not education, not economics. We just do not always see the values. Values are time dependent; ecological time is much longer than social time. Our social values depend on ecological values.

The goal of economics should be mature development, not growth. Growth has been a substitute for quality and equality; in that sense it has been necessary to forestall revolt. There is no necessary association between development and growth. Development means the introduction of an innovation. Economic development will still require technology, but, ecologically sound technologies could minimize stresses to the environment.

7.6.1.1.4.4. *Accommodating Limits*. The transition to a sustainable state does not mean returning to an all-natural, that is nonhuman, condition for ecosystems. Human activities have always had some impact, as do the activities of all species, on ecosystems. Sustainable development requires recognition of the large number of limits. The popular definition of sustainable development is inadequate; the Bruntland Commission defines it as "meeting the needs of the present while not compromising the ability of the future to meet its own needs." But, as Herman Daly has pointed out, this definition is contradictory in practice, where it really means "expanding the needs of a growing population without inflation." Daly offers 3 rules of sustainability to make the concept consistent and meaningful: (1) harvest renewable resources only below or at their rate of regeneration, (2) limit wastes to the assimilative capacity of the local ecosystem, and (3) require part of every profit be invested in renewables.

The ecological approach to development makes it less important to discuss global limits to growth. Local limits are far more significant to a majority of people. Regardless of how much food exists, people will starve unless they can get it, as is happening so often now. Every community is forced to accept some upper limit, beyond which it cannot grow any further. Further growth results in destruction or disruption of the community itself and the natural communities on which it depends.

Complex societies depend on production of resources. Increased complexity requires more information processing and more integration of disparate parts. The costs of communication increase. Complex societies need control and specialization. Yet, investment in complexity yields declining marginal returns because of the increasing size of bureaucracies, increasing taxation, and costs of internal control.

At some point society is investing heavily in a course that is less and less productive; increased costs just maintain status quo. In a mature ecosystem, a larger percentage of energy is used for maintenance of the system, until net community production approaches zero. However, the system also becomes more efficient, supporting a larger biomass with the same amount of energy in weblike food chains. If society were to parallel this development it would probably be very stable. Societies can fail (and disappear) when they become inefficient and spend more energy than exists in the system flow to maintain the system.

The theory of complexity shows that complex systems do not allow predictions; they are influenced by factors that are not statistically significant. Yet, the climate is roughly predictable and stable, where as the weather is unstable and unpredictable. The best economic policy is probably one that tries to balance long-term productivity and competitiveness with short-term benefits (trade-offs).

The economy is not an automatic mechanism for good. We cannot predict which transactions will have good effects. We have to understand it and direct it. We expected faithfully that the market would promote the general welfare. But, people work to maximize their own good, as Hardin has pointed out, and self-interest makes it difficult for us to acknowledge our dependence on nature and on others. Economics started as a branch of moral philosophy. In a large sense, morality is a set of rules for living together, and economics is still a branch of moral philosophy.

7.6.1.2. Ecological Economics

Business as usual, with its inertial model of growth, could end in catastrophe for humanity and its environments. Industrial cultures, with their characteristics of simplification, naiveté, homogeneity, and incompleteness, turn wild landscapes into "flatscapes," where variety disappears and significance is ignored for the comfortable standards of meaningless continuity. Rapid growth might precipitate a catastrophe sooner, while modest efforts at environmental protection and increased efficiency may only postpone catastrophe a few years. An ecological economics could provide another order.

7.6.1.2.1. Ecological Integration

Human beings, and especially economists, focus their consciousness on the visible parts of the world and forget the invisible that makes everything possible. Theodore Roszak suggests that the necessary invisible background must be described. He characterized economists as urban intellectuals automatically endorsing growth with ecological stupidity. He called for a nobler economics, one that is not afraid to discuss spirit, conscience, moral purpose, and the meaning of life. Schumacher and Roszak have grasped that economics is a subdiscipline of ecology, as have other economists such as Angus Black, K. Boulding, N. Georgescu-Rogen, and M. Friedman.

Ecology and economics must be integrated. The goal of economics cannot be growth. It must be tailored to the ecosystem; its central tenets must be consistent with ecological principles. An ecological economy is survival-oriented, not profit-oriented.

Economic and ecologic systems interact. Economics must recognize that ecological health is vital to its own continuation; it cannot make large mistakes. The concepts of economic value must be redefined. Resource use is an ethical question. It is not known how species and communities are regulated; if by environment or internal interaction. A free market has to be limited by conservative calculations of ecological balance.Because human and natural systems are interlocked, there must be a common framework for ecology and economics. Economic decisions are based on human reference and not nature. Human reference is not large enough. Economics is the study of budgets, material and energetic. Modern economy is a rheology, a study of things. Human economics grows from positive feedback due to feeding on the wealth of the past; it will have to reverse its charge sometime. Most local human development was achieved at the expense of other people, descendants, or from other species. Ecology is the study of natural budgets, material and energetic. Ecological and economic processes and values are often the same. Benefits can be assessed in a common metric.

Environmental quality cannot be treated as a scarce economic good. Daly maintained that the final benefit of economic activity is service or psychic income; it is yielded by stocks of capital maintained by material flow. The capacity of nature is limited, that is, scarce, but it is also irreplaceable and essential to life. The price mechanism ignores the possibility that something may disappear; it assumes substitutability.

Both ecology and economics attempt to understand and predict the behavior of complex, interconnected systems where individual behavior and flows of energy and material are important. There are many other common or similar processes: resource allocation, optimal behavior, adaptation, and energy flow. How do species and associations persist in evolutionary time under environmental stress and change? Perhaps some economic systems are resilient and stable like ecological systems. No one has complete information about the current environment or the results of actions.

7.6.1.2.2. The Ecological Framework

The ecological provides the appropriate framework for economics, as exchanges are based in natural ecosystems. A new paradigm of economics is based on new ideas, analogies, and metaphors. This is the ecological paradigm, where: Real ecological limits exist and must be respected (what Rachel Carson showed so well); all beings have value for themselves; people live in a mixed community of beings; people have similar basic needs and wants; intelligent development can supply these needs and some wants; and, small-scale, quality processes can be developed efficiently. The new ecological economics is based on an orderly view of the world, a cosmology.

A new theory is needed to relate economy to ecology. That theory must include externalities in consideration. And it must include intangible cultural values. It would be better to expand the circle of economic categories to include more factors that affect the economy, than to simply switch to supply side from demand. Traditional supply/demand theory uses current supply and demand of energy to determine current prices, ignoring renewability and long-term availability.

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Environmental quality cannot be treated as a scarce economic good. Daly maintained that the final benefit of economic activity is service or psychic income; it is yielded by stocks of capital maintained by material flow. The capacity of nature is limited, that is, scarce, but it is also renewable, as well as irreplaceable and essential to life. The price mechanism ignores the possibility that something may disappear; it assumes substitutability, that is, one form of capital can be substituted for another, and this leads to the disregard for any one form, such as land.

7.6.1.2.3. Ecological Economic Wealth

Values are based on knowledge, which is measured partly in terms of information. And information can be considered a source of wealth. Some business economies are based entirely on providing information. Information is apparently boundless. Yet it can be manipulated. It is information that defines the use of resources by people. For example, hydrogen is worthless unless technologies exist to transmute it to helium and manage the released energy. What is not limited is our use of information. A sophisticated technology needs fewer resources. Ecosystem productivity becomes less important if food can be grown in tanks using solar energy.

The economic argument for valuing plants and animals is based on the fact that animals and plants are self sustaining factories, that is converters. (Hermann Reinheimer, 1910, thought that all organisms were economic traders anyway. He espoused cooperation rather than competition, however.) Economic value is a function of our state of knowledge; penicillium was just mold before Fleming amplified antibiotics from it; wheat was a natural grass before being hybridized with a weed, goat grass. We should preserve much of nature for its undiscovered wealth, that is yet to be know. The technocratic vision treats all interests as human interests; but even so, this cannot be used to reduce all to instrumental value. Not all human values can be quantified and assigned common dollar values. Even if human values have objective meaning, not all of them will have dollar values; therefore not all natural processes can have dollar values, but all have some kind of values. R.F. Dasmann notes that birds or dolphins have values to observers that do not fit any yardstick. Wildlife has commercial value, e.g., fish can be caught without being produced.

According to Buckminster Fuller, wealth consists of physical energy combined with metaphysical know-how or know-what. In terms of solar energy—real wealth according to Fuller—all humans are potentially rich. This type of wealth should be based on what is valued most: Happiness, clean air and water, good food, technological devices, art, or goods like automobiles, apartments, and clothes.

7.6.1.2.3.1. *Information & Resources*. Any economy must consider the needs of its members, as well as the limitations of its resources. Surprisingly, political and psychological factors have been and may always be more important restraints on food supply than physical limitations. Deprived peoples have difficulty striving for better crops and supplies; planners have difficulty envisioning an agricultural system operating on ecological principles in specific areas.

The problem of food mirrors lesser problems. There are shortages of land and energy; there is overpopulation; and there is degradation of land and people. Any solution must address the whole complex. At least half the population of the earth is suffering from malnutrition, according to Borgstrom. Although some shortages are caused by transportation and logistical difficulties, food production is still falling behind population growth. Food is one of three types of resources: Fastly accruable (i.e., renewable); slowly accruable (basically nonrenewable); or, slowly dispersed (really nonrenewable).

Most of the wealth used by modern economies is nonrenewable. These resources are limited, interrelated and distributed unevenly. Forests are a special problem; although trees can grow to a good size in 30-40 years, forest ecosystems may take 300-600 years to develop and then last for thousands of years. Oil, coal, peat, and some woods are functionally nonrenewable. Geological time periods are required to produce them. Mineral reserves may be understated by a factor of 5 (Limits to Growth) or 1,000,000 (Hudson Institute). But, they may be located so far and so deep that it would cost more energy to extract them and move them than they are worth, unless we used a “renewable” energy source—the sun.

Slow accrual and slow dispersal resources should be equally available to all cultures. It is impossible to sustain any quantitative arguments about resources and population pressure on them without a comprehensive overview. Demands on food, fertilizer, energy, and metals are related inseparably. Organic and inorganic assets need to be assessed together. Population carrying capacity cannot be formulated until both resources have been quantified.

We depend on vegetation for far more than food—for newsprint, construction, furniture, clothing, and packaging. Furthermore, with shortages of minerals, many substitutes are expected to be organic. The measurement of the total production of vegetation is difficult and complex. Wild plant communities, which could form experimental controls, have been altered over thousands of years. Original wild communities were efficient and flexible.

The International Biological Programme embarked on a large number of projects to assess the biological productivity of all the main types of terrestrial ecosystems. Efforts based on these materials have been made to compute the actual Net Primary Productivity (NPP) of land vegetation at the present.

7.6.1.2.3.2. *The Real Wealth of Nations*. Samuel Eyre based his own calculations on these and other criteria to calculate the NPP of the original wild vegetation of the planet. Eyre, in his book *The Real Wealth of Nations*, calculated the NPP for wild areas of the earth and for wild and domesticated areas of individual nations. He calculated that national boundaries have different potentials. Australia, Zaire, Canada, and Brazil have the highest potentials. Among the most poorly endowed are the heavily populated European, Eastern Asian and West Indian countries and the dry Middle East and Southwest Asia.

Eyre then calculated the terrestrial production per capita: At the world population of 4 billion, and an above ground NPP of 50 billion tons, we get 13 tons per head. Currently the average person in the United States eats the equivalent of one dry-weight ton per year, including waste and meat production. In addition, over half a ton of timber per person is consumed in paper and packages. He considered that an average of 10 metric tons per capita potential NPP was necessary for self-sufficiency (that is, we are approaching the limits of the planet).

Eyre also devised a common denominator to consider organic and inorganic assets together. Population carrying capacity can be formulated only using both. He assigned a nutrition equivalent unit weights of metal to measure the population carrying capacity, but this calculation depended on a dollar value for food and minerals.

The advantages of primary production as wealth are that the wealth is sustainable, plants are renewable, and minerals can be recycled. The disadvantages are that the Net Community Production (NCP) is not considered, which takes all of the food chain into account, dollars are used instead of fair human work units and the technological production costs of food are not considered. Many countries, such as Surinam, with very high NPP figures, have low NCP figures, and therefore low potential for development.

Until human labor is equalized across cultures, dollar value only reflects the unfairness and inequality of the past—this is not to say that unskilled work is the same as skilled work, but that people performing similar kinds of work should expect equal rewards. Many external costs, such as those costs associated with forests cleaning and holding water, never enter the calculations of modern economics.

The original vegetation cover of the planet was extremely diverse. The potential natural productivity of wild vegetation is 120 billion tons of dry organic matter per year, but not all is available for human exploitation. The proportion of NPP above ground would only be 80 billion tons. These are both rough approximations, since this is the theoretical amount that would be produced by wild vegetation with no major environmental changes.

Much of this is not usable by humans. For example, in the production of forests, 65% of above ground production is not used by most lumbering operations. Possibly, over all ecosystems, the representative average of unusable material is only 50%. Taking most of the material is not desirable anyway because mineral nutrients are locked up in plants. Complete extraction of plants would result in removal of from one to two thirds of potassium in the whole ecosystem. Although there is plenty locked in rock particles, this is released slowly.

Some crop productivity, usually at experimental stations, is capable of producing high NPP, in total dry weights, since the land has been "improved" to pastures and crops. The most productive crops can approach the NPP of the original cover, but average crops produce less than half of the natural cover. The highest figure was achieved in Japan, where substantial dressings of fertilizer were applied. In countries where no fertilizer is applied, the annual productivity is unlikely to be more than one quarter of the native vegetation.

In tropical climates, the NPP does not appear to increase in proportion to increased sunlight, because tropical plants use up far more energy for their own metabolism. The hotter the environment the higher the metabolic rate; so temperate zones produce higher yields than tropical. Although tropical ecosystems offer less potential for high levels of secondary production, microorganisms (autotrophic and decomposing) and invertebrates could be potential converters to high quality animal food.

In a world no longer regarded as unlimited, it is important to know the annual production of organic material. The potential food producing capacity of the earth is represented by conflicting views. Many ecologists fear that agricultural activities have strained the earth's productive capacity, while supporters of the Green Revolution regard food shortages as simple organizational problems. These extremes cannot be adjudicated until there is some idea of the productive capacity of lands using their original wild vegetation and of the amount of material produced in cultivated replacements.

In Productivity of the World's Ecosystems, Rodin, Bazilevich and Rozov estimate the phytomass of land at 2.4×10^{12} metric tons of dry weight—82% of this is concentrated in forests. Since those figures refer only to a standing weight, it is important to know the rate of production. The total primary production of land is 1.72×10^{11} metric tons per year. Forests produce over 49% of that.

Eyre estimates that the total annual terrestrial NNP has been reduced by 38.5 billion tons since the advent of agriculture. The complete removal of all forests, converted to cultivation and pasture, would lower the NPP to 27.6 billion tons, assuming all savannas, prairies and scrublands remained unaltered.

Even in low-use areas, there are affects from human occupation. Although an old primary forest ought to be able to grow back out of the young secondary, the transition may take thousands or tens of thousands of years. With its two-year pay-back horizon, market economics cannot allow ten-thousand year plans. An economics with vision, with new images, could accommodate long return cycles.

The basis of all wealth at this stage has to be the operation of the planet. The planet hosts the life forms that create the production. The planet provides the cycles that keep necessary nutrients and elements available. And, the planet has produced the human abilities to generate new forms of wealth from ideas and inventions. The protection of all these forms of wealth requires common rules of conduct on the global stage.

A crucial part of ecological conomics has to be koinomics, the equal apportionment of 'resources' to all living, interacting participants in the global or local commons. This involves recognizing the entire legacy of the planet as it is created, developed and maintained by its tenants, and allowing reasonable access by nonhuman beings for their needs, since we ultimately depends on their 'services.' For human beings, it means limiting our interference with living webs and biogeochemical cycles.

Figure 63-1. Office of the Mountain Grove nonprofit corporation 2003

7.6.2. *Local Problems: Corporations*

A corporation can be defined as a legal entity independent of the persons who created it; or, as a group of people who act as an individual; or, as a large belly (there may be a possible connection). The oldest surviving corporation of any sort is the Benedictine Order of the Catholic Church, which was founded around 529 A.D. The oldest surviving business corporation in the world is probably Sweden's Stora Kopperberg, which was founded in 1288 and is now known as StoraEnso. The first significant American industrial corporation, the Boston Manufacturing Company, was established in 1813.

7.6.2.1. Corporate Independence without Limits

The first corporations were quite limited to public service, such as private highways, and did not challenge the host nation. As a result of changes in technology and several social changes, however, corporations were able to overcome limitations to their business.

In 1886 the U.S. Supreme Court made the ruling that corporations were persons, entitled to rights and privileges given to individuals by the Constitution and Bill of Rights. The corporation is legally fictitiously a person, an individual, although now they may be immensely large, rich, immoral, and powerful, supercitizens.

Supreme Court Justice Louis Brandeis noted that U.S. citizens were reluctant at first to grant corporations privileges for doing business, even though they were recognized as being more efficient. The reasons for this reluctance were: Fear of encroachment—on liberties and opportunities for individuals; fear of subjection of labor to capital; and, fear of monopoly. Privileges were granted, with restrictions on the size and scope of corporate activity.

Gradually state governments removed those limitations. The corporate system evolved like a feudal system, according to Brandeis, where American society came to be ruled by a plutocracy, where a few old, white men control hundreds of thousands of people through corporate mechanisms.

Even more controls have been lost since the 1950s. The stockholders have lost control to management, thus ownership and control have become separated. Managers can pursue a course without the direct supervision of the owners. Antitrust laws failed to control corporations. Regulatory legislation as a legal limit on corporate power has also failed. The labor unions are no longer restraints on corporate power.

7.6.2.1.1. Constitutions Federal & Corporate

The U.S. Constitution was written during a specific social context, at a certain level of technology, and at a certain point in the development of the industrial revolution. The forces that have developed as technology and corporate organization developed are not consistent with democracy and its ideals—and in fact, the constitutional and economic vision of that time have been rejected. The system resembles an iceberg; the visible parts look like a democracy with a free market, but the invisible base determines where the ice heads. The dark down-side majority determines how things function. Because it was not foreseen by the U.S. Constitution, this situation has escaped the traditional controls and limits. Corporate icebergs can direct the free market, by-pass democracy, and dominate people's lives. Corporations are powerful and indifferent to human life as well as to the free goods of nature, which is why not everyone gets lifted with prosperity or why nature is also decaying. This new system has arisen from the alliance of government with private corporations, for profits.

Corporations have developed their own constitutions for operating for profits. Among managers there are shared knowledge and assumptions, acquired in schools and social situations. These assumptions become the real operating constitution of corporate government.

Skills that will advance the interests of the corporate government are the ones that are selected, but understanding of the world below them or of the effects of their decisions on that world are not considered important. What are the shared assumptions?

1. Impersonal economic forces (a myth not often recognized) produce better choices than planning by thoughtful people.
2. Economic growth is the measure of well-being of society as a whole and benefits everyone (another myth).
3. All important social values are quantifiable and measurable (trust, loyalty, and beauty are outside but can be willed by strong people).
4. Treatment of people as employees does not effect the rest of their lives, regardless of layoffs and coercion.
5. The market will supply all social needs, although the massive efforts made by advertising to influence people to buy unhealthy and unnecessary things are not detrimental.
6. People are rational actors whose behavior can be controlled. They are dominated by economic interest but should forgo interest for others and the community.
7. The product of this system is the best system, not necessarily good people or a healthy society and environment.

Based on these assumptions the elite managers make decisions that affect all of society, although this consensus may not be conscious. The access to position and wealth has become controlled by corporations now.

7.6.2.1.2. Corporate Rule

Corporations are ruled from top down. Rules are not adopted democratically, or enforced with the fairness required by law. Because of the success of corporations, other institutions, such as schools and colleges, follow the corporate model.

People obey the dictates of corporations to avoid being laid off. Employers then demand subservience and obedience far beyond what governments require with laws. And, the punishment, of loss of job, is more effective than the threat of imprisonment. Independent thinkers are discouraged from government jobs, the result of background checks and standards for conformity. Punishment, of course, is a modern version of ostracism or exile.

Corporations have become exempt from the Bill of Rights, because the Bill applies only to actions by the government and its agencies. They do not allow employees freedom of speech or due process.

Under the flag of efficiency, institutions have adopted an authoritarian model. An authoritarian workforce has advantages for a corporation. Civil liberties can be suspended in the name of profitability. The technology and communication works better in authoritarian mode. Its wealth gives it power. So much so that it does not require the use of force, although the public government allows it to use other forms of coercion.

Is this the operation of a free market, where workers can negotiate for benefits or working conditions? Or can corporations coerce workers into accepting a job under any conditions, to avoid being one of the surplus unemployed? Possibly a free market could favor a healthy society if balance was maintained. The coercive market upsets that kind of balance. The economic government has chosen to devalue labor to be able to compete on a world market. By causing lower labor costs the corporation saves on labor, but larger costs are imposed on individuals and the society that has to support the under and underemployed.

The efficiency of large scale is an axiom of modern economics. But, the efficiency is enforced by corporate control of resources and employees. Corporations that control the entire process of acquiring resources, manufacturing, distributing and marketing have advantages.

Thus, the market is not free; it is fixed by corporations. Price and production are controlled by planning, research, and programming, not by a free market.

7.6.2.1.3. Corporate Growth

In the past, at least as recently as the 1930s in the U.S., public government worked to protect people from the harm caused by private government. But, economic power has been leveraged to political power, where corporations can deny free speech to employees outside of the work place. The economic government, according to Robert Reich, creates a corporate hierarchy, with pervasive inequality between all levels, not a democracy. To keep profit growing, corporations have been willing to accept damage and conflict.

The growth of corporations caused a growth in government in response, mostly to help those hurt by large corporations: Small farmers, small businesses, and individuals. According to Reich, the government expanded its constitutional powers, not by amending the constitution, which would be the appropriate way, but by allowing the Supreme Court to give broader interpretation to the Constitution. The government ended up trying to regulate parts of the economy or those parts that corporations were unwilling to perform. At least until government simply became a willing partner in the changes. Economic government dominates public government, which helps it.

In the past corporations exploited child labor, until government intervened. Corporations could dismiss employees without offering them assistance, but the government started to provided social security, and unemployment and training benefits. This response to the narrowing of opportunity and independence has been termed the 'welfare state.'

Individuals cannot, and corporations will not, take responsibility for public services such as highways, airports, national defense, national parks, schools. So, government takes sole responsibility (as it should be responsible for national things). National defense for instance, has enriched many corporations, but the corporations do not even provide efficient or competent work, in many cases. Public resources such as oil and forests flow to corporations as subsidies. Radio and television licenses were distributed to corporations. Now, corporations dominate public airways. Public lands used to be the support for individuals. Now, they support corporations.

As private corporations became larger and international in scope, local and state governments have been unable to regulate their activities. That would take a strong local or national government or international body. In their own interest corporations work to reverse the intent of the people. For instance, although U.S. President William Clinton in 1992 promised a pro-employment policy, the minimum wage was not enacted, and interest rates were raised. What the people voted for was reversed by invisible management of corporate government. The legal system becomes another tool for power, to justify the distribution of wealth, as a result of favors. This destroys the neutrality, fairness and dignity of the law.

7.6.2.1.4. Corporate Tyranny

As long ago as 1958, John K. Galbraith observed that the public sector became more affluent as the private sector was impoverished. Public poverty has become deeper. The money is not missing; it simply migrated to the private sector. Urban parks and wilderness suffer neglect or destruction; parks and forests used to be the symbols of freedom. The free market did not decide that; corporate managers did.

The broad and deep middle class of the U.S. in the 1950s acted to stabilize life. Now, the new structure of the work place, with its steep hierarchy in megaglobal corporations, is destroying the middle class. Security is lost; community is destroyed. Corporations control the workplace without interference by government, unions or competition.

There are new kinds of tyranny, not just from governments now, but from corporations. U.S. citizens once fought taxation without representation, but they seem reluctant or indifferent to fight economic decisions without representation. Is corporate tyranny more acceptable than governmental? Is abuse of power by kings not acceptable, but abuse of power by corporations okay? Are unjust executions by government terrible, but cancer from toxic wastes from corporations acceptable? Is government mismanagement reprehensible, but abandonment of communities by capital just a part of business?

We fought taxation without representation. Economic tyranny could also be reduced by balancing society more, by recognizing the immeasurable values that exist before being economized in an economic dimension. Control of corporations could lead to a better balance of natural, human, and economic environments.

7.6.2.2. Corporate Intersections: Ownership & Capitalist Scale

Ownership has changed meanings many times in the past 40,000 years. At first it was rare and may have applied to only a few personal items such as ceremonial clothing. Now that humanity has divided up the earth, every part is claimed and owned. Every forest is owned, even if the tribal residents do not become aware of it until some company starts logging it. One would think that this gigatrend of ownership has ended with the finite territory of earth, but it shows signs of continuing through the solar system.

Large-scale ownership patterns may be relatively recent. In China by 594, the state of Lu instituted land taxation instead of expecting direct labor. Individual ownership and a free market may have appeared afterwards.

In England, a forest was originally a tract of land owned by the sovereign and used for hunting; the word also referred to a dense or profuse growth of trees. By the eighth century, forest referred to the royal woods, where the right to hunt was reserved by the king. Other rights, however, such as the right to cut wood for home fires, remained free for everyone. The forest then became a legal term that applied to a large tract of land, governed by laws, with its basis on the right to hunt. At one time, almost a third of England was royal reserve. Enclosure of common fields gave some people ownership of the fields.

With ownership comes management, with management administration. Administration, from the Latin words meaning to serve, means the activity of an institution in the exercise of its powers and duties; it also means the management of an institution. Ownership also has effects on productivity and disposition.

Some people are not permitted to own things. For instance, tribal ownership is usually ignored by federal governments. Private ownership is influenced by taxes and regulations. Federal ownership can limit or accelerate the use of resources, such as forests; Canadian forests, for instance, where 90% of all land is in provincial Crown hands, are vulnerable to the fads, style, and influence of industry—in the U.S., where 72% of lands are private, industry has far more people to convince.

Perhaps the most important condition is the security of land tenure. Management has never invested in land that is regularly changing ownership from the government to tribal to individual or back. Religious organizations that have persisted for centuries have done well at preserving individual trees or stands; both Chinese yellow pine and dawn redwood, long thought to be extinct, were found in temple gardens. By contrast, the Queensland Australia management system for moist tropical forests was closed down by a political decision after a state-federal struggle for control. Long-term stability, with secure ownership by state, culture, or tribe is a necessity for permanent forests. This means intergenerational management.

Perhaps ownership will reflect a change from individual and corporate to land trusts and community. We need to find the best combination of ownership, trusts, easements, and plans to ensure that the forest will be cared for in the long-term.

7.6.2.2.1. Free Use of the Commons

Economists try to bronze the economy in its current structure; but it is a changing system. Since it is changing, strategies that are appropriate at one stage are totally inappropriate at another—this is the remorseless working of tragedy, where successful strategies are applied in inappropriate circumstances. Tragedies imply conflicts larger than the individual or even society. The external order of things or the cosmic plan is challenged, even if the cosmos is the size of a city. The source of tragedy for economics is a fatal flaw of the world-view. This is the root of Hardin's tragedy of the commons. The tragedy of the commons occurs only when people are locked into a system of self-interest through economic gain; it could not happen in a culture that understood common holdings. Hardin's definition of tragedy is the working of fate. But economic tragedy results from the failure of a cosmology: humans are responsible, not chance or fate. We can choose between the tragedy of the commons or that of Leviathan, or we can expand the cosmology using ecological knowledge and wisdom and the limit economics to a sustainable place in the cosmology.

Sustainable development requires recognition of the large number of limits. The ecological approach to development makes it irrelevant to discuss global limits to growth. Local limits are far more significant to most people. Economists have claimed that the minimum does not apply in a growing system, but our system has been growing through transformation and not real growth. We simply convert ecosystem economies into human ones.

Complex societies depend on production from resources. Increased complexity requires more information processing and more integration of disparate parts. The costs of communication increase. Complex societies need control and specialization. Yet, investment in complexity yields declining marginal returns because of the increasing size of bureaucracies, increasing taxation, and costs of internal control. If complexity can be restrained, the society may be healthier.

If complexity, especially in an economic sense, increases too much the entire society can collapse as its disadvantages start to outweigh the advantages. Various authors, summarized by Joseph Tainter, have concluded that economic reasons explain the collapse of many societies historically, from the Maya to the Ottoman Empire and the Ik (in Uganda).

The current economic style is too great, fast and reckless for ecological systems to absorb its impacts. The scale of things is an independent problem that can ruin the best intentions of policy. A bigger system to control systems that are now too big might be a mistake.

Every economy depends on the stability of the environment and on the stability of social institutions. The environment provides air, water, and land, and provides renewing, both physical and psychological. Institutions, from sanitation, police, schools, churches, and community centers, provide a supporting network. As these institutions wobble or fail, or environments do, economies may have to subsidize or replace them to survive.

An economy has traditionally been seen as a morally neutral body, but even if it has only to conform to the nominal rules of society, it is already a moral agent. Economies are no more neutral than other organisms. Many areas of moral concern already are recognized, including worker safety, affirmative action, advertising truth, foreign investments, and harm to the consumer, public, and environment.

Responsibility occurs wherever the interests or rights of a person, society, or ecosystem are significantly affected by the actions of economic actors. Responsibility can be understood in terms of costs and benefits, that is, through operations and their consequences rather than abstract behavior. Every action entails a gain and a cost (or profit and loss). Profits and losses are distributed privately, socially, or environmentally. Unfortunately, the modern system privatizes the gain and externalizes the loss to the "commons," considered as a pool of "unowned resources," where in traditional societies, it was surrounded by rules for use. As long as this is possible, it is profitable to charge the cost to the environment.

Externalizing costs works fine in an uncrowded world, where the costs are negligible and can be absorbed by natural processes. Resources were traditionally seen as free for the getting; air and water were seen as free sinks. Modern economies, embracing the notion that "nature is capital," draw on the accumulated "capital" of ecosystems for production. By ignoring the real cost of the capital, as well as the costs of natural services, such as nutrient recycling, soil building, and atmospheric renewal, these economies create a temporary wealth. Decisions regarding resources are made on short-term economic grounds and lead to shortages and environmental degradation.

Modern industrial culture places an emphasis on individualism and competition. Cooperation, with an understanding of rights and responsibilities, is based on cultural understanding. This kind of understanding, once prevalent in many cultures, is the reason why the tragedy of the commons (Hardin) did not always occur with common resources. Cooperation is crucial.

7.6.2.2.2. Capitalism & Growth

The English encouraged trade to increase their wealth. This lead to government regulation of the economy to ensure growth by granting monopolies, or mercantilism, an early example of regional trade going to global trade. Mercantilism allowed the accumulation of capital. And, capital required more energy and new technologies. This lead to the separation of people from the land and resources, at least in England in 1650, during capital production, or capitalism. Goods were privately owned. Later, there was a shift to assembly-line factories using fossil fuels. As immense legal individuals, corporations created monopoly capitalism.

Capitalism flourished with the agricultural revolution that began in England in the 1700s; the other half of the revolution was science, which also benefited capitalism. The two, capitalism and science, have not quite been compatible. They have different logics and different goals. Many times capitalism forces environmental destruction, due to the limits of the system. The gamble is to win big or lose big.

Capitalism rose when kingdoms were becoming more democratic, but capitalism is not linked with democracy; it does not contribute to democracy. In fact, it can adjust quite nicely with many totalitarian states or dictatorships, such as Russia, China, and Saudi Arabia, all of which have fast food restaurants with fizzy drinks.

7.6.2.2.2.1. *Perpetual Growth*. Capitalism has felt the need to grow. The need to grow is intrinsic in this kind of economic system. A large literature has treated perpetual growth as the only conceivable state of affairs. Capitalism depends on growth for stability. There is some analogy with plants. Some stability can be gotten from growth in early stages; later stability must result from limits and metabolism. Growth in plants can delay the onset of senility by ridding the plant of waste products in more diluted form. However, too much growth produces a strain on tissues and early decay. In fact, one herbicide promotes excess growth as a means to kill weeds.

The production of wealth from growth depends on technology. The technological perspective is oriented toward materials and not humans or natural processes. Nature is considered to be a resource to be exploited. The immediate objective of technology is to create wealth through knowledge. Technological activities are justified on humanitarian grounds, scientific discovery increases the well-being of human society, yet the social consequences of scientific activity are ignored; short-term suffering will be offset by long-term benefits, it is claimed. But because the long-term view is not taken, long-term benefits will be worse.

Economic growth can produce great wealth for some. Fortunes await those who can increase the demand for unnecessary items, such as electric swizzle sticks or pet rocks. Free enterprise provides initiative to any willing to show a profit without regard for the immediate consequences. The economist Paul Samuelson illustrated the skewed distribution of wealth with an income pyramid made out of children's blocks: if each layer represented $1000.00, the peak would be as high as the Eiffel tower, and most of us would be playing within a meter of the ground.

Wealth is based on production in capitalist countries, and on useful production in Marxist countries. The difference is mostly rhetoric. Production is measured as Gross National Product (GNP), which measures flow, not stock, which is equally meaningful. The GNP adds the dollar value of all goods and services, including cigarettes and lung cancer, oil wells and spills. There is no deduction for environmental damage or deaths. GNP also measures services, such as banking, many of which do not raise industrial output. However, gross production may not be as desirable as thought. The world prices of food and industrial raw materials have increased far more rapidly than those of manufactured goods. It can be seen that economic growth is not equal to progress.

Inequality is more the result of differential development than of exploitation. According to Kenneth Boulding the greatest source of the differential is different rates of accumulation of knowledge, capital and organization; the rates are essentially internal properties of cultures. Although a minor element in terms of transfers, it is a large psychological perception, which may need to be compensated for in a global community.

7.6.2.2.3.2. *Perpetual Borrowing*. Capitalism has developed other difficulties. It is disruptive of resources and culture; the unequal exchange of goods, and the advertising of goods as necessary, leads to accumulation. Many of the characteristics of capitalism are destabilizing to a national economy: The goal of perpetual growth, the continuous accumulation of goods, the myth of progress, increased inequality and polarization, and the hierarchical division of labor, as well as of nations.

These difficulties have forced corporations to liquidate capital assets, such as old-growth forests, rather than keep them as long-term capital. The answer might be provided by recent economic history: After the second great depression starting in 1932-3, the U.S. government tried to flatten out the boom and bust cycle of our capitalist economy by manipulating taxes, interest rates, and money supply, by subsidizing jobs, and through corporate welfare. Although the government discouraged monopolies, it did nothing to regulate oligopolies—the control of the market by a few large companies. Prices are set by the costs of production, including bloated bureaucracies and executive salaries, rather than by demand and supply in the free marketplace. As the automated production of goods became more efficient, goods-producing jobs declined. On the other hand a large, well-educated labor force, mostly women, was available at relatively cheap salaries. Information processing and human services proved to be far less efficient than automation. Marvin Harris suggests that corporate bureaucracies wasted labor and lowered productivity faster than automation could save or raise it. Corporations were no longer efficient enough to expand production out of sale-generated income and took on additional debt.

As economists point out, debt is inflationary because borrowing puts more money into circulation. Rising interest rates caused cash-flow problems, which many large corporations responded to by lowering quality and by passing the costs of borrowed money on to consumers—which allowed them to borrow more at even higher rates, which the government had raised to cool off borrowing. Corporations have gradually increased their dependence on deficit financing to supply capital. Harris notes that corporate debt has gone up fourteen times while federal government debt has gone up only three times, as a percentage of gross national product. As more money was owed, more was paid to service the debt and less was available for cash flow. More short-term debts were taken on to keep up cash flow. Corporations can borrow faster and pay more to borrow, but can keep raising prices to consumers so they can keep borrowing—or liquidate some of their assets, which is probably why Burlington Northern and other land-owners allow massive clearcuts: Cash flow needs due to long-term inefficiencies and massive short-term debts. The impulse to save a corporation may override the need to save the natural heritage, such as old growth forests.

7.6.2.3. Summary: Frivolous & Savage

United States residents are criticized by the French, not unreasonably, for having a "frivolous" culture based on "savage" capitalism. Capitalism increases the pressure for uniformity, a single pattern of existence. Formal development is more concerned with an assembly-line model—simple, isolated, efficient, and easy to maintain. We become remote from, and indifferent to, the system that supports us. We acquire unrealistic images of the world and harmful values, and then make bad decisions based upon them. We have not developed qualitative indicators of ecological health or quantitative measures of social health, much less an ecocentric view that would value preserves of nature for themselves.

Capitalism, as practiced by uncontrollable corporations, has been accelerating and enlarging its markets. The effect of their dominance has been to redesign the economic and political patterns that developed near the beginning of the Industrial Revolution, according to J.G. Speth. These patterns decentralize control and shift power away from nations to the corporations themselves, which are free from national regulations. At the same time, the failures of the corporations to protect resources and labor push those costs onto all the nations and ecological support structure.

Flexible regulated markets can be efficient instruments in the distribution of durable goods, but coercive, unregulated markets can never produce and distribute everything, especially spiritual values or social justice or sustainable environments. Government should still provide public goods, from public education and culture to employment, social welfare, and penology. Most important is ecological survival.

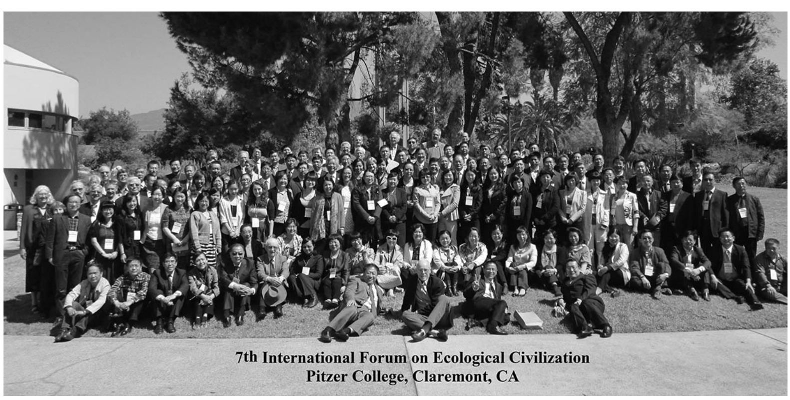

Figure 75-1. J.B. Cobb, Jr. at the Ecological Civilizations Conference

7.6.3. *Local Design Solutions: Charting Ecologically Responsible Corporations*

The metaphor for a corporation used to be a simple mechanical model for turning resources into products. To be successful, a corporation had to grow and turn a profit continually. Unfortunately, the assumptions of the model were also simple and failed to consider human needs and natural cycles, causing great suffering and great disruption.

To be really successful, corporations need to adapt a more comprehensive model, one that reflects stability, cooperation, justice, and respect for nature. With an ecological model, the ecological responsibilities of corporations, to themselves, to nature, and to human communities, are described.

7.6.3.1. Corporate Organisms

A corporation is defined legally as an individual person, although one that is defined by law and exists only in contemplation of the law, hence it is artificial, invisible, and intangible. A corporation is not the stockholders or officers; it has its own entirely separate and distinct existence. This kind of artificial person was the invention of commercial interests; the first corporations in Britain were granted charters by special acts of parliament to provide services for the state. Most corporations have characteristic legal features: individuality, permanence, limited powers, continuing succession, action in the corporate name, limited liability of members, transferability of member's interests, and representative management. Charters have become easier to get, until now corporations can be formed under general law. Corporations have been adapted to meet most modern business and social needs. Real persons can do anything not prohibited by law; corporate actions are derived wholly from law and limited to the charter, although charters have become very comprehensive statements that allow a great variety of activities.

In the publication *Integrating the Enterprise* by Digital Equipment Corporation, it is stated that "Digital is a living organism," tending toward a state of dynamic equilibrium by adapting to circumstances as fast and economically as possible. This is a natural-enough metaphor, and it leads to interesting deductions.

Like an organism, each business is born, grows to a certain size, then matures and dies—perhaps a natural span is hundreds of years, like the Oxford University Press, for instance, or perhaps only a year like so many new businesses. Biologically, maturity marks the end of physical growth in humans, but not necessarily the end of emotional, intellectual, and social development. Like an organism, the corporation, unconsciously through its officers and managers, starts to act to preserve itself before completing its formative objectives, such as maximizing profit. Like an organism, a corporation lives in place and alters that place to some extent by living, although some of the larger ones risk destroying the mixed community of humans, animals, and plants (and all their associations) on which they depend. Every organism must fit in its community and environment. It must be integrated and limited—self-consciously so in the case of humans and corporations.

Corporations are unique organisms. Corporations are more than just groups of people without structure. Corporations are described by analogy with individuals. But, each has unique characteristics: the corporation has a right to property and free speech, but not a right to worship or vote. They can be longer lived than their human components.

7.6.3.1.1. Problems with Corporate Organisms

The old analogy of the corporation as a machine leads to bad assumptions: that everything is a resource; that resources are unlimited; that production must continue endlessly; that the corporation has to keep growing to survive; that the purpose of the state was to legitimize exploitation; that the purpose of humanity was to multiply, produce, and consume; and that the purpose of the universe was to supply human and corporate needs. The machine analogy also leads to false economic beliefs: that mass production is most efficient; that obsolescence is necessary for successful growth; that people's needs and wants are fulfilled by advertised products; and, that quality does not matter very much.

Some companies have started to work around these beliefs. Kodak and Head, for instance, have succeeded with custom production, high-quality, long-lived products that people did need. Other corporations are suffering problems as the results of bad assumptions and false beliefs. These problems include: overgrowth, with an increase in complexity and costs (many of them social); economic and ecological instability; social burdens (from pressures on family from relocation and powerlessness); misdirected effort on ill-conceived products; slack employee attitudes and performances (sickness, accidents, turnover, layoffs).

In the effort to control their problems, corporations have sought more control. The corporation tries to avoid being vulnerable to change and uncertainty, fluctuation, and market conditions by relying on planning and control. Corporations try to ensure stability by taking over the supplies of materials, controlling their subcontractors and the buyers of their products, controlling the work force with pay and incentives (as well as by cultivating identification), and managing demand by sales influence and advertising. Many corporations try to be flexible about resources, using what costs the least, say, cheap energy to replace expensive labor. Corporations, especially multinational ones, seek raw materials everywhere, in any nation, under any ocean. Corporations become international, mining, assembling, and selling in three different continents. Where developing countries were once regarded as sources of raw materials, they are now used as bases for manufacturing, and they are becoming growing markets.

This control is possible because corporations have acquired such great power. Large multinational corporations have great power to control national economies and ignore environmental laws, partly because of their historical promise of providing social services to national states. Unfortunately, as private good became identified with public good, corporations became less concerned with social service and more concerned with greater profit through greater technology. Greater technology lets the power to change overwhelm the power to see the consequences. So, social amenities, such as clean air and fresh water, are violated legally—after all, no right of contract or fair use of property has been breached. Corporations exercise enormous influence over our lives, probably more than governments or churches. Furthermore, the size of some companies means that their influence is felt like shock waves through societies and environments. Multinational corporations are a force in the business world and a major influence on world affairs. Size and complexity give them special power, not only financial but political. Power is supposed to evaporate in a purely competitive economy, but capitalist economies are not purely competitive; power accrues to corporations.

Usually the goals of a company are generously, nobly, and broadly stated as intentions to support the best interests of owners, managers, shareholders, employees, the public, and, lately, the earth. Many corporations pride themselves on their generosity and personnel standards and on their good corporate citizenship, although the public concept of good is being extended beyond traditional bounds as citizens become aware of the interactions of business, politics, and the environment. Even corporations that claim to make clean products in safe ways often seem to depend on "dirty corporations" for power and packaging, as well as for paper and materials.

Business as usual, with its inertial model of growth, could end in catastrophe for humanity and its environments. Industrial cultures, with their characteristics of simplification, naiveté, homogeneity, and incompleteness, turn wild landscapes into flatscapes, where variety disappears and significance is ignored for the comfortable standards of meaningless continuity. Rapid growth might precipitate a catastrophe sooner, while modest efforts at environmental protection and increased efficiency may only postpone catastrophe.

An organic model offers the best alternative, with its emphasis on energy efficiency and alternative sources, its major commitment to environmental protection and the internalization of environmental costs, and its change from growth to stable, sustained development. Such a model would provide organic assumptions and beliefs: that resources are limited, that human value is only part of ecosystem values, that humans are more than consumers and producers, and that the quality of life is more important than quantity of possessions.

Like organisms, corporations may have an optimal size and a home place; organisms that occur out of place are often called weeds, and organisms that grow too large monsters. Perhaps corporations should be limited in size and tied to one place.

Healthy organisms, even humans, are educated to take their place in a culture that limits their impact on the environment, proscribes their actions towards one another and towards others outside the culture, and trains them to reproduce themselves and renew the culture. Most corporations act like improperly socialized individuals who have not been taught how to take a proper place in society and how to be responsible for their actions; instead, corporations hide behind their legally limited liability.

Any organism, like robins to fermenting berries, can be addicted to certain things in certain circumstances. Corporations have become addicted to cheap energy and easy defense money. It is possible to create circumstances that limit or cure the addictions (for robins, the berries fall to the ground and get covered with snow).

7.6.3.1.2. Ecosystem as Metaphor

Perhaps the metaphor itself is not adequate. Even organisms take a large part of their identity from their context, from the surrounding environment. It might be more productive, since corporations actually contain organisms, mostly human, to consider the corporation as an ecosystem. Ecosystems occur in a large diversity of sizes in nature, from a rotting log to one covering most of a watershed.

7.6.3.1.2.1. *Definition.* An ecosystem is defined as a biotic community and its nonliving environment functioning together. An ecosystem is also a self-organizing, chaotic system with emergent properties. Ecosystems develop in time. That is, a community develops by a reasonably orderly, directional process that involves changes in structure that results from community modification of the physical environment. Although the physical environment imposes limits and determines pattern and rate of change, the community controls the succession. The result is a relatively stable configuration characterized by a high biomass (or information content).

7.6.3.1.2.2. *Characteristics—Energy.* The "strategy" of ecosystem development is increased control of (or homeostasis or homeorhesis with) the physical environment—to protect itself from perturbations. There is a fundamental shift in energy flows, as increasing amounts are used for maintenance. The structure of a community changes: organic matter increase, inorganic nutrients are used internally (instead of being extrabiotic), biochemical and species diversities become high, and pattern diversity becomes well organized.

As more and more energy is used for maintenance, the net community production approaches zero. Agriculture keeps an ecosystem immature in order to harvest the larger yield in immature systems. The mature system becomes more efficient, as it supports a larger biomass with the same amount of energy. The food chains become more weblike (dominated by detritus chains as opposed to linear grazing). Mineral cycles become closed and the nutrient exchange between organisms and the environment slows.

The life history of organisms undergoes change as well. Organisms tend to be larger (perhaps as a result of shift from inorganic to organic nutrients), with longer, more complex life cycles and narrower niche specialization. Population growth slows, with emphasis on the quality of life of organisms. Internal symbiosis becomes more developed, conserving nutrients and resisting perturbations.

7.6.3.1.3. Corporations as Ecosystems

Corporation and ecosystems have similar characteristics, which are useful for comparing functions and operations.

7.6.3.1.3.1. *Development in Time*. Corporations have been evolving for hundreds of years. There have already been shifts in the meaning of corporations and in the forms of organization and style: From a stable product line to continuing innovation process, from a product based definition (shoes) to a process (information), from a single pyramid of organization to constellations of satellite concerns, from the static to the flexible, from product line management to networks and innovations (the management of change), and from stable forms to temporary. Mature systems have a greater ability to trap nutrients for cycling. Corporations have settled in an artificially maintained pioneer state, feeding on the extra productivity.

7.6.3.1.3.2. *Energy Use*. If corporations follow similar patterns over time as ecosystems, we would expect their "food chains" to become more complex, with most of the energy flow following detritus pathways. Optimizing material and energy use, reusing `wastes' as resources (food webs between companies, where wastes are products, not side-effects), and closing loops by recycling. Reciprocal adaptations between plants and animals, or between producers and consumers, leads to mechanisms that reduce grazing and increase feedback.

7.6.3.1.3.3. *Low Productivity, High Stability*. A mature ecosystem produces many things, most all of which are used by the system; wastes are broken down into component chemicals by microbes, while other resources, like nitrogen, are fixed to roots by other microbes. The tightening of the biogeochemical cycles is an important trend. Corporations sometimes parallel the aging of an ecosystem, from a pioneer state to a mature state.

7.6.3.1.3.4. *Life History, Symbiosis.* The longer lived the corporation, the less clear the divisions between private and public and economic and environmental concerns. Short-term individual concerns meld into long-range corporate and social concerns. The short-term pressures may seem immediate and irresistible, but the long-term goals cannot be ignored for long. We may need electric power or paper now, but the cost cannot be the destruction of the source of those needs. We need the social and environmental health and stability first and always. Partnership between unrelated species, say mycorrhizae and trees, becomes notable. Corporations would team up with other companies and social and environmental groups (the pattern could be industrial symbiosis). Pollution is the most limiting factor; possibly we could predict new corps arising to deal with pollution.

7.6.3.1.3.5. *Differences*. Although ecosystems can be long-lived—thousands of years for tropical rainforests—corporations can disband at any time. Furthermore, unlike ecosystems, corporations still seem to be bound inflexibly by the rule of two-year payback. This means that decisions are based on short-term return and not on long-term durability.

Furthermore, although large organisms are the case for mature ecosystems, the scale of many corporations is too large; the patterns are unsustainable—large institutions lose touch with their constituents, become self-absorbed and less responsible.

The differences between ecosystems and corporations allow for the possibility of changes. Human communities can redefine corporations and limit their impacts. They can change the charter of corporations for the benefit of the community. Corporate responsibility is more complex than a simple linear cost/benefit analysis. Using the metaphors of corporations as organisms and ecosystems, it is possible to outline a new set of responsibilities for corporations and a series of behaviors that human individuals and communities can do to integrate corporate behavior into the communities.

7.6.3.2. Ecological Responsibilities of Corporate Organisms

The public responsibilities of corporations, according to Harvard management, are to grow and prosper (thereby providing customer satisfaction, employment, taxes, and contributions to the economy) and to control their hazards. According to Milton Friedman, the only social responsibility of a corporation is to make money, by striving after profit as an efficient agent of production, although he admits that the corporation should conform to the rules and norms of society.

Profit making is a necessary part of a for-profit business, but not the sole reason for business. The best business serves public goods as well as private interests. (This is similar to Ruth Benedict's original anthropological meaning of synergy as it applied to individuals. In secure, nonaggressive societies, an individual serves her own advantage as well as that of the group with the same act. The institution ensures mutual advantage; the acts are mutually reinforcing. High synergy institutions transcend the polarities of selfishness and altruism. Virtue pays because the rewards for selfishness coincide with benefit for the society. The social structure of low synergy cultures ensures opposition and counteraction; the advantage of one individual is a victory over another, as in a zero-sum game.) This is necessary for employees, since they have to feel like their work is meaningful and contributing to the public good. The path of production should therefore serve public good as well as profit. Environmental and social problems should get as much attention, because their part of the process, as sales, finance, and production.

Economic recession may bring a re-examination of values, not only by individuals who may have less material wealth, but also by corporations that have emphasized growth. The public may insist that corporations consider social performance as well as strictly economic performance. The single economic purpose may only be the focus in a social ecological environment. Economic actions, such as where to build, who to relocate, hire, or dismiss, will be subjected to greater public scrutiny. Corporations will have to adapt to changes in standards. Business cannot assert primary self-interest at a cost to the public or environment. Corporations need to keep track of their environmental impacts. Many of the problems that corporations face are connected to the problems of environment and society.

Every corporation depends on the stability of the environment and on the stability of social institutions. The environment provides air, water, and land, and provides renewing (both physical and psychological). Institutions, from sanitation, police, schools, churches, and community centers, provide a supporting network. As these institutions wobble or fail, corporations may have to subsidize or replace them to survive. Schooling for example, is often inadequate to provide literate, numerate, ecolate, or imagate workers. Police may not be able to provide secure conditions on corporate grounds for female workers. Public transportation to plants from town may not be available in enough volume.

A corporation has traditionally been seen as a morally neutral body, but even if it has only to conform to the nominal rules of society, it is already a moral agent. Corporations are no more neutral than other organisms. Etymologically, the word moral means simply "living together.' Sometimes even routine business (nonmoral and nonenvironmental) matters become deeper ethical conundrums about justice. Many areas of moral concern already are recognized: Worker safety, affirmative action, advertising truth, foreign investments, and harm to the consumer, public, and environment. Corporate responsibility occurs wherever the interests or rights of a person, society, or ecosystem are significantly affected by the actions of the corporation.

Responsibility can be understood in terms of costs and benefits, that is, through operations and their consequences rather than abstract behavior. Every action entails a gain and a cost (or profit and loss). Profits and losses are distributed privately, socially, or environmentally. Unfortunately, the modern system privatizes the gain and externalizes the loss (to the "commons," considered as a pool of "unowned resources," where in traditional societies, it was surrounded by rules for use). As long as this is possible, it is profitable to charge the cost to the environment. Externalizing costs works fine in an uncrowded world, where the costs are negligible and can be absorbed by natural processes. Resources were traditionally seen as free for the getting; air and water were seen as free sinks. Modern economies, embracing the notion that "nature is capital," draw on the accumulated "capital" of ecosystems for production. By ignoring the real cost of the capital, as well as the costs of natural services, such as nutrient recycling, soil building, and atmospheric renewal, these economies create a temporary wealth. Decisions regarding resources are made on short-term economic grounds and lead to material shortages and environmental degradation.

Similarly, labor was seen as minimum value. For example, the idea that "labor is a resource" implies that, like any common resource defined by industrial society, labor is cheap and can be used up. The real costs of free goods and externalities have had to be accounted for, yet—this often influences the selection of corporate priorities and growth. Furthermore, the production and distribution system for most corporations is linear (straight throughput) and not circular (complete recycling), although this is logical economically, given our frontier resource-use accounting. Major changes are occurring, though. The scale of civilization now makes externalization unfeasible. The costs of pollution and waste are being internalized; other inputs, such as labor and capital, are becoming more expensive. Corporations will have to internalize or be forced to internalize. With the internalization of costs (since the losses as well as benefits will accrues privately), the system will benefit from intrinsic responsibility.

Corporations need to work cooperatively to make sure the costs and benefits are extended equally throughout the system. They could start by sponsoring the rational use of rare resources through taxation. Influence the government to determine priorities for wilderness areas or special landscapes. Beautiful, fragile, unique, or endangered ecosystems and species must be protected at the expense of commercial activity. Corporations have at least three large, ecological responsibilities.

7.6.3.2.1 To be Economically Healthy

The first responsibility of a corporation is the maintain its own health, to mature organically, limiting its size and impact to the locality.

7.6.3.2.1.1. *Create a department* with ecological authority to envision long-range plans and impacts. Corporations need to react more quickly, to monitor their ecological and social environments for emerging patterns that determine their future. They need to anticipate and participate in the social and natural framework. A new department, with global, anticipatory functions could provide direction and continuity. Such a department could be justified in the same manner as military forces. Military expenditure is a nonproductive cost; its benefits are general and long-range, that is, it must discourage war in the next decade as well as in this one. Its scope of advice would include educational services as well as advertising, capital acquisitions as well as new products, plant engineering as well as security.

7.6.3.2.1.2. *Plan all foreseeable consequences of a product*. Advanced technology permits the power to change to overwhelm the ability to foresee the consequences of change. Avoiding the opposite actions of intentions (the enantiodromia recognized by the Greeks as the operation of tragedy) is extremely difficult. Good intentions are not enough: Laborsaving devices may contribute to unemployment and social problems; foreign aid may result in starvation for more millions as local agriculture cannot compete; the environmental management of some species for sustainable yield causes population collapses.

7.6.3.2.1.3. *Determine the optimum corporate size*. Limit the size of the corporation. After a point, growth results in inefficiency and nonadaptibility. Development, on the other hand, can continue for hundreds or thousands of years. A smaller size could mean more flexibility and faster response to local conditions. Recognize material limits. The global economy is probably too large already to be supported by the natural systems of the planet. What is the upper limit to the economy of scale? Accept limits to growth based on materials and on nonrenewable or dangerous sources of energy. This should not limit development based on advancing technology and knowledge.

7.6.3.2.1.4. *Adjust corporate strategies to changing values.* Smaller social and cultural groups have different and diverging values, so corporations are going to have to adjust to a diversity of values instead of to a monolithic standard. Now, the structure of power is disintegrating (with information replacing things as wealth). The knowledge-driven economy is more decentralized and customized. This moves us towards customization of production and away from mass production. Change the shape of the corporation to a framework coordinating separate divisions sharing information. Each could react much more quickly to market conditions.

7.6.3.2.1.5. *Work to delineate a new information model* of production in which the stages of a process (capital, materials, workers, design, advertising, selling) are simultaneous and synthesized. The conception of the product is extended from design (even customer contributions and design of working conditions) to aftercare, including ecologically safe retirement and disposal (recycling). The notions of efficiency and productivity are changing. Innovation and computer technology shortens product life cycles. Production diversity is increasing. Convert the information model to an understanding model. Information is just data without appropriate structure. Provide a structure and material base for understanding through communication, education, and training.

7.6.3.2.1.6. *Enter partnerships with the employees*. Address the optimum productivity of employees. For instance, government studies show that half-time employees are more efficient than full-time ones. So adjust the work force to fewer, more flexible hours (thus avoiding layoffs during the transition). Increase worker participation. What is extent of worker participation in management of workplace? New forms of ownership could mobilize workers in a more efficient and democratic economy. Productivity is declining, so is job satisfaction. Efficiency and productivity are often less important than use and appropriateness. Better pay and shorter work weeks have not compensated for lack of worker control. Offer more control. Streamline the organizational structure. Organizing workers hierarchically is costly. The best path for organization is lateral modularity, not bureaucratic hierarchy. The levels of management could be reduced drastically.

7.6.3.2.1.7. *Promote the principle of least effort*, allowing the company to consume less, recycle, use longer, and avoid waste. Corporations could develop renewable energy sources. Reduce office costs through energy conservation plan. Use renewable energy sources. Corporations need to maximize recycling. Energy and materials can be used and reused, flowing through the system. Ship by the best transportation, probably rail. Cars are ecologically unacceptable forms of transport, yet companies intrinsically recognize them with large, free parking lots. Discourage commuting; encourage telecommuting or even alternate forms of transportation (bicycling, buses, and trains). Minimize wastes, for instance, by using permanent packaging (Milk bottles and cola bottles can be reused forty or more times). Conduct a complete series of audits, including an energy audit for every building, an environmental audit to determine negative impacts, from acid wastes or product disposal, and a problem audit, including inherited problems. Produce a comprehensive annual impact statement.

7.6.3.2.2 To Preserve the Health of Natural Communities

The second responsibility is to maintain the health of the natural communities—because environmental health is the basis for community health, and community health is the basis for economic health and worker health. The quality of life depends on the quality of the environment. If the environment is degraded to raise the quality of life, the effect will be very limited and never be self-sustaining. Fitting economic costs and needs to the limits of ecosystems and monitoring the economic process would reduce wastes and pressures on natural processes. The coupling of agricultural productivity to a solar budget, and the conscious restoration of degraded systems, would contribute to the health of ecosystems. Sufficient wilderness would allow the self-maintenance of global cycles. With the increase in security, wealth, and self-esteem, human populations could be dependent on ecosystem productivities and still be diverse and unique.

7.6.3.2.2.1. *Be accountable for ecological impacts*. Corporations will be held more accountable for their technological impact. New technology will be more closely regulated. Corporations could anticipate this by favoring open appraisal of new technologies. By studying the potential consequences, physical, social, and ecological, as far as possible into the future, of its innovations in information technology, a corporation can gain credibility. Otherwise, it can wait and be forced by public and governmental pressure.

7.6.3.2.2.2. *Avoid interference with natural processes*. Technological processes must be brought into balance with the cycles of the earth. They must not damage or degrade natural cycles. Avoid unnecessary harm. It may be appropriate to use trees or to compete with black bears for tree use, but it is never wise to destroy the ecosystem of trees and bears. Laws on pollution and noxious wastes have been notoriously lax and sometimes wrong-headed. Minimal acceptable tolerances are legal, yet people often prefer zero amounts of many substances. Minimal compliance with them is virtuous in comparison with many companies, but it would be better to lead to higher standards. Work toward setting zero-level goals. Do not dump exotic or dangerous wastes. Do not discharge quantities of `safe' wastes.

7.6.3.2.2.3. *Integrate loops and material flows*; internalize cycles. This will minimize waste and the associated costs.

7.6.3.2.2.4. *Convert to ecological grounds practices.* Corporations maintain building and plants in thousands of locations, each requiring support. Forgo economic development of key ecosystems, which are not available for human use. Consider adjusting economic pace to natural rates; do not cut trees, for instance faster than they grow. Consider minimizing use of ecosystem productivity to the net ecosystem productivity, rather than the gross productivity, especially as regards fisheries.

7.6.3.2.2.5. *Promote ecological design*, which starts with questions. Is the product low-cost, aesthetically pleasing, and ecologically wise? Where does it fit in society? Ecological design, both responsible and socially responsible, must be radical, that is, rooted in a community in place. Membership in a place, in fact, leads to community. Corporations must become responsible members of the community. It would encourage an ecological approach to systems and processes in the whole environment, where the product, with its plant, engineers, and advertisers, is a link in a long biomorphic phylogenetic chain reaching from knotted ropes to surgical microchip memory implants. Ecological design has important characteristics for responsible technology: The products are designed by interdisciplinary teams considering all parameters and consequences; ecological sciences offer creative insights into design through a search for underlying organic principles; the product must be related to the particular environment, the tool is a link between human and environment.

7.6.3.2.3 To Support the Health of Human Communities

It is hard to protect communities when the way most business is done tends to disrupt community life. Because of its size, power, and intentions (for profit), the corporation should take higher risks than the surrounding communities. This will ensure the safety of products and wastes.

7.6.3.2.3.1. *Support the community*. A work place is not just collection of individuals. It is a number of groups. Group interaction can change attitudes. A working community can build mutual responsibility. Show proper behavior; learn community etiquette.

7.6.3.2.3.2. *Design the corporate structure* and size for the community. Limit unnecessary movement or disruption. Plan the shape, size, and products of the corporation to fit the local community. Encourage self-reliance in communities. Communities can be self-reliant by producing enough food and shelter, by limiting their population to what can be produced, by using local products and raw materials (soil, minerals, plants), by using general and not specialized machines, by having multipurpose factories, by networking with other communities, and by doing without things that are not needed (bombs or additives).

7.6.3.2.3.3. *Behave ethically.* An ecological corporation could use corporate buying power to promote acceptable technologies and discourage unacceptable practices. Deal less with nuclear weapons contractors and more with solar energy companies. Deal less with one-shot paper companies and more with recycling paper companies. Boycott paper companies involved in Rainforest destruction or old-growth forest destruction. Avoid banks that invest in anything that brings a high return (from third-world debt to Amazonian destruction and South African discrimination). Favor peace-oriented companies as business partners. And refuse to participate in work that is socially destructive.

7.6.3.2.3.4. *Participate in the economic and social functioning of the community*. Economic development and social progress are necessary for the welfare of humanity, but must be conducted with environmental knowledge. The goal of economics and politics is to provide suitable and comfortable human habitations and meaningful activities. Human settlements must be planned and constructed within environmental constraints and according to ecological priorities. Work to preserve the structure of the natural and social communities. Corporations can encourage decentralization and restore schools, clinics, and shops to local communities. Offer cooperative control with the community. Change the pattern of ownership to reflect employee and community participation.

7.6.3.2.3.5. *Promote ecological education in a total context and interdependency*. Encourage cultural traditions to stop letting social and spiritual needs be subverted by economic ends. Help lead the young into their adult responsibilities through training and participation (perhaps apprenticeship programs). Educate for appropriate ways to achieve wealth and well-being. Teach appreciation of services rendered by nature through flows and cycling. Point out the unexpectedness of consequences of even simple corporate interventions and innovations (positive feedback, biological concentration of poisons, and synergetic effects of simple new chemicals like CFCs). Trace the complex and reciprocal relations of soil, climate, vegetation, and human activity.

Emphasize that a fixed set of ecological parameters in an ecosystem can not be maintained sustainably, because the system is dynamic and changing. For example, where do computers fit in schools? Children do not need computers to develop the powers of thought, but they do need an ecological curriculum where animals display greater powers of mind than computers or machines. The important technological advantages of a computer, word-processing, database searches, complex connections, and rapid computation, are not really needed before high school, unlike myths, languages, and physical activities.

7.6.3.2.3.6. *Implement community responsibility*. In education, integrate business with humanities; the responsibility for the welfare of the citizens belongs in the community, as does education, safety, and the whole infrastructure. In management develop programs and management as source of influence by setting goals, modifying structures, and introducing criteria for measuring progress. Implement by the Board of Directors, the architects of responsibility and stewards of all resources, and by the government, in its legislative, judicial, and regulatory functions, which provide rules and permit freedoms.

7.6.3.3. *Summary: Changing the Model*

The corporation, regardless of its legal definition, is a long-lived, collective, impersonal body. Yet, it has more physical, legal and moral power than any one individual. Its investment is long-term in actuality. Many stockholders keep their investments for decades or a life-time. They are not concerned about only one dividend. Like the corporate organism, they want the long-term outlook to be positive; they want to know that their investment is stable and that the quality of life it encourages or supports is continuous.

The complexity of environmental problems should not permit escape of responsibility. The context of corporate responsibility falls within the spectrum from individual responsibility to social responsibility (the designation of property or trading conventions—capitalism or communism). Perhaps that responsibility could be enforced if the entire earth were incorporated and concerned with maximizing its own values: healthy beings in living contexts. Certainly not having `free' services and resources would force corporations to internalize all costs of production.

In any case, there are strategies that a corporation could pursue to become ecologically minded. Instead of treating decisions as trade-offs, an ecological corporation could aim at a congruence of moral, economic, and ecological objectives. Responsibility could be manifested in organizational structure, manufacturing, and marketing practices, without departing from economic decision making.

Such a corporation could bring corporate research and development capacity to bear on the transition to a sustainable society. Where technologies play a role in the transition, companies can assume social responsibilities equal to their size and wealth. By commanding their vast resources, corporations can ease the transition to a sustainable society (which would actually meet their needs for stability). The model of corporate life needs to change, from dependence on continuous growth (of profits and waste), to be being based on stability, sustainability, cooperation, justice, and respect for nature.

7.6.3.3.1. Designing the Business Model

Corporations could be subsumed under an ecological business model that emphasized the diversity of institutions, such that nonprofits and trusts could compete with profit-making institutions. So much of business is an “underground” reciprocal form that the strengths of those forms have to be considered and factored into the entire business model. These forms might be far more useful and beneficial on a smaller scale of operation.

7.6.3.3.2. Redesigning the Economic Model

The overall model of the economy itself has to exhibit concern for the survival of the members of a society as well as the social and ecological structures of which they are members. The model has to be able to respond to crises by changing its function to repair the breaks or wobbles rather than simply increasing consumption. The model has to be self-examining, to identify destructive economic principles, standards and trends and then analyze the forces that form them and drive them. For instance, is the momentum of the dominant economy causing it to be slow to respond to negative trends? Or is it our value system, much of which is based on the metaphor of machines?

We need to change the operating rules—the principles, standards and practices—to allow profit only after natural systems and human needs have been restored to health and protected. This is where koinomics becomes a factor. Resources rights are distributed to all beings equally, before human beings can exploit theirs for their needs. Profit is a recent idea that arose from a system concerned with raising capital for exploration and trade. It has become a trap that has been made a critical factor of modern economics, which is riding a sudden exponential expansion based on fossil fuel use, resource dumping, the continuation of extreme inequities—and complete indifference to environmental costs and human suffering. Profit is being driven to growth along with the conversion of resources and fuels to commodities.

Yet, it does not have to be. An ecological economic model shows how human welfare can be increased without growth or profit, using rules that limit drawdown or overshoot, or any of the other catastrophic trends that are deepening. It would slow resource depletion while increasing productivity and efficiency. It would reconnect processes into cycles of reuse and lower waste streams causing pollution and deadend sinks. More than just the purchase of basic goods, the economy can provide a spectrum of services, while protecting the sources of energy, materials, and labor. It can make the strong connections to ecosystem and community health, to the availability of good jobs and security of homes and work places. With strong connections to education and healthcare, with limits to salary differences, the ecological model should provide an ethical responsible approach that could lower poverty rates, unemployment rates, and all forms of sickness. By understanding the limits of ecological and political systems, by respecting the properties of healthy ecosystems, place and cultures, ecological economics can still provide for the needs and luxuries of most all of humanity (allowing self-sufficient cultures to remain mostly outside of a new economic system).

Of course, a good government could oversee the shift in economic models and coordinate the responses of other governments. The government could intervene if necessary to set the standards and goals that an ecological economics could implement ethically and efficiently. Common lands need to be regulated for the health of the lands first. Public goods, in the form of clean air and water, biodiversity and monumental places, need regulation for use and protection. A government can offer incentives as well as regulations and laws. Incentives can range from tax shifts to and higher wages for less desirable (or more dangerous) jobs. Government can strengthen national economies, which are the basis for self-sufficiency and self-reliance, and control the global economies to make them more committed for their social and ecological responsibilities. This may mean controlling and regulating global corporations so that they cannot take advantage of some resources and citizens to continue an unsustainable hypergrowth to make obscene profits.

7.7. *Managing Multiscalar Interacting Technologies*

At one time, new technologies were adopted because herding animals and cultivating crops were more reliable ways of producing food than hunting and gathering. This may have been a choice between moving and staying in one place, between finding food in different places and increasing the food in one place. These waves of innovation started with digging sticks and horse harnesses, and continued to iron and water power, through steam powered cotton mills, to electricity and the combustion engine, and to petrochemicals and aviation, digital networks and biotechnology. We have to entertain the possibilities and directions of further human technological evolution. As humans continue to create extensions of their bodies through technology, using surgical or genetic enhancements, their patterns and behaviors change. Human cultural evolution has already resulted in more complex forms of culture, with technological modifications. If humans finally become domesticated, then sexual selection will become controlled and perhaps artificial. Evolution can be considered in Merleau-Ponty's term as a 'pattern mixed-upness' of styles of living, as beings radiate through time and place, unfolding into new, complex patterns. Evolution is less a hierarchical ladder or an up-escalator than the history of forms fitting and refitting changing environments. Human needs and goods get mixed up with the needs and goods of other beings. The mixture rapidly becomes complex.

We already use computers for dazzling communications. We are starting to embed chips in our bodies and brains, to repair diseases or enhance memories. Perhaps smaller computers will be internalized, for better modeling and communication, or perhaps for dealing with the complexity of global design. Biotechnology and nanotechnology seem to be qualitatively different from external tools, such as knives or tractors. With nanotechnology, we think it might be possible to create a distributed energy plan with alternative energy networks. This would be a radical solution harnessing quantum foam and manipulating atoms. Nanotechnology is the emerging science of manipulating molecules at the atomic scale. One need only move a few atoms around to create wood or energy. Nanobiology is expected to push a convergence of biology and technology.

Several writers and futurists have predicted teleportation in 20-30 years. Of course, this would create a real problem with what to do with the excess matter and energy at each end. There are also predictions of space tourism to the Moon or Mars, designer genes for improved health, hydrogen engines for transportation, cybernetic health enhancement for humans, downloading memories and drugs, and domestic robots.

Some computers may radically increase our ability to understand the complexity of ecological systems as well as the shape of the future. There might be an infinite number of multiple universes or mere worlds that we may be able to visit physically or virtually. The interactive realities of gaming may become more immersive. Robots may become more common. Artificial life is projected to arise from new electronic beings, perhaps emerging from robots doing web searches or digitally engineered characters in games. If a network mind forms and gains self-awareness, we may need new forms of communication or influence (control?). Can we translate its communications if it operates at the quantum level?

Will these technologies use less resources or more? Maybe more in the short-term development. Combined with biomimicry, the argument is less energy, less materials, and less waste. By controlling matter on a scale smaller than 1 micrometer, waste may not be a factor. It is likely, however, that these technologies, independently or as hybrid systems, will create new problems and threats.

7.7.1. *Threats of Technologies & Scales*

Many of our current emergencies are a crisis of our image of the world as a machine and nature as a passive environment. This leads to excessive consumption and blind faith in technology and luck. We have had dramatic global changes, such as the ozone layer disappearances and increases in annual wildfires. But, we prefer to pursue comfort rather than adjust to the real actions of a dynamic and dangerous planet. We have made an enormous investment in technologies with little regard for the environment, related to our goal of growth at any cost. Our growth, pollution and terraforming have put us in a trap.

Advances in technology allowed cities to scale up. But, now the infrastructure investment is high and some parts of cities get abandoned. Aluminum and steel are being replaced with composites. This is transformative of the overall socioeconomic production process. The introduction of silicon and the fabrication of the microprocessor that is now the center of information technologies. The telegraph transformed technology first, so it is not just computers in the last twenty years, although communications technology makes a difference to the to the political structure.

7.7.1.1. Technological Dependence

Dependence is a problem with any technology. As we depend on a tool, we sometimes lose the ability to work without that tool, whether knives or writing. We are dependent when we cannot go back to living without it. For instance, now that cash registers in fast food restaurants have pictures of foods on the keys, and it might be hard to return to numbers.

7.7.1.2. Technological Stagnation

Stagnation becomes a problem when we cannot think of alternative forms of technology. For instance, with transportation and energy, we have been stuck in a rut of burning. Most energy is generated by variants of the steam turbine, which relies on burning something, not much different from dung and wood, just more concentrated and centralized. Transport is primitive burning also, for automobiles or trains. For the flight of aircraft, the gas turbine jet was developed in the 1930s and although it has been improved, it has not been replaced.

7.7.1.3. Heroic Scale

The unconnected actions of almost seven billion people are really a scale change that can result in environmental disasters. Of course there are other factors, including extinctions and poverty. The scale of industrial output is massive.

Furthermore, emergence, which describes the appearance of a macro scale form from the evolving interactions operating at microscale, has to do with local cultural landscapes social structures and organizational problem-solving.

Feedbacks continually emerge as products of evolution at the local level, and they can have a large influence at the global level. One question is why regulatory feedbacks predominate at the global scale to make and maintain habitable conditions for living beings on the planet. Perhaps because the role of life on influencing feedbacks means that when life is wrong it disappears, when species make mistakes they disappear. So far, no local mistakes have made the entire matrix collapse.

7.7.1.4. Heroic Collapse

External disturbances such as asteroid impacts or basalt eruptions could have triggered significant transitions to less stable states or to collapse of the system. However, most transitions appear to have been generated internally with evolutionary innovation playing a large role. There are many questions relating to transitions or collapse: To what extent is the Earth system self-regulating? How does the system develop? What is the contribution of life to maintaining habitable conditions for other life? Why does regulatory feedback predominate at the global scale?

One thing to consider about collapse and timescales is the presence of multiple stable states. We know that cultural systems can bounce to a lower state and yet survive for a long time in that particular state. We also know that change is neither continuous nor gradual, but is often chaotic. Change is better described as episodic with periods of slow accumulation of natural capital that are punctuated by sudden releases and reorganizations. Redmond and others suggest that scaling up from small to large is not a simple process of aggregation. Stabilizing forces are important in maintaining diversity, flexibility and opportunity. Stabilizing forces are also important in maintaining productivity, fixed capital and social memory. Political management that only applies fixed rules for achieving constant yields, independent of scale and changing contracts, can lead to systems that lose resilience.

Joseph Tainter notes that one factor in addressing these issues is the change of scale that occurs when local people become embedded in larger systems at national and international levels. This is now called globalization, but that term merely denotes the most dramatic changes of the past seventy years or the recent phase of the development of the past 500 years. When the periphery is incorporated into a larger economy, it experiences a change in scale of its economic and political relations. However, the information pool remains local. This disjuncture of scale can undermine the sustainability of local populations. For instance, the introduction of roads after WW II initiated many changes in remote villages in Europe.

Tainter concludes that the lesson is that, unless these and other local people become knowledgeable about the full range of factors that affect them, they will continue to be vulnerable to distant processes and to others who profit from their ignorance. One approach would be for systems theory, either alone or in conjunction with other research, to develop a body of knowledge of such fundamental importance that it would be incorporated along with other mainstream social sciences. Tainter concludes that world systems create disjuncture and scaling between the flow of materials and the flow of information. This disjuncture must be remedied. People must become cognizant of the factors that does affect them at all scales. Tainter wonders if his proposal is utopian and unrealistic, but suggests that globalization demands the attempt. One certainty is that failing, local places will eventually collapse from poverty, dependency and ecological deterioration.

7.7.1.5. Technological Trends

Trends, however, can be predicted. To understand trends well, we need an ecological perspective to look at the interacting factors. Some trends are long-term, such as climate change and urbanization; others are short-term, such as biotechnology and nuclear energy. Cascading problems can trigger the next problem. Trends can also be deflected or reversed.

Human beings have no complete guidelines to interacting with other species in an ecological context. Cultural ethics are usually restricted to some members in a local ecosystem; such ethics are assembled inductively, from experiences from living in specific places. Many ultrahuman cultures have standards (or codes) of behavior to regulate interactions. In birds and simple mammals, these rules may be very rigid and predictable. With increasing brain complexity, however, learning takes a larger role. Human learning can find meaning in abstruse and absurd patterns of change. One way to do this is to notice trends in many temporal patterns.

7.7.2. *Extreme Technology & Scale*
Scientists have worked on reasoning holograms and on cloned sheep (although the first one did not live to a normal life span). Scientists might continue to clone humans. They might design specialty bodies for working in a vacuum, for eating cellulose or even for converting solar energy directly into calories. More complex bodies could perceive other wavelengths. Would those bodies replace the evolved organic bodies we use to dream and make art? What characteristics would be lost or added or improved? Of course, it might be possible to create new bodies with new brains that have self-awareness and consciousness. Technology and design could take great leaps, but they would need to be enhanced to deal with the unanticipated consequences of such radical changes.

Extreme technology could remotely combine new bodies with faster than light signals (possibly through quantum entanglement or wormholes). Communication would literally take a quantum leap. External storage would be unnecessary, since it could be done at the atomic or molecular level inside the body, although its permanence, as in the life of the universe, might be problematic. Nevertheless genes, memes, and wenes could be accessed and modified temporarily or for the long-term.

7.7.2.1. Extreme Fixes
The technological fixes, from the modern industrial response of geoengineering, are problematic themselves. Geoengineering is the deliberate manipulation of global metabolism to correct or adjust human interferences. This approach offers several options: Orbit mirrors to deflect sunlight, launch sulfate particles into the atmosphere, or fertilize the ocean with iron. It would consider burying CO_2 gas or solids in the ocean or land. They are simple symptomatic responses that ignore the system. If the problem is simple, pollution or fossil fuels, and the fix is simple, then it neglects the complex issues of human conversion and scale. It ignores the proper relation of humanity to the planet. Technofixes are based on an inappropriate logic, linear and cause-effect, instead of nonlinearity and multiple effects.

Americans and Russians made proposals in the 1950s and 1960s to control the weather and modify the environment, for instance, Mikhail Budyko's proposal for artificial volcanoes in 1977. How do we remove the 100 ppm excess CO_2? Atmospheric scrubbing on a heroic scale? Planting more trees on continental scales, and restoring more forests to Pleistocene levels?

7.7.2.2. Limits of Extreme Technologies
Although several national space programs have been able to keep people on ships and space stations for limited amounts of time, with bottled oxygen, scientists in Arizona spent $200 million to prove that we did not have the technology to keep eight people in oxygen for more than a week, using a balanced ecosystem approach. So far, our best technologies cannot substitute for natural processes, especially in terms of detoxifying wastes.

Friedman suggests that the limits of systemic growth can be understood as the threshold of exhaustion of the system. A limit would be related to technological and economic factors, as well as to contradictory tendencies within the system. One bad assumption about computer intelligence and manufacturing is that people and machines perform optimally at all times. Another is that we have anticipated all the consequences of new technologies.

7.7.2.3. Scales of Technologies

On the other hand, we experience problems with scale. We have a human scale, based on our body and images, but this scale does not seem to be favored by the universe. Scale is problematic with smaller technology. What works well at one level may not adjust well when scaled up. Scale changes the interaction. If the technology is too large, there are too many interactions to monitor or understand. Scale also changes the relation to the individual.

The problem of using metaphors between scales is that there are too many emergent properties that do not appear in the smaller, and better known, scale. What can translate as a metaphor between scales? Foam can be found at the smallest sizes imaginable smaller than subatomic particles, and at the largest scales imaginable of the entire universe. But, its predictive value might not be adequate. Seafoam, which is white, refracts a large fraction of sunlight than water. The interaction of light and foam has an effect on temperature and climate.

The problem of scaling is central to linking local case studies to global processes, as we know. And, as we know, ecological variability tends to increase as the scales become smaller in our understanding of the factors on variability is modified by the scale of observation. What does that mean? Global cycles of local exchanges link scales. But the larger the scale, the longer the lag time before any changes show.

Really large scales, bioregional or global, are not considered often at all. At large scales, other factors have to be considered. Many cosmic tendencies, such as disorder (entropy) and order (ektropy), as well as change, creativity and temporality, are relevant to these scales. But, managers tend to emphasize only those tendencies that seem positive, such as creativity, diversity, and order, and not those with negative connotations, such as entropy, death, and uniformity. The universe comes with the whole package, and we risk serious error by choosing only the tendencies we want.

7.7.2.4. Connection & Complexity

Global cycles of local exchanges link scales. But the larger the scale the longer the lag time before any changes show in interactions. All interactions are ecological interactions, from the modification of mammals in Australia to the transformation of grasslands. These are all dynamic interactions between human societies and their environments, from the perspective of long-term patterns and processes. The interactions become tightly coupled. Ecologists call the excessive integration of a system hypercoherence. According to Holling a too-highly connected system is an accident going to happen. Rigidity increases vulnerability to change. The number and strength of the connections is a problem if disruptions occur. Essentially because the different processes were so overly interconnected that all the flexibility disappeared from the system. A reduction in flexibility is not the only effect of interactions. Globalization suppresses many diversities. But, diversities are essential for human stability, capacity and resilience.

Even progress is not even. In the short run it has incredible dips and highs as we go from accomplishment to disaster. William McNeill suggests that escalating vulnerability is the price of growing local and short-term mastery, especially when the scale is increased to the global. Joseph Tainter argues that societies choose to increase their complexity to solve immediate problems, their social and political dynamics, but that leads to increased vulnerability in terms of returns on investments of energy in the complexity itself. Human complexity, like ecosystem complexity, requires demands for more energy. Globalization is a titanic effort to put us all in the same boat, more complex and advanced, but just as vulnerable to human error and natural catastrophes, and ultimately to a global collapse.

7.7.3. *Designing Hybrid Systems & Mixed Communities*

Given the limits of the Precautionary Principle, as well as other principles and standards, it seems possible to create living cells that could create machines. It seems possible to produce nanotools that could scrub or repair living cells. In fact, it might possible to create entire communities of machines and living beings on a very small scale that would have a vast number of interconnections to wild ecosystems. It is quite likely that these systems might be more fragile than natural systems, collapsing or dying out in months or years. And, it is quite possible that the remaining waste might not be completely biodegradable. Ecosystems already get mixed with plastics and pollutants. Given the possible dangers, however, these possible changes and applications need to be kept isolated for extensive testing. In fact, the proposals need to be critically reviewed by panels of ecologists, engineers, and other scientists and literate reviewers. This kind of explosively reproductive technology has to be planned out and engineered through complex thought experiments, especially before it becomes part of the mix. Thought experiments let us describe complex, unpredictable interactions.

Human and wild communities are already mixed. Humans use tools, so that means that technology and nature are also mixed (many mammals are observed to use tools). Humans have always collected food from mixed systems, without landscape conversion. A maturing agriculture might recapture some of this strategy. Mixed crops are easier to grow, we know that. Mixing is part of the process of ecosystems, as animals and plants try to fit and excel. Hybridization occurs in species, especially grasses and bacteria. Hybridization may be a solution to the survival of some species, but it is a problem with human biological classifications. Biological and legal issues have already raised by documentation of instances of hybridization, for instance in red wolves and coyotes, using molecular markers. Zones of habitats become hybrid zones. Large-scale changes in habitats, such as from land clearing, may result in hybrid zones between closely related species (Ontario might be such a hybrid zone).

Cultural development also changes through a process of hybridization. Industrial culture becomes a hybrid as it tries to satisfy the needs and wants of a growing population, especially for space and food. We have hybrid political systems, such as democratic socialism (Britain). Religion is becoming aware of human-machine hybrids, as well as the concept of universal gods and a living planet.

We need to have mixed communities. This is what evolution and wildness do—provide the turbulence and chaos that every system needs to be mixed and renewed. Nature, the formal matrix for wildness and chaos, pursues a strategy of overproduction and waste. This is not the wise, motherly Nature of our dreams, this is a wild creator, profligate with energy and forms of information through low-efficiency and the waste of cells, seeds, and sperm, and with the escalating warfare of plants and animals. The sheer magnitude of energy and diversity allows tremendous margins of error, that Evan Eisenberg suggests is the envy of human artists. Error pushes the whole process, allowing possibilities and diversities. Flawless transmission would have stayed at bacteria level. Freeman Dyson suggests that the reign of genes, like that of the Hapsburgs is "despotism tempered by sloppiness." The harmony and stability of nature are perceived by human minds as they make them abstract.

7.7.3.1. Potential Damages & Alternatives

Some business organizations, with people using some questionable or uncertified technologies, can threaten to destroy the mixed communities of humans, animals and plants, and their flows and patterns. We have to have goals and define new niches in mature hybrid ecosystems. We may not need much technology, but we need to be cautious and monitor it. Symbiosis can be a model for cooperative designs.

7.7.3.2. Surprise
An unimaginable part of our recent predicament, especially for older readers who have lived through two doublings of population size, is the scale of change in the past 80 years, the dramatic expansion of the human population, and its economic and political systems. Based on cheap, abundant energy, in unique and high concentrations, machine power increased, then the factory system increased efficiencies and productivities. Buoyed by capitalism and nationalism, justified by beliefs in a mechanical, progressive nature, we have come to worship growth. Through positive feedback and ignorance (or greed), growth became automatic and uncritical. Human numbers increased 6-fold in 200 years, but the size of the economy increased 10 times faster than population (over 60-fold), and energy has blossomed 80-fold. The concentration of wealth allowed more dramatic effects, from rampant SUVs to private air travel. The past 80 years has created more change than the previous 500 generations. These changes have pushed us beyond our traditional cultural experiences.

The dangers from this are immense: Slow catastrophes, such as extinctions and conversions (ecosystem loss); sudden surprises, such as dead zones in the ocean or holes in the ozone layer as a result of overfertilizing (or overenergizing or overpoisoning); human ignorance of change and uncertainty; and slow, inadequate responses to very long-term changes (as opposed to short or 9-year limits).

The novelty and complexity of interactions of innovations can lead to thresholds that are tipping points, triggering punctuations in natural functions with consequences that may surprise humans. The current global environmental condition has no comparable analogs to any other previous time. One source of surprises seems to be the interaction of climate and environmental change combined with economic development and human and animal health. As tropical forests are converted to farmland people encounter diseases without having evolved resistance. One conclusion is that we have to intensify our search for discontinuities and surprises that we may not be able to predict, although we can learn early warning signs.

7.7.3.3. Mixing Natural Systems
Agriculture causes greatest disturbances to ecosystems. Damage to ecosystems, however, can heal faster if small and surrounded by the original matrix.

7.7.3.4. Mixing Cultural Systems
Jeffrey Sachs notes that all successful economies are mixed economies that rely on both the public sector and the private sector for economic development. Eliminating poverty at the global scale is a global responsibility that will have global benefits. This is something that no single nation can do by itself. It has to be done, as we think globally, and as we create a global network to apply all this at once.

Jane Jacobs advocated dense, mixed-use neighborhoods and frequently cited New York City's Greenwich Village as an example of a vibrant urban community. Advances in technology allowed cities to scale up. But now the infrastructure investment is high and some parts of cities get abandoned. Urban ecologies view cities as heterogenous, dynamic landscapes, as complex ecological systems that provide services and links. It may be more efficient per capita, but it is overwhelming in scale, especially energy and waste.

7.7.3.5. Mixing Technologies
We feel it necessary and important to embrace new technology. That is one lesson on human value. The revolution in learning demonstrates another lesson: That technology matters less

than the changes it triggers in substance, content and focus of schooling. Environmentalists consider that sustainability is a sufficient basis for technological design. This may not be so. It may be necessary, but not sufficient. Perhaps some kinds of large-scale thought, such as Messianic thinking, have influenced our disposition to large-scale technological fixes, as well as the idea of redemption and the practice of irresponsibility.

Our growth, pollution and terraforming has put us in a trap and only design and engineering, combined with severe conservation and changes in rich lifestyles, can get us out of. Urbanization can help. So can technology. The new technologies promise help but also will create larger problems. These are nuclear power, biotechnology, geoengineering, and information technology, which might be effectively multiplied by convergence, and either enhance or wreck human performance and a global perspective for rethinking science.

The first thing any technology has to do is reverse the bad effects of the previous unconscious technology. Market forces could encourage cleaner technologies as well as cleanup technologies. This new industry should be very promising. Obviously, this would be a response to dirty technologies. Local design has to consider the percentage of the area covered by asphalt or concrete. Global design has to consider for the whole planet. This is necessary to balance local or regional areas that are overbuilt or too intense. Local design does not have to worry about such balance.

As part of restoration on a large scale we have to consider whether it would be viable to green North Africa using technologies to promote rain and build soil? Would moving icebergs to water the coasts of South America or Australia be of use or importance? What about micromachines and the use of nanotechnological devices? Should we use ocean ranching and farming for food? Is life extension even important given current suffering and inequity?

For climate change, one technological option might be large-scale planetary geoengineering, which requires equally large oversight. Energy use is so large that it requires a government. Extreme technologies are so large that they might require a global government. The scale, speed and scope are large. Most meaningful actions have to be at the largest scale possible (hence, global design). But to be good at global, we have to think solar system.

We always think that technological problems are easier to solve than social problems. They are not, partly because they become social, and need fixing. We will have to redo the worldview and values so that they do not emphasize competition consumerism and inequality. The emergencies are a crisis of our image of the world as a machine and of nature as a passive environment. It promotes excessive consumption and blind faith in technology and luck. We have had dramatic global warnings, such as the ozone layer disappearances and increases in annual wildfires. But, we prefer to pursue comfort rather than adjust to the real actions of a dynamic and dangerous planet.

We need a mixed image! New metaphors already exist for interactions in an ecosystem. These include a process view (A.N. Whitehead, from the 1920s) in which organisms are dynamic structures that are immanent and simultaneous with the process, rather than consequences of natural selection of past random mutations; a field concept (C.H. Waddington, in the 1960s) for development, emphasizing dynamic transformation (form as organized spatiotemporal domain), in contrast with the particulate concept of an organism—understood in terms of group dynamics rather than selective advantage or cost-benefit; self-organization (Franceso Varela, in the 1970s) or autopoesis, which refers to the dynamic self-producing and self-maintaining activities of living beings, which incorporate materials through physiological processes; and reciprocally constrained construction (R. D. Gray, in the 1980s), according to which the organism and environment are co-implicative, co-defining, and co-constructing in a process of self-assembly, where the self is the organism/environment system.

Combining metaphors, we can see that organisms put together (enfold) structures based on historical patterns, and move (unfold) through a filter of limits, like minnows through a fish net, rather than behaving as interchangeable units competing for resources. These metaphors could form the basis of a new image for humanity, where we are an integral part of food chains and part of an organic cycle of birth and death. We humans need to recognize that we automatically participate in everything, and that we cannot unparticipate by choice. Participation starts at the quantum level and extends through the ecological and cultural. Human nature does not find meaning in an absurd world, but discovers its structure through interaction with the surrounding order. Human identity exists partly in relation to nature; the destruction of ecosystems may lead to the destruction of human identities mediated through cultures.

7.7.4. *Managing Mixed Systems with Design*

We have learned from Charles Darwin and others that nature chooses the 'fit,' those who adapt to a specific environment. But, that nature was more stable and predictable. We are learning that the 'flexible,' those who can adapt to several or changing environments, may survive better under changing conditions. And, now that nature and culture are coevolving, it may be the 'creative,' who can change the conditions slightly and limit the changes wisely, who may survive even better! For instance, the North American species that were adapted to forests, died out 12,000 years ago. Flexible generalists like humans did not.

We have to let the dream of control fade, now, in order to creatively adapt to and interpenetrate the uncontrollable uncertainty of a new climate. If we make mistakes, they can be repaired if small enough. For restoration, we can experiment, improvise and innovate at a small-scale. Mohandas Gandhi and E.F. Schumacher argued for appropriate technology, but we also have to behave appropriately with other forms and scales. That is we need to keep an appropriate level of complexity. Why be too complex in our civilization and social structures? We need to arrive at a goal of an appropriate population size. Materials can be a problem, especially plastics or others not integrated or recognized, that resemble real food or resources. How do new substances reconfigure the fabric of material interactions? By killing off the unsophisticated? How do coexisting materials embody concepts of style and meaning? Can design intervention shape future biogeochemical cycles?

Technology has to fit ecological and social knowledge. Sonar technology meant that big actors could catch more fish, but there is little feedback on the state of the fish population, until it crashes. Thus people invest more in vessels and technology up to the crash, after which they can write off their investment as a loss. This is a tragedy of the commons.

On the global scale, we can build an observation network for global change and found local institutions to assess the change. Very much like the thought experiment earlier, the observational network can function like a macroscope, spanning different scales. The macroscopes themselves, rather than being physical instruments, might be a combination of conception and awareness. That would allow us to view the interconnections of major systems of a complex planet. The macroscope system of observation and reporting would complement existing systems of environmental and economic accounting, by allowing both local and global perspectives of the planet. This would be a prerequisite for coordinating global actions.

In any discussion about solutions, we have to consider personal solutions, technological solutions and social solutions, such as frugality. Stopping technology all together might lead to disaster, unless we combined it with radical reductions and conservation, which may be considered in any mix of strategies. But, we can also assess our current technologies and combine them with other approaches to create a truly mixed design on all levels.

7.8. *Local Ecological Design Planning & Monitoring*

We have always tried to exceed the physical and biological limits of places rather than recognize them and be guided by them. This framework suggests an approach to comprehensive planning based on the biohistory of an ecosystem, the cultural values of the people, and knowledge of the limits for sustainable development. This approach makes the limits explicit and set sustainable goals within those limits. As a synthetic framework, this approach provides for the health of the ecological system, as well as for the health of its human inhabitants.

7.8.1. *Ecological Planning & Limits*

A number of proposed plans to heal the earth and improve human communities have been presented in popular books. Many of them are too philosophical and general, suggesting that we could change values without showing how or urging us to alleviate some of the symptoms without addressing the disease. Other plans, such as the Limits to Growth, are too global. And still others, such as Design with Nature, are less concerned with limits than with basic conservation. Goals for Mankind offers a similar compendium of global goals that can essentially be summarized to be health and freedom for people in a healthy environment. Many of these plans offer admirable models, but little in the way of specific goals or paths.

A plan should consider the whole system. Communities should be designed for an optimal fit within the limits of the system. Ecological planning considers an optimum or satisfactory population within one ecosystem, although it is connected to others by trade for some necessities or luxuries. This kind of planning is a conscious adaptation of the benefits of technology to the traditional idea of physical, as well as cultural, limits. Direct observation and traditional knowledge yield far more "information" about the societies of animals than autopsies and mathematical models. An outline of a comprehensive plan is presented, to deal with some of the implications, as well as question them.

1. Identify our place within its natural boundaries. Most places exist in a uniquely identifiable ecosystem, with recognizable boundaries and a unique history and character.
2. Calculate the optimum amount of wilderness to preserve the natural cycles indefinitely. If the current area is less than our calculations, restore the difference and set it aside.
3. In the remaining area, zone areas for appropriate use, including conservation, preservation, reservation, and artificial areas (with cultural and functional importance).
4. Identify the resources needed for human use, including raw materials and the productivity of the areas. This productivity can be used to calculate a base line population.
5. Apply cultural modes—in style, values, and technology—to set limits on technology and population. Preserve the cultural values. Renewable resources will sustain a population longer than energy capital like oil or gas.

As part of the formulation of a plan, we have to examine the natural and cultural histories of a place. We need to understand interactions in the ecosystem, as it was with no humans, as it was lightly settled, and as it is now, dominated by humanity.

7.8.1.1. Limits & Planning

Our modern cosmology, with its basis on machine metaphors and the principles of plenitude gets in trouble because it does not understand how basic the concept of limits is to the physical universe, to life, to ecosystems, and to human constructs, such as cities and economics.

Limits are important at all levels, starting with the physical.

The limits of the universe, like the speed of light or quantum of a field, put limits on freedom. Events are limited to localities; size limits function; history limits development. Biological order is built on physical and chemical orders. That is why life is limited to such a narrow range of conditions. And that is why the most complex orders are vulnerable to changes in their substrates; energetic radiation can alter and destroy an individual, a small change in climate can destroy crops and civilizations.

7.8.1.2. Limits of Human Populations

A population of the human species, like any biological population, is a group of individuals of one kind that allows the exchange of genetic information in a specific place. A population has unique properties that can be described statistically, such as biotic potential, density, dispersion, birth rate (natality), death rate (mortality), age distribution, growth form, and structure (in terms of isolation or territoriality). A population also has certain other qualities that can be described quantitatively or qualitatively, such as: Dynamicism, variability, adaptability, reproductive fitness, stability, and persistence, the ability to leave descendants over time.

The population is the unit that evolves in nature, according C.J. Krebs. Populations interact in neutral, positive, or negative ways. Competition, which can be negative or positive, limits the number of species in a niche (this is the competitive exclusion principle, which Garrett Hardin states as: complete competitors cannot coexist). Many of these interactions, such as competition or parasitism, can limit a population. Niches must be different for species. Krebs states that the fundamental niche of a species has an "infinite number of dimensions," making a complete determination impossible. Niche size can limit a population.

Many other factors other can limit a population: The environment (weather, water, heat), change (or catastrophe), food Supply (with minerals, trace elements), territory, predators, and psychology (the choice of or desire for certain foods or places). These factors also filter a population so that less fit individuals die before reproducing.

The cost of evolution by filtering (or selection) is so heavy that most of the time most populations are not perfectly fit to their changing environment, which they are changing in fact through living. Evolution never expresses total fitness; it requires destabilization, a risk accompanying all innovation. Self-presentation offers the possibility of new symbiotic relations or of extinction.

7.8.2. *Create Monitoring of Local Properties*

Local institutions, such as universities or laboratories, need to be monitoring watersheds and habitats. Monitoring watersheds involves a larger spatial scale than ecosystems. Evaluation of data must occur in an integrated manner that spans biological and physical scales, watersheds, administrative boundaries, as well as functional areas. To understand how ecological processes are connected we need to relate information across disciplines and agencies, and collectively perceive the effect of our actions on the environment. This approach follows ecosystem theory (the hypothesis that cycles in nature integrate the physical, chemical, and biological components of ecosystems), and the hierarchical organization of ecosystem functions throughout the landscape. Hierarchy theory can be described as the development and organization of landscape patterns, e.g., vegetation communities, through time and space.

By incorporating the three primary attributes of biodiversity, as described by Jerry Franklin—composition, structure and function—into four levels of organization—province, subprovince, watershed, and site, monitoring can be very comprehensive. Indicators incorporating composition, structure and function at the appropriate levels of organization have been identified for many ecosystems; they range from landscape morphology to human demographics and cultural influences. For watersheds and habitats one has to consider the impact of any kind of vegetation removal. What is a minimum, optimum or maximum vegetative cover for various watersheds? Science might identify minima or maxima but philosophy and conservation can aim at optima.

7.8.3. *Preparation for Emergencies & Catastrophes*

Any agency that monitors ecosystems and watersheds has to also monitor the potential for destructive events and catastrophes. It has to treat them as emergencies when they happen and be prepared to respond rapidly to protect human and wild life, as well as their habitats and resources.

7.8.3.1. Local Threats

The planet is still a very active planet. Some threats to humanity rise from the normal activities of the planet, such as volcano-building or continental drift. Many local systems are in geologically active zones; others are vulnerable to extreme weather events, and still others may be affected by long-term changes, such as drought.

7.8.3.1.1. Geological Threats

Typical geological threats include earthquakes volcanoes, and mudslides; rare threats may be comets or sunspot activity. While technology may be able to retard some of these threats or counter them early, the best solutions are design. Cities can be moved from floodplains active earthquake zones; cities can be required to have quake-resistant buildings.

7.8.3.1.1.1. Climatic Threats

The historian Will Durant said that civilizations exist by the consent of geology, subject to change without notice; however, the consent of the 'first empire of climate' might also be needed. Climate is a constant and immediate challenge. Many variables affect climate. One variation, with a long cycle of perhaps 100 million years, is continental drift. When Panama closed a gap between two continents, it forced the gulf stream north. The earth's orbit around the sun, a 100,000 cycle, also changes climate. This is close to the spacing of ice ages. Other smaller cycles, at 10,000 years or 6,100 years are minor harmonics perhaps. Other activities that influence climate are sunspots, comets, and volcanoes. The most stable periods seem to be the coldest or warmest weathers. For instance, 400,000 years ago, a warm period lasted 25,000 years. If we are in a 10,000-year warm period, it may be almost up. This means that predictions are relevant.

Cooling can lead to disease and depopulation, which can lead to further cooling. Farmland is abandoned to trees in times of collapse. Because trees take CO_2 out of the atmosphere, the regrowth of forests after the plagues in 1322-1351 in Europe and China, would have allowed drops in CO_2, which would have allowed climate to cool some.

The years 1997 to 2004 broke most heat and storm records, especially as some of the warmest years on record. The northern hemisphere experienced 500-year floods, droughts of the century, and other extremes. Some of these events have been related to greenhouse effects.

7.8.3.1.1.2. Oceanic Threats

Ocean currents affect not only islands and coasts, but they affect the entire climates of continents. For example, the effects of the Pacific El Nino current can be linked to droughts in India and China in the past 150 years that caused three times the deaths of the Black Death, and more than the 60 million people who died in World War II. There does not seem to be a single trigger for El Nino. One trigger has to do with water overflow and then back flow from the western pacific. Others have to do with sunspots, which would reduce radiation, or volcanic eruptions. Many of these atmospheric, oceanic and geophysical triggers may converge. Nineteenth-century famines may be correlated with ENSO events that influenced China, Indonesia, Brazil, and southeast Africa.

The adherence to political colonialization and 'free market' economics, along with climate changes, made the suffering from famines worse. Millions died within the market system of the golden age of liberal capitalism. Thus, the famines were evidence of political and economic failures. Even at the height of the famines in 1877-78 and the 1890, Britain continued to export grain from India to England, which had its own agricultural downturn. The invisible hand did not lift those starving in India or China. There was starvation before the British, especially during El Nino events in 1596 and 1630, but many droughts did not result in such widespread and deep famines. Market economics and politics magnified the effects. The market economy can spread risk, through insurance companies, when crises are local and intermittent, but they may not be able to respond when the crises are global and ubiquitous. As the risks increase everywhere, fewer things can be done.

Other movements of water, such as tsunamis or floods, can be linked to earth movements, such as landslides or earthquakes.

7.8.3.3. Protection against Interference Events or Disasters

Local institutions have special groups, such as police, who would be expected to be prepared for natural disasters, including the extraterrestrial. The police would focus on the prevention of man-made disasters, from watersheds that were compromised to chemical spills. Collisions with asteroids will always be a threat due to the nature of the solar system. In the past centuries, the flexibility of natural ecosystems to respond to change has been reduced, so either we have to take over control, which could cost quite a lot, or we have to adapt to the diminishment after some climatic episode.

7.8.4. *Designing Local Links*

A long-term model might consider that the locations of some cities and cultures should not be renewed if they are destroyed in particularly active zones of rapid geological or climactic change. There are links between climate and disease, and between disease and new patterns of poverty. Local climate change, from atmospheric heating, can increase the incidences of some diseases, like malaria in northeastern European states. The drying out of wetlands, which causes smaller stagnant pools, can increase outbreaks of mosquitoes. Ecological models can delineate thee links between ecosystem attributes and stresses. They could suggest standards for design of wild system and human system interfaces.

James Lovelock suggested that local bacterial ecosystems manufacture trigger chemicals that influence regional and global cycles. The natural cycles of sulfur and iodine take place through biological production of dimethyl sulfide and methyl iodide. Dimethyl sulfide is linked with algae on the ocean surface, clouds and oceanic climate regulation. Climate regulation on land is coupled with growth of trees in tropical, temperate, and boreal regions. Ecological design could identify these connections and offer designs to keep the larger system healthy and productive.

The design of wild ecosystems is linked to the history and properties of the system. It is also linked to the cultural images of those who want to restore the system. Nature and culture are adaptive systems that change and develop over time. The design has to link the ecological and cultural dimensions to become a self-making and regulating system. These systems are also linked to global biogeochemical cycles that provide elements, air and water to local systems.

The linking of local corporations and economies everywhere has resulted in a fragile interdependence at regional and global levels, which has reduced the functional independence of many communities and nations, which can no longer supply their basic food and shelter. Separate regions may want to discontinue or reduce links to financial risks, such as the international commodities market. Economic links can be beneficial in small clusters. With the Grameen bank, Muhammad Yunas decided to link people in clusters, so that a borrower had to join a five-person borrowers group. The group then took responsibility for each borrower (perhaps at this level shame is a critical factor in being financially responsible). Scale-linking is one the principles of ecological design; local banks could be linked to regional and global forms. Small units, with short linkages between groups, are simpler and allow faster feedback. The same ecological design principles work in banks, ecosystems or nations.

7.9. *Designing Landscapes & Networks*

(Being edited)

Figure 633-1. Prescribed burn preparation at Mountain Grove forest 1999

8.0. Designing Good Places

Any single human group can make a good place for themselves. Many cultures have made good places. Often, the making is a slow mutual adjustment among life forms, environmental constraints, and human cultures. But, many stakeholders need to participate in the making. And certain problems have to be addressed. The levels of intolerance and conflict that are permitted between groups, communities and nations have to be reduced. This change can occur through actions of large design factors, such as recognized global commons, or through local factors like reducing inequity between stakeholders. Local corporations or local governments could take ownership of all commons, especially those that provided ecosystem services for cultural areas.

This could happen as a result of a framework to allow cultures to develop without unfair competition or dominance. But, the frameworks can only be viable if they are run on a local level. The framework could allow good places to be designed and managed for long periods of time, within the limits of the dynamicism of the region and planet as well as accidental events in the larger universe.

8.1. *Local Problems: Intolerance Conflict & War—Grey Earth*

We tend to think of problems as unwanted 'side-effects' of the wanted main-effects, but all effects are equal, as Buckminster Fuller noted, and must be addressed as equal. Most things identified as problems are embedded in a network. Nothing is simple; there is not one truth, there is not one way, and there is not one goal. Problems could be considered also as challenges that we must respond to continuously, in the process of living, not as puzzles that have to be solved once for all time. It is about consciously choosing to see what can be done, rather than dismissing a conflict as terrible and unsolvable. When challenged by some situation, we react by habit, although this may be disconnected from other habits. Habits protect us from many problems. Addressing a problem often has to do with a power struggle, which becomes part of the problem of the problem. If problems are regarded as challenges that require a social response, then much of the conflict can be avoided.

8.1.1. *Intolerance*

One problem that typifies every culture is intolerance. Intolerance means a lack of toleration or the unwillingness to tolerate the contrary beliefs of persons or groups. Intolerance seems to be a fact between cultures and between individuals; it can lead to conflict and violence. It used to be understood that intolerance and violence occurred between 'irrational actors,' whether individuals or ethnic cultures were involved. Therefore, violence could not be explained rationally.

If cultures or individuals were rational actors, then the irrational actions of conflict and violence would have to be explained in some other way. M. D. Toft suggests that ethnic group settlement patterns, socially constructed identities, charismatic leaders, indivisible issue, and state concern with precedence could lead rational actors to escalate a dispute to violence, even when doing so was likely to leave contending groups much worse off.

The problem of intolerance and conflict can be more easily understood with reference to the cosmology of a culture. A cosmology is basically the complete set of ideas about the nature and composition of the universe used by an individual culture. This idea provides people with a collective orientation. It is a collective image. Ezra Pound stated that the image is an emotional and intellectual complex in an instant of time.

All cosmologies cause destruction and waste; all sometimes produce the opposite of the good intended. Once cosmological ideas are adopted, they may remain unquestioned and unquestionable, and they can influence a culture over centuries. The principle of otherness, where others are not true humans, is an example. This principle may have made perfect sense when cultures had to protect their territory, especially when the territory was rich but limited, or when there was a large investment in it, as with agriculture. By representing others as nonhuman or subhuman, they did not have to grant them consideration in the ethics of their culture. Many modern political ideologies and economics have been shaped by this principle of otherness. Intolerance justifies inequity, domination and conflict.

8.1.2. *Kinds of Conflict*

Conflict is sometimes perceived as the only response to intolerance or to other problems. However, conflict can be related to various losses or cultural norms. Understanding these conditions may allow us to resolve some kinds of conflict.

8.1.2.1. Conflict as Loss of Fitness

Fitness is the ability to function under normal environmental conditions. Stress, obesity, illness, toxic chemicals, social conflict, and other kinds of dysfunctions, can reduce fitness. A lifestyle dependent on physical and energy slaves, not to mention a diet riddled with addictions to cheap fats and sugars, decreases our fitness. All of the elements of a true addiction are present in modern lifestyles: We get a short term high, and we suffer long term health problems. Air pollution, sedentary life styles, exposure to stressful city environments makes things worse, even as we acquire more information about the dangers and options to deal with them. Conflict is an attempt to correct the problem by capturing more food and energy, or by acquiring clean air and water, or by conquering new land. The stress of conflict however, can lead to a declining cycle less fitness and more conflict.

8.1.2.2. Conflict from Loss of Equity

Although many resources are distributed unequally over areas, as a result of different kinds of historical geological processes, trade can allow access to those resources. However, as a result of long-term processes of inequity, from keeping people enslaved to cultural hoarding, many people have far less than others. This has resulted in permanent overclasses and underclasses, which are often maintained by physical force, as well as by the force of economic and religious myths. These myths tell all people that they participate in the “best possible economic system” regardless if it justifies the differences of inequity based on history, on luck or on perceived racial abilities. Most people are hungry; few people are fulfilled. Even low average levels of food and fulfillment can be maintained only through theft from other species and from future human generations, and through the degradation of billions of humans, as well as the ecosystems on which they depend. Conflict is one attempt to bring about more equity, although it can result in greater disparities and losses.

8.1.2.3. Conflict from Loss of Accord

As a result of the unequal distribution of natural resources, including unincorporated waste and pollution, and the unequal distribution of materials and wealth between people, economic conflicts arise, often becoming violent political conflicts. Accord, by definition, means agreement or the concurrence of will or action. As an agreement between the parties in a controversy, by which satisfaction for an injury is stipulated, accord allows people to reconcile their injuries and interests. Because many political boundaries were drawn as a result of colonial expansion and contraction, many cultures are artificially combined in large territories or stretched across several traditional territories. This has created the conditions for continuing cultural and political conflict. In addition to the normal conflict between different cultures with different ways and values, usually resolved by trade or distance, this new conflict resembles an indefinite series of small permanent wars over large numbers of territories. This kind of hot conflict not only destroys habitats and resources, but it causes immense human suffering. As the rules change, and conflict includes noncombatants, as well as plants and animals, there is less accord between conflicting groups. Accord requires the ability to trust, which requires self-reliance and confidence.

8.1.2.4. Conflict as a Result of Bigness

Leopold Kohr identifies the basic conflict between man and mass, citizen and state, large and small communities, as being the result of size. Kohr's theory of size states that the cause of most forms of social misery is bigness. We have always tried to exceed the physical and biological limits of places rather than recognize them and be guided by them. Every advanced country is now over-technologized by its attempts at control. Past a certain point, the quality of life diminishes, not improves, with each advance. Big science serves big technology, which supports and is supported by big government. And there is no science like big science, and no administration like big administration. But this enthusiasm is misdirected. Scientific advances and technological changes result in unforeseen consequences, good and bad. They cannot be controlled or legislated against before the fact. But the investment seems too big to abandon.

8.1.2.4.1. Personal Conflicts

Individual conflicts often resulted from insults or broken promises. In Mesopotamia, people paid fines for hurting others. For instance, severing the bones of another man with a weapon resulted in a fine of one mina of silver.

When arguments could not be resolved, there was open conflict. Resolution of individual conflicts was usually informal within the confines of the community. For the Inupiat and other egalitarian cultures, song duels are a ritual pacific form. The disputants publicly insulted one another until the audience laughed down the loser. If individual disputes were not resolved, then they were settled by community consensus.

The predominant value in small cultures, and then many larger cultures, was harmony. This minimized conflict that might have resulted from inequality. Confucian concepts of ritual and etiquette helped to regulate social conduct and made people feel good about their station. For example: "Inequality is the nature of things" and "seek no happiness that does not pertain to your lot in life."

8.1.2.4.2. Group Conflicts

In a Tiwi example from Australia, a dispute occurred because the elders of one band reneged on their promise to bestow daughters for marriage to the sons of another band—a violation of the norm of reciprocal marital exchange. Two war parties of fifteen warriors each met in adjoining territory. They wore white paint symbolizing anger. Both sides exchanged insults the first day. Then agreed to meet the next day for socializing and renewing acquaintances. The third day the duel resumed; words escalated into wild spear throwing that wounded a few spectators and warriors. That ended the dispute.

Are conflicts different between groups? Why is warfare limited in band societies? Could it be due to a lack of interpersonal competition for status? Are people taught to be restrained? Are conflicts are resolved by ridicule before getting out of hand? Is size a factor in explaining larger conflicts? Population density was controlled by the traditional approaches to resources. In archaic societies, cooperation and consensus, as opposed to competition and individual exaltation, permitted planning to remain informal. Population growth triggered competition and conflict, which lead to positive feedback of the thing that caused the stress.

8.1.3. *War*

At what point does a conflict become a war? Does every society have war? The anthropologist Carol Ember surveyed band societies and found that sixty-four percent waged some kind of war. The reasons for war have gone from insults and personal conflicts having to do with bride exchange, broken rituals and personal honor to group and external reasons, such as territory, resources and patriotism.

The nation states are closely related to large-scale violence, usually having to do with trying to consolidate their power. They then have a monopoly on power. They specialize on political and economic issues—the Spanish, for instance, ransacked every land they could for gold. Nations enlarged and consolidated their territoriality, which gave them increased capacity for marshaling resources.

Wars, like the recent one in Iraq, are based on weak assumptions: That the war can be waged by blasting away any threats, and that it can be contained by using conventional weapons. But, like most actions, it has affects that can get magnified in the larger system. Furthermore, the war breaks out of the barriers that the participants try to create, destroying properties and civilians—there are no longer any safe buildings or noncombatants, and ruining the social and ecological fabrics.

All wars now are ecological wars that destroy the basis of civilization. There are no nonmonotonic effects with war. There are no side-effects. There are only effects and they can all be measured. Perhaps the next war will be to directly destroy the ecological basis of a community, culture or nation, an extreme scorched earth policy by the aggressors. These wars would be social wars that destroy entire generations and traditional social structures. Perhaps, future wars will have less to do with honor and territory and more to do with crises, such as famine, population, and environmental collapse. Perhaps, wars will have to do with symbols and religion, again, as they have in the past.

8.1.3.1. Advantages & Disadvantages of War

War has advantages and disadvantages. One of the advantages of war is its long tradition, being simpler to understand than rights, the attendant macroeconomics or the workings of enantiodromia. Another advantage is that war is cheaper than ever before, especially for those who attack. Of course, war is also stimulating and fun, at least for the victorious survivors, who are bonded by the danger.

It used to be that it cost more to attack than to defend, with preparations and supply lines. Now, it costs more to defend against a bullet than to attack with one. Cheap bullets destabilized the western U.S., but laws and enforcement, also with bullets, restabilized it. Possibly the same thing will happen with cheap cruise missiles. Maybe not, as the cost of attacking will now continue to be less than defending. This means that the world may become more violent and less stable, especially at select local levels. Can information warfare be cheaper or less destabilizing? No, because information attacks may be even easier to perform. Unless everyone has the same weapons.

The disadvantages are greater than the sum of all advantages. Ecosystems in disputed and ravaged territories are always disrupted, damaged or destroyed. Human suffering is always made worse than it was before the war. And, war never solves the original problem.

8.1.3.2. Style and Scale of War

Politics is the management of people through equitable distribution of resources, and the management of relations with neighbors or trading partners, using negotiation or force—war if necessary. Wars have changed in style and scale. From disagreements, wars have become a centralized state function. From religious reasons, where Gods lived with people, it has gone to the secularization of state concerns. The style of warfare has changed dramatically over 500 years (see Table 8132-1).

The essence of war is to defeat or destroy an enemy. Governments are efficient killing machines. On the average in the nineteenth century, states killed 3.7% of their subjects. In the twentieth century states killed 7.3% of the world population.

War is related to growth. Often the same factors that allow unsustainable growth allow unsustainable war. Growth is promoted for its advantages, usually without recognition of its disadvantages—or the difference between growth and development.

Table 8132-1. Styles of War

Kind	*Reason*	*Examples*
Personal Conflicts	Insults, broken promises	Palouse, Aborigines
Leaders Conflicts Group conflicts	Social insults, food, territory	Uruk
General's wars	Food, Luxuries	Babylon
Psychological wars	Prestige, Glory Idealism Patriotism	Greece, Macedonia
Professional Soldiers wars (Army wars)	Food, territory, unification	China, Rome
Religious wars Royal wars National wars	Territory / conversion	France, Britain
Economic trade wars	Control of resources in colonies	Britain, France, Portugal, Spain
Chemists war, with poison gases and explosives	Territory expansion	World War I
Physicists war, with radar and nuclear weapons	Territory expansion	WW II
Mathematician's wars, with computer-guided missiles.	Resources Potential threats	Iraq Gulf War I
Electronic wars, to destroy computers and databases.	Destruction of information or economic structure	Iraq II
Ecological wars	Destruction of land base Against Nature	Vietnam, Iraq Pesticides, Medicines

Notice the sequence. Competition with other species and groups leads to conflicts, which grow in size and sophistication, gradually including noncombatants, crops, land, other species, and ecosystems, until the war is against large groups of human communities and then against nature in its various aspects from microorganisms to invasive plants. The sequence also parallels the growth of groups from tribes to Nations and Unions.

The historical rhythm between war and peace inevitably leads back to peace. When does peace occur, when it is won? Unlike many forms of war, peace is a process with a less rigid beginning. It can never be won or kept permanently. It does not have the prestige or honor of war, and perhaps this is why so much less time and effort is devoted to peace.

Is there a way to limit war, within the context of peace? Is there another way to humiliate or embarrass an enemy, or let some other kind of balance be found? Is there a way to limit violence to heroes or to leaders, as if either would agree to have their individual expertise be responsible for a whole population.

Perhaps one basic problem is the easiness of war. War has become too easy. It seems easier in the immediate or emotional short-term to use institutional violence to solve any dispute. It is exciting, and it allows the combatants to form close bonds, perhaps much closer than those in business or play.

The largest problem with war, however, is its scale. War is waged between nations and groups of nations against other nations or groups of nations. Even on a local scale, it often involves larger complexes of political links.

8.1.4. *Summary: Inseparable Behaviors*

Conflict cannot be separated from other interactions, such as environmental destruction or inequities. Conflicts have been escalating, regardless of who won a cold war, or whether nuclear disarmament was achieved. The constant conflict of cultures and the loss of life, human and other, is tragic. But, this kind of tragedy results from a failure of cosmology; humans are responsible ultimately, not fate or chance (see Section 8.2.4.). Humans all are equals, not subhuman others. Humans are tragic because they are responsible for their actions. They can choose a tragedy of the commons or of dictatorial control—or they can expand a cosmology.

Militarism, conflict, intolerance, crimes, and health problems are symptoms of the instability of cultures. Confusion and misinformation contribute further to the destruction of cultures. If cultures are lost and new forms cannot fit themselves to the patterns and uncertainty of natural systems, then people may not be able to adapt to the continued development of the planet and its ecosystems.

Each culture develops rules for living together. A common culture provides an ideal framework for public and private decision making. The Sami in northern Scandinavia have institutionalized ways of avoiding conflict, for instance, by shaming those who would impose their will. The Fipa of Tanzania use cooperative exchange rather than competition to keep the peace. The Akawaio of Guyana believe that community disharmony upsets the spirit world, resulting in illness and misfortune, so harmony is worked for.

The individual in a culture is responsible for the style and simplicity of their life and for its effects on nature and society. The individual is responsible for being tolerant of others in the culture, and is free to make many kinds of choices. Individuals could assimilate new knowledge from their experiences without changing if the experiences fit in the framework of their cosmology, that is, if the experiences aligned with their internal representations of the world. This may also allow them to ignore or judge unimportant events that did not fit. Jean Piaget noted that when individual experiences contradicted their internal representations, they had to change their perceptions of the experiences to fit their internal representations. He called this accommodation, the process of reframing personal mental representation of the external world to fit the new experiences.

Accommodation can lead to learning. When the world violates our expectations, we can fail, but by accommodating this new experience and reframing our model of the way the world works, we can learn from the experience of failure. In a scientific view, ethics and cosmology are separate. But in a good mythology, there is a coherence between areas. The individual feeds back into the cosmology in altered form what has been received. It is almost like a closed loop between cosmology, culture and the individual, even if human cosmologies are limited and contradictory.

Conflicts, territorial or symbolic, are symptoms of insecurity. Many of our wasteful conflicts could be more easily resolved through a neutral international power. Conflicts would still occur. Conflicts over prestige or power, as much as for various crusades as for a true state, still lead to human and environmental destruction. The United Nations Security Council would be charged with the responsibility to avoid massively destructive forms of conflict, such as biological war or nuclear war.

8.2. *Local Design Factors: Commons*

Traditionally, a commons was a territory managed by a community so that individuals could share the land for grazing or farming. This form of use characterized many tribal groups for 40,000 years. The commons were only open to the members of the community, and perhaps to a few who asked permission. Community beliefs or a kind of ecological ethics discouraged overuse, in that overusers were shamed with informal sanctions or forbidden to continue using the land. In a sense, any territory not explicitly claimed by one community is a commons. That would include the atmosphere and oceans especially, or rather air and water in any form, since these are global things and can move between systems, and their character is determined by the globe itself. Some global economic or ethical method of management, not just for human use but for nonhuman use, must be devised.

In a traditional English village, inherited bundled rights provided commoners with rights of grazing and gathering fuel wood nondestructively "by hook or by crook," which indicated the way wood was gathered by shepherds. The form "commons" is plural, and refers to the whole group of commons, subject to these effects.

8.2.1. *Tragedy of the Commons*

Garrett Hardin extends the idea of the commons to rest on the idea of a carrying capacity of the territory, which is a very dynamic concept, susceptible to change by the weather, season, food preference, or other things. When the commons is not tempered by rules, then an individual user gains all the advantage and the disadvantage is shared by all users. Ecological degradation is assured and the system collapses, a tragedy due to the "remorseless working of things" in Hardin's words. In a limited system, the self-interest of one person cannot decide the public good, or the ecological good. So, the "invisible hand" does not provide a long-term solution. The hand needs to be visible. Necessity needs to be recognized by freedom, as Hardin restates Hegel.

The misuses of commons, some of which are alluded to by Hardin, include: Uncontrolled human population growth, depletion biodiversity, transformation of fossil fuels, pollution of waterways and the atmosphere, logging of forests, overfishing of the oceans, private vehicles jamming public roadways, tossing of trash out of automobile windows (littering), graffiti, poaching, noise pollution, and email spamming. Each of these misuses places a burden on most of the other users.

Many of our less wholesome behaviors, such as rapid technological change or wars, can disrupt tradition and lead to misuse of the commons. If the commons were presented as a prisoner's dilemma for a community, then individuals would have two options, cooperation or defection. Defection, or private mismanagement of common areas, can lead to economic madness, as Paul Shepard indicated. If there are unavoidable costs to defection, then it would be the less likely choice.

The tragedy of the commons is not that the traditional commons system did not work—it did, because it was controlled ethically in a community—it is that other kinds of commons have no such rules governing their use. The tragedy occurs especially when there is a transition from an ethical community use to a free market system that encourages overuse.

Most problems are local not global. So, we have to take responsibility for our local environments, and respect the cultural carrying capacity, as a term for the whole integrated concept of capacity that includes human luxury as well as minimal eating and nutrition.

8.2.2. *Actions Profits & Losses*

Modern industrial culture places an emphasis on individualism and competition. Cooperation, with an understanding of rights and responsibilities, is based on cultural understanding. This kind of understanding, once prevalent in many cultures, is the reason why the tragedy of the commons did not always occur with common resources. Cooperation is crucial. B.F. Skinner suggested that a genetically-based "short-term egoism" leads to a global Tragedy of the Commons. We are tragic because we have to accept responsibility for our actions.

Every action entails a gain and a cost (or profit and loss). Profits and losses are distributed privately, socially, or environmentally. Unfortunately, the modern system privatizes the gain and externalizes the loss to the "commons," considered as a pool of "unowned resources," whereas in traditional societies, it was surrounded by rules for use. As long as this is possible, it is profitable to charge as many costs as possible to the environment. Externalizing costs works fine in an uncrowded world, where the costs are negligible and can be absorbed by natural processes. Resources were traditionally seen as free grabbing; air and water were seen as free sinks. Modern economies, embracing the notion that "nature is capital," draw on the accumulated "capital" of ecosystems for production. By ignoring the real cost of the capital, as well as the costs of natural services, such as nutrient recycling, soil building, and atmospheric renewal, these economies create a temporary wealth. Decisions made on short-term economic grounds could lead to material shortages and environmental degradation.

Economists try to bronze the economy in its current structure; but it is a changing system. Since it is changing, strategies that are appropriate at one stage are totally inappropriate at another—this is the remorseless working of tragedy, where successful strategies are applied in inappropriate circumstances. Tragedies imply conflicts larger than the individual or even society. The external order of things or the cosmic plan is challenged, even if the cosmos is just the size of a city. The source of tragedy for economics is a fatal flaw of the world-view.

8.2.3. *Resolution of Tragedy*

The present causes of the ecological crisis lie in the combined action of technological advance, population increase, and conventional, erroneous ideas of the nature of humanity and the environment. Garrett Hardin asserts that the problems of the ecological crisis are direct results of the tragedy of the commons reproduced on a global scale. In a sense all global resources are part of a resource commons, due to their mobility, connections or depth in the earth. Therefore, overpopulation, pollution and resource depletion can have no technical solutions; they can only be ameliorated through political reform, which can only result from changes in perception.

Privatism or socialism could work, depending on population size, resource distribution, traditions, or other factors. Privatism works well within a system with intrinsic responsibility. The problem with the socialism is its contrived responsibility; who shall watch the watchers? Commonism, a system of cultural commons, or altruism, might not work as effectively in large systems. One necessary condition for the preservation of finite resources is sovereign power. To share resources without the discipline of power invites the tragedy of the commons. The limit of sharing has to coincide with the limit of sovereignty; otherwise runaway destruction could result.

Any kind of aid is a distribution from a commons, as Hardin notes. Dealing with a commons is more effective through laws that end destructive behavior. Furthermore, laws are a second-order altruism, in which an individual does not risk acting as a lone altruist (in violation of Hardin's Cardinal Rule of Policy, which is to never ask a person to act against his own self-interest). If it can be demonstrated that the long term effects of egoistic actions are really harmful, then people may be persuaded to forgo short-term gains. But, again, laws are needed to keep personal actions in social context. To prevent a tragic end to commons, the system must be changed. People will be reluctant to change because of the uncertainty of technological forecasting and political stability.

The tragedy of the commons could happen in a mass economy, although not necessarily in an information economy, if people were truly rational actors. Hardin believes that coercion, centrally controlled by majority rule, is required for survival. Self-interest and knowledge of capacity could also contribute to avoiding tragedy. J. Martino claims that private property can eliminate the tragedy also; the self-interest of the owner would dictate common sense. In this case, a global socialism would work because it would be responsible to national cultural units, whose interests would be represented. Economic cooperation in world of scarcity, however, may make it difficult to solve environmental problems.

8.2.4. *Fate & Tragedy*

Humanity can still be a part of nature and still be tragic, however. Even if moral laws are natural. Tragedy is more than an ethical conflict. Tragedy can imply conflicts larger than the individual or even society. Becker claims that the tragedy of evolution is that evolution produced a limited animal with unlimited horizons. For Becker, tragedy is wanting an earth that is perfect, a heaven abstracted from imperfection. Of course, the swing of the pendulum ensures that humans cannot create a perfect place. In the sense of employing a successful strategy in all circumstances, perhaps natural selection in evolution is tragic (the tragedy of reality)—M. W. Fox and Garrett Hardin hold this view.

Modern science is one-sided (or single-visioned), in denying poetic knowledge. The attempt to avoid the pendulum (enantiodromia), without understanding the operation of nature, ends in tragedy. The definitions of tragedy can be linked to cosmology, the image of the place of humanity in the universe. Tragedy challenges the external order of things (the cosmos), even if the cosmos is only the size of a city (*polis*). The fatal flaw of the individual is the fatal flaw of the world-view of the individual. This is the root of Hardin's tragedy of the commons. The tragedy of the commons occurs only when people are locked into a system of self-interest through economic gain; it could not happen in a culture that understood common holdings. Hardin's definition of tragedy is the working of fate. But economic tragedy results from the failure of a cosmology: humans are responsible, not chance or fate. We can choose between the tragedy of the commons or that of Leviathan—or we can expand the cosmology using ecological knowledge and wisdom and the limit economics to a sustainable place in the cosmology.

8.3. *Designing Behavior Constraints: Ethics & Religion*

Human behavior was traditionally linked to ecosystem limits, certainly the patterns of plants and animals, by codes of behavior enforced by shamans and the elders, who were responsible for monitoring animal numbers and health. The set of rules governing the conduct of a group of people, based on traditional behavior of that group, came to be called ethics. Over time the rules became separated from ecological constraints. An ethics abstracted from its ecological and historical context, detached from other societies, and alienated from nature becomes academic, insular, and strange. Plain ethics is the way of living alone. Such ethics tend to depend entirely on local human utilitarian values.

Although philosophical systems of ethics attempted to be universal, their basis was mostly theoretical. Kantian ethics is unsuitable for treating other beings in nature; deontological ethics has a weak subjective foundation in human conscience. The areas of concern of ethics and bioethics are not broad enough; their foundations are not deep enough. An ethics refounded on ecological knowledge, by comparison, places human behavior in vital social and biological communities in nature—birth, death, illness, and sex all take place within nature. The frame of reference of ethics is enlarged, leading to appropriate behaviors in a larger context. Human health is related to the health of ecosystems. This ethics addresses animal rights and wilderness preservation, as well as human concerns.

8.3.1. *Pan Ethics, Living Together*

A new ethics can recover its basis from nature itself, not from an extension of the old anthropocentric ethics, with all its limited assumptions. It is based on ecological knowledge, grounded "in the breadth of being," in Hans Jonas' words, and founded on principles discovered in existence. Many ultrahuman cultures have standards (or codes) of behavior to regulate interactions. In birds and simple mammals, these rules may be very rigid and predictable. With increasing brain complexity, learning takes a larger role.

Animals are ethical already; they live together by rules; they respond to situations to other animals. Ultrahuman ethics are rules for living together. The human community is one of many communities that make up ecosystems. Human relationships embrace other beings as well as other humans. Human ethics describes a small part of the rules, perhaps the only self-conscious part.

An ecocentric view emphasizes human moral responsibility for vulnerable ecosystems and habitats. An ecocentric view recognizes the ends and means of all beings. An ecocentric ethics can place human ethics in proper perspective, in proper relationship with other living, interacting beings. Understanding ecological relationships permits the toleration of fluctuation, irregularity, uncertainty, diversity, spontaneity, flexibility, looseness, and limits. The basic premise of nature is interrelatedness. The interpenetration of boundaries makes humans less discrete, less alone. A shared biology establishes the fellowship of beings.

8.3.1.1. Ecological Ethics

Humanity has started to remember that it is an integral part of food chain and part of an organic cycle of birth and death (Paolo Soleri and others have been celebrating this for decades). Humans need to recognize that they automatically participate in everything, and that they cannot unparticipate by choice. Participation starts at the quantum level and continues through the ecological and cultural. Human nature does not find meaning in an absurd world, but discovers its structure through interaction with the ultrahuman order. Human identity exists partly in relation to nature; the destruction of one involves the other.

A new ethics starts from nature itself, not from an extension of the old anthropocentric ethics, with all its limited assumptions. It is based on ecological knowledge, grounded “in the breadth of being,” in Hans Jonas’ words, and founded on principles discovered in existence. Many ultrahuman cultures have standards (or codes) of behavior to regulate interactions. In birds and simple mammals, these rules may be very rigid and predictable. With increasing brain complexity, however, learning takes a larger role.

Ethics are assembled inductively, from experience in living in places. Now, because of the uncertainty of human actions, ethics has to encompass the far past and distant future. No one knew that when DDT killed mosquitoes, it would concentrate in the food chain to kill birds. Values are time dependent, and ecological time can be very long indeed. The futures we invent are viable only if compatible with constraints imposed by evolutionary past. An ethics that requires a long-range responsibility also requires a new humility, since technological power exceeds the ability to foresee its consequences. An ecological ethic recognizes the moral obligation to leave the world habitable for future generations.

To address problems with extermination and pollution, Aldo Leopold proposed a conservation ethic, dealing with human relationships to land, plants and animals. The land ethic that Leopold had in mind was a sense of ecological community between humanity and other species. “When we see land as community to which we belong, we will use it with love and respect.” Such an ethic would change the human role from master of earth to plain member of it. Predators are members of the community; and no special interest group has the right to exterminate them for the sake of benefit for itself. This attitude is important for habitat protection. Leopold describes the extension of ethics (emphasis added) as “actually a process in ecological evolution. Its sequences may be described in ecological as well as in philosophical terms. An ethic, ecologically, is a limitation on freedom of action in the struggle for existence. An ethic, philosophically, is a differentiation of social from anti-social conduct. These are two different definitions of one thing. The thing has its origin in the tendency of interdependent individuals or groups to evolve modes of cooperation.”

The extension of ethics to animals and land is an ecological necessity. Extended ethics defines a social conduct that is a mode of cooperation and, ultimately, symbiosis. Leopold argued that ethics are voluntary limitations of freedom, necessary in a complex world of which we remain incredibly ignorant. Ethics are developed in response to problems that arise from increasing knowledge. Science has phenomenally increased our knowledge of physical and biological processes. It has now become the basis of our moral code, but it cannot very long be a science divorced from feeling and art if that code is to help us survive. To do this science requires aesthetic perception as well as disciplined thinking and feeling. As there is a rational component to ethical judgments, so there is an intuitive and emotional one, also. An evolutionary ethic suggests that humans avoid tampering with complex evolved systems, not because they are good, but because they are the basis of life at this stage of development. Ecological ethics is situational because ecology is the study of changing systems. The morality of the act is determined by the current state of the system. Adaptive modes should conform to ecological patterns. An ecological ethics is based on attributes of ecosystems and human compliance with ecological laws. The aim of an ethic must be harmonious to the idea of the world’s population of living beings.

8.3.1.2. Natural Value

Humans have stripped the world of qualities and significance and claimed them for themselves. By valuing humans alone, value is made subjective, and ends are without value. However, the human perspective realizes only a small part of the spectrum of rich possibility of experience. Humans use an incomplete source of value for ultrahuman beings; that source is human need. Abraham Maslow established a hierarchy of human needs, beginning with food and continuing through social acceptance to self-actualization. But human needs are based on the health of the earth. Nature, which is self-supporting and self-managing, is the human life-support system. Human systems depend on natural ones, for recycling of wastes, water, and air. But, as human growth is logarithmic, so is human need, and need shapes facts, like kind and quality of resources.

As Goethe recognized, all fact is theory, a blend of perception, imagination, and needs. Granting this, the need for wilderness is as much a fact as the need for food. Wilderness is ecologically important, for it accounts for ninety percent of the energy trapped by photosynthesis from the sun; it is crucial in the global energy system. Trees and plants are good sources of energy. Energy and materials can be produced through photosynthesis. In fact, wilderness is the greatest producer of renewable sources of energy and materials. As habitat for incredible number of species, it is insurance against the dangers of simplified agricultural systems; it is a depository for genetic types. Biological species are essential to the maintenance of ecosystems. Wilderness is the source of evolutionary process.

Rich sensory and emotional experience can be derived from contact with the wilds. These values are not often mentioned by economists and planners. But values usually encode information having survival or prestige importance. Perhaps the most valuable thing is living time. This may be why humans value walking in the woods or observing the production of art. The value of wild nature is its independence and wildness.

We find that kind of knowing more in literature than in science. Whitehead turned to literature because it corrected the excess of objectivity that occurred in science. Poetry carries an expression of the organic character and value of nature. Value refers to the in-itselfness and for-itselfness of the process of realization. Besides having value for itself, it shares value with the rest of the universe. Everything has signification in the universe, says Whitehead: "Remembering the poetic rendering of our concrete experience, we see at once that the element of value, of being valuable, of having value, of being an end in itself, of being something which is for its own sake, must not be omitted in any account . . ."

Perhaps there is a hierarchy of value from simple forms to complex, corresponding to richness of experience, as John Cobb suggests. Although there is no hierarchy of being, there may be one of richness or value, depending on the frame of reference. There is value for each, and for the whole. And the whole may invert the value. Ecology can expand the narrow anthropocentric evaluation and see things from the perspective of the whole. Lovejoy's 'Great Chain of Being' traces the deductive order in classical nature from Greeks to German idealism. But Lamarck inverted the chain in his theory of transformism; mind is immanent and can determine transformations. Although the hypothesis of inherited characteristics was rejected by Darwin, who shared that hypothesis but denied mind as an explanatory principle, both Lamarck and Darwin inverted the value of life. By inverting the great chain of being, Lamarck escaped the directive that the perfect must precede the imperfect. The result of Elton's food chain was the realization that the bottom link—plants—is the most important.

Ecological value starts at the broad base of the pyramid. Our ethics and legal system is species specific (Singer 1981), but it occurs in a larger, normative order. Ecological science has a very normative component. Even a set of genetic codes is normative; genes show what is valuable for a life-image. So value is morphic on all levels of being. A sort of natural relativity of frames of reference encompasses the smaller human system.

Perhaps we should not argue that things have value in the human system. Let us just respect the existence of the ultrahuman system. Every being has an intrinsic value, before any utilitarian value to humanity. The value of wild nature is its independence and wildness. Perhaps our astonishment contributes to its value. Bees have bee value; wolves have wolf value. Wolves are not efficient at binding nitrogen; neither are humans. Lichen are poor predators, but they break apart rock better than bighorns. The world would not be a better place without sharks, silverfish, cockroaches, rats, hyenas, or whales. Their existence has value; they have functions. From a functional point of view, all beings are equal. In an ecocentric perspective, all beings have intrinsic value and are equally important.

8.3.1.3. Reverence for Being

The recovery of implicit natural values can be expressed as a reverence for natural systems. The systems scientist Ervin Laszlo proposed a social ethic for the age of humanity, calling for reverence for the level-structure of the microhierarchy, including all systems on all levels, from atoms to an emerging planetary culture and ecology. "We can express the recovery of our implicit natural values in requesting a reverence for natural systems," he said. This reverence expresses the insight that humanity is in nature, a part of an embracing network of dynamic self-regulating and self-creating processes. Our thoughts and ideas are nature, as much as clouds and waves. Marveling at humanity is marveling at nature, the matrix from which we arose. Although there are others, humans are remarkable examples of dynamic order brought forth by the universe in its history.

Reverence must include all natural and artificial beings and things and fields, from atoms to weeds, computers to galaxies. Atoms, molecules, and organic cycles are parts of humanity. We must revere all the arrangements of earth stuff. The greatest human dignity follows from the respectfulness of everything as meaningful as ourselves. Such a reverence treats all substances of the earth as precious, to be used carefully, if at all—and certainly not for a flood of mass-produced consumer items. It includes all human artifacts, manufactures, and societies. It promotes a society where individuals would live in close contact with natural support systems. It provides each with the aesthetic necessities of life to develop all capacities.

The basis of all value is being (the verb form). It is reality undistorted by human needs. Of course, humanity can still enhance nature with its presence, in a nonexploitable manner. The reverence for beings as they are results in the rule of noninterference. In nature, the rule of noninterference means 'letting be' (Heidegger), 'letting alone' (Wilson), and 'not killing for pleasure' (Fox). A formal presentation of the rule states that human beings ought to avoid behavior that disrupts essential ecological processes or destroys biotic communities. As Paul Taylor states his rule of noninterference, it requires a "hands-off policy" for whole ecosystems and biotic communities; the rule stated here is concerned with limited and sustainable exploitation of ecosystems already shaped to some extent by human activities. Noninterference is not indifference, which is diffuse. It is caring. Noninterference will not lead to chaos, poverty, and stagnation. The technocratic vision strives for "life under control," but the earth is self-managing, productive, efficient, and orderly. Reverence can only be felt at the alienness of nature, not at its comfortable conquest. With so little wilderness left, however, formal rules may be necessary.

8.3.2. *Relating Being to Rights*

An ecological ethical model is not distorted by human needs and wants when it argues for the preservation of animals and habitats themselves, because they are, as they are. Paul Shepard says the argument is not new, and that its application is ambiguous because "unlimited rights" will conflict with human interest. But, there are two bad assumptions: that human interests are not ambiguous—they are—and that animals will be granted unlimited rights—they will not. Rights seem to follow the expansion of the sphere of ethics, as formal statements of intuitive knowledge. But codifying rights is more difficult, especially for philosophers, who tend to limit rights with a series of restrictions. For example, a contractual theory assumes a perfect detachment and a rational debate of rules. Animals and imbeciles are left out. Scott Lehman argues that natural objects are not the subjects of experience (certain animals excepted) and so cannot possess rights. He limits experience to mental states (perhaps he meant nervous system states). Some philosophers maintain that a right is a claim to something (Feinberg); others, that it is an entitlement. Richard Watson takes reciprocity as central to the general concepts of rights and duties; few animals and no natural objects have rights intrinsically. He mentions that some primates and mammals are moral entities because they are self-conscious, have free will, understand principles, and intend to act accordingly. But the assumption of self-consciousness would rule out children and feeble-minded adults, as well as most beings. So, a larger definition of claim or reciprocity is needed, without regard for contracts and mutual duties.

8.3.2.1. Natural Rights

When humanity was divided into citizens and slaves, there was less freedom. When it was divided into governors and governed, freedom was advanced by providing the governed with protection against the tyranny of governors. When people became self-governing, protection was needed against majority opinions, by distinguishing between the individual and society. New contrarities—public and private—provide clarification of rights. Rights protect the interests of those holding rights. Natural rights are the rights of an underclass that has not been granted legal rights. These "natural rights" are used by minorities to legitimate their claims against controlling powers. Rights and obligations were first thought of in a political context consisting of customs and practices within and between states. In the 17th century they were thought of in a constitutional context, where forms of government were established to protect natural rights. Now they are thought of in a human context. Freedoms of—speech, worship—depend on institutional protection and are political rights. Freedoms from—want, fear—are extensions of economic rights. Freedoms for—pleasure, reproduction—are considered biological rights.

Humanity has taken its own opportunities. These opportunities have been codified for centuries as rights. Now, we must allow other beings equal opportunities. The interrelatedness of life dictates the interrelatedness of rights. And these rights are necessary to the integrity of the whole planet. Humanity developed in a community of animals and plants, as part of a clade on the same tree of life. The quality of human life has always depended on the quality of animal life. Animals have sensations and feelings, as important to them as ours are to us. Furthermore, the extension of rights to animals and plants does not deny any traditional human rights. Animals should be accorded higher moral regard and legal standing to reflect the intrinsic worth afforded by their existence and sentience. Welfare laws to conserve species and to guarantee humane treatment in research, transportation, and slaughter indicate a growing concern among people. A new ethic can keep animals free from human intervention, prejudice, or overuse. Animals should be preserved because they are as they are; their existence is moral justification. Their intrinsic worth is independent of the instrumental values imposed on them by humanity.

The strongest argument for rights is interrelatedness in communities. It is a basis for assigning rights to ultrahuman nature. Existence implies intrinsic worth. Garret Hardin considers interrelatedness, but interprets it narrowly. He considers rights as rules of competition; every right is a ploy in the struggle for existence, and every right implies an obligation to furnish it. This is good as far as it goes. Life is more than competition, however; it involves cooperation and play. Rights are formal rules for living together. Society should be organized on the basis of functions, not rights. Ecological rights (customs) could be based on functions. It is foolish not to assign rights to animals, plants, and the earth because of contractual formalities. The reverence for all beings is concerned with the right functioning and right numbers in the right places, according to standards of health and quality of life.

One problem with the current legal system is that all nonhuman beings are given the status of inferior human beings, legal incompetents, thus keeping humans in a guardian role. A new legal category is needed that would respect the existence, competence, and excellence of natural beings. Christopher Stone recognizes that the judicial system has granted rights to a variety of inanimate holders, trusts, corporations, and nations, for instance. The legal system already operates with fictions, so the extension to natural entities should not present an insurmountable problem. To be sure, formal rules should to be altered to account for unconscious, interdependent beings. Current legislation on animal experimentation and protection implicitly recognizes the right to life and to a healthy habitat. Laws are needed to protect entire habitats of animals and plants from human interference.

8.3.2.2. Rights in Justice & Law

Socrates argued in *The Republic* against the conception of justice as giving every man his due, and proposed a definition of justice as every man performing his proper function. This proportion of reward to function in the community was named distributive justice by Aristotle. It describes the right to participate in the benefits of science and culture. If justice is a proportion set up in the community between men and goods, justice is also the restoration of the relationships of men and goods, when disturbed. Aristotle called this justice rectificatory. This has constituted the business of recent laws and courts. During this stage of universal rights, world order transferred the criterion from the nature of man to the community of men; both law and justice, obligations and rights were reduced to equity. Thus, new nations demanded to participate in a common justice, as opposed to the extension of natural rights. A principle of justice based on need can be extended to the ultrahuman community. To be sure, it needs to be altered to account for unconscious, interdependent beings. The right to use nature is a right to share. Current legislation on animal experimentation and protection implicitly recognizes the right to life and a healthy habitat.

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Formal law tends to seek guidance on normative issues from the general population, rather than from legal experts. People care for animals and wilderness. Natural rights are defined by positive laws and by negative restraints on behavior. Laws are needed to protect ecosystems and wilderness, now. Legal or religious action almost always precedes the general shift in conscience. The obligation to treat others equally includes an obligation to change human social patterns in the direction of equality.

We act by intuition and feelings. Like the inductive creation of cultural ethics, we are building a framework of intuitions, feelings, theories, and principles. The whole is recognized as a valuable end by hunters and actors as well as by scientists and politicians. The framework is supported by principles and theories developed by ecologists and philosophers, by the working rules of conservationists and activists, and by specific instances from cultural traditions as well as from the industrial paradigm (determined to become its own worst enemy as well). Stone considers that these things are only part of the framework. In The Laws, Plato has the Athenian say to a youth that all things are ordered with a view to the preservation of the whole, each portion contributes to the whole, and every other creature is for the sake of the whole. Ethics has expanded in wholes, from the family, to the human community, and to nature, on which everything depends.

To protect the whole, we need laws to encourage practicing the 'Rule of Noninterference.' A machine metaphor approach, with its assumptions of interchangeability and quantity, has difficulty distinguishing between exploitation (the normal use of resources) and interference (destruction for temporary or no gain). An ecological metaphor, that is more receptive and reverential, may be more appropriate to understanding organisms and nature in general. Such an approach would stress noninterfering observation rather than controlling manipulation.

8.3.3. *Binding Humanity to Places*

The problems of ignorance and inappropriate images are multicultural, ecological, and cosmological, and must be solved on the level of culture—the entire activity of culture is guided by metaphors. Metaphors emphasize likenesses between living things and languages (or human constructs). A metaphor furnishes a label and emphasizes similarities. It not only defines and extends new meanings, but redescribes domains seen already through one metaphoric frame.

An understanding of ecological metaphors, with an emphasis on limits, can lengthen the life of a culture, but ecology is not enough. Cultural metaphors are necessary, as are good rules of behavior. Culture can provide the rules. Ethics and economics, for instance, are rules of behavior; and politics is the practice of changing the rules as society changes. Religion is the practice of binding us to constant rules and values regardless of temporal changes.

G.W. Leibniz, concerned for the purpose of restoring the unity of Christianity, worried that without a common belief in God, secular religions would emerge that would be tyrannical and suppress the freedom of the individual. Later, Rousseau thought that society could and should control the individual. Then, Marxism offered its advanced secular religion. But, it collapsed, although it and the secular religion of capitalism exalted the freedom of the individual without linking it to a belief in God, thus compounding the effect of rampant individualism.

Now, what will replace the failed communism and the failing capitalism? Could religion, for instance Christianity, replace the secular attempts? Is that what religion should do? Form a rebirth of belief and shape the person in a 'knowledge' society? Will there be new religions, like the pastoral ones in the US, which will try to do this? Peter Drucker thinks that the end of the salvation through society will make possible a renewed emphasis on the individual. But, an inspired religion could correct that continued damaging distortion, and allow a resurgence of culture that would encourage individual responsibility in the cultural context. James Lovelock considers Gaia as a religious and scientific concept. As sacredness and wonder are essential to any belief system, including science, an inspired religion could incorporate a global model of the planet into its universal beliefs.

Religion asks us to realize that we are obligated to respect larger harmonies in nature, not just be restricted by rules to not disrupt them. Religion can balance some of the other tendencies of a culture. Consuming is much easier than restraint. Maybe that is what religion helps with, reasons for restraint. It provides a supportive social environment, where people practice restraint. E. O. Wilson states that religion possesses strength to the extent it codifies in enduring poetic form the highest values of humanity, which are consistent with empirical knowledge. Only a cultural consistency can provide compelling moral leadership.

Religions have developed in the past 40,000 years. There were long period of animal and force gods. Then, there was a cosmologization of thought systems from 500 BC to 300 AD. Religion has gradually widened the sphere of inclusion, from kin and tribe to nation, animals, humanity, and ecosystems, to maybe the planet and solar system. Religion has its own gigatrends, from Gods of natural forces to war gods, regional gods, global gods, and universal gods. Maybe it will be concerned with machines and hybrids, now. Religion has changed forms, from allowing anyone to contact spirits or ancestors, to limiting authority to shaman and priests. It has been used to justify institutional theft as it became larger and more formal. The original goal of religion was truth, followed by wealth and attendance or conformation. But, meaning went missing. So, religion went to popularization next. People responded by seeking personal religions. But that got replaced by trends such as Scientology. What is replacing those trends? Loose associations?

Religious organizations that have persisted for centuries have done well at preserving individual trees or stands; both Chinese yellow pine and dawn redwood, long thought to be extinct, were found in temple gardens. By contrast, the Queensland Australia management system for moist tropical forests was closed down by a political decision after a state-federal struggle for control. Long-term stability, with secure ownership by state, culture, or tribe is a necessity for permanent forests. This means intergenerational management.

Perhaps ownership will reflect a change from individual and corporate to land trusts and community. We need to find the best combination of ownership, trusts, easements, and plans to ensure that land will be cared for in the long-term.

As a cultural form, religion has potential to help humans adapt to the constraints of a wild planet. Religion could help control disruptive forces, especially those that result from distribution and power. Religion coerces people into a social contract. Religion and storytelling reduce the variability of individuals wants in a group. The introduction of new stories and myths, concerned with partnership and equality and with the value of other places, species and people, could change our attitudes about them into a healthier context.

8.3.4. *Conclusion: After the Start*

A start has been made. Ethics now considers almost every human being and human interaction. The restriction of ethics to exclusively human modes of existence, however, leads to a troublesome isolation. Human beings are not separate from their social and biological communities and these communities are embedded in ecological contexts with biogeochemical processes. Ethics must be extended to the framework and to the nonhuman communities in the framework, without which there would be no human health or wealth. Through science as well as through mysticism, we understand that communities of other beings have their own values and rules for living together. It remains for us to integrate and codify human rules that recognize the values and rights of other beings.

8.4. *Local Design Factors: Ecological Politics & Panocracy*

For Aristotle, politics was the science of the possible. The city (or *polis*) was a human artifact whose structure could be modified by reason; it was potentially a work of art in which only the capability of the artist limited the expression. The *polis* was made for the amateur; and it produced more complete men (women were erroneously considered lesser beings at the time). The city was necessary for politics then, as face to face communication. Now, communities are different, larger and dispersed, so politics has to change. As a science, politics, or ecocybernics (a neologism meaning 'governing the house'), was concerned with two things basically, a way of distributing power and luxuries internally within society, and a way of surviving contact with other cultures.

Archaic nations governed their areas independently, distributing power and protecting themselves. Their political principles were similar: All land was communally owned by the tribe, although household goods may be personally held; all decisions were made by consensus in which everyone participated; chiefs were not coercive rulers, but teachers and leaders with specific duties limited to their realm— medicine, war, or ceremonies for example.

When the Europeans or Chinese settled many areas, they brought their centralized governments. The original goal of the U.S. republic, according to Jefferson, was to make each person a participant in the everyday affairs of government. But, the government (state or federal) has become gigantic, managing the area from remote locations of power, and participation has dwindled. Despite a recent emphasis on personal responsibility and international cooperation, our political institutions have not responded.

Central politics usually overwhelms local politics. It dominates the process of decision-making. Politics deals with words, which are arbitrary symbols for events or things. The wrong relationship of things and symbols can result in misguided politics and violence. Decisions are made on narrow political grounds. Citizenship in industrial cultures is the abandonment of responsibility on the assumption that others know how to manage things; government is the assumption of responsibility, without knowledge, that leads to immense and interrelated problems. Government promises to judge disputes in values and protect its citizens from external attack. Besides centralization, size and power, there are other things that make governing difficult: Division of labor (are there professional citizens?), centralization, and technology.

Politics is the science of government; it is concerned with the regulation and government of a nation or state, the preservation of its safety, peace, and prosperity, the defense of its existence and rights against foreign control or conquest, the augmentation of its strength and resources, and the protection of its citizens and their rights, with the preservation and improvement of their morals. Politics depends on common rights, trust, information, and consciousness.

Ultimately, politics defines social reality. Different societies have had different realities. The Athenians despised the merely wealthy, for instance, and respected community service. North Americans, on the other hand, revere wealth; community service is romanticized on television but hideously underpaid. Politics is also the art of creating new possibilities for human progress. The current system is defective, however. Although it is admirable to work within the system to prevent further environmental degradation, it might be necessary to produce a change in consciousness that would lead to a new political paradigm.

The function of politics is to ensure that decisions are made at the right level. A state protects individual freedoms, guards national culture (values and identity), and holds groups accountable for their use of power. The logic of individualism creates conditions that require constraints. Politics has to make them palatable. Although we realize that nothing in nature is without some limit or cost, we may dislike giving up what we now consider (wrongly) as rights. Humans may have to expect much less than they want, even though many expectations are rising.

8.4.1. *Functions of Ecological Politics*

The functions of politics are internal and external. Internal functions are characterized by activities like the fair distribution of food and rewards. External functions are: To coordinate interaction with other nations, and to decide matters of exchange of people through emigration and immigration.

8.4.1.1. Internal Functions of Politics

Internal functions include: To promote the survival of the nation and communities; To preserve the balance of society; To maintain the affairs of the nation and communities; To guarantee fair distribution of food, goods, and necessities; To manage the distribution of power; To preserve the safety of the nation with laws and defense; To represent the citizens, to educate them, protect their rights, and remind them of their morals; To resolve conflicts between citizens; To regulate the activities of citizens regarding safety of the environment; To encourage conversation and communication; and To moderate the forces of change (internal and external).

8.4.1.1.1. To Promote Survival of Communities & the Nation

Politics has to be successful enough for a new generation to take over ruling the culture and nation. If rulers promote the wrong images, that do not fit the environment, eventually a nation will collapse.

8.4.1.1.1.1. *To Preserve the Operation of the Environment*. Nations are embedded in places. If the place itself, the environment, fails, then no political assurances will be able to feed hungry people. So, political decisions should not interfere with the operation of global cycles or local renewal.

8.4.1.1.1.2. *To Preserve the Balance of Society*. Place sustains government. Land sustains government. Land produces food and resources, but the land is not equal or consistent. Poor land does not produce as much as rich land. Agriculture in general does not seem to produce as much wealth as business. Business does not seem to produce as much wealth as artists (symbols and abstractions have fewer limits on productivity). So, government needs to preserve some balance and equality by giving and taking. Individuals are produced by a community. So, the community in place seems to be the source of most of the wealth. Restoring balance in a small community can dislocate people. Leon MacLaren states that balance can be restored by depression, war, or revolution, and it can be painful. Of course, planning and conscious adjustment might be less painful and less risky.

It is important to encourage conversation and communication. We can best understand the social aspect of culture by realizing that the central function of human symbolization is communication, and it requires adherence to understood conventions. Constant communication allows a culture to be coherent. Lack of communication can lead to misunderstanding, unhappiness or violence.

Government has to manage individual civic relations and conflicts. Many cultures have built-in limits to local kinds of conflict, but conflict between cultures requires some laws or understandings. Behavior has to be understood in a context as meaningful. Sometimes conflicts are the result of language, behavior patterns , or simple geography. There has to a path to resolve conflicts, either through consensus, mediation, or neutral judgment.

Government has to decide limits to growth, development or movement. Keynesian economic theory, the predominant theory in industrial countries, holds that the full utilization of resources is necessary to ensure full employment and the maximum social good. This economics depends on economic growth to avoid crisis. The major premises assume that: Population will grow, that social good is related to the equitable distribution of material products, and that if resources are limited, technology can erase the limits. The economist Kenneth Boulding referred to this as a cowboy economy, an economy that has yet to bump against the limits of wealth.

One solution is to work within limits of sustainability. The population could be stabilized. Consumption could be stabilized, especially with a shift to recycling and solar energy generation. The technology already exists, but educational and political problems are more difficult.

8.4.1.1.2. To Manage the Affairs of the Communities & Nation

Hutterite communities were able to manage their community as long as it was less than about 150 people, Garrett Hardin noted. With more than that, distribution of goods failed, due to some doing less than their share or getting more than their share. So, the Hutterites split communities into two, when they got too large. The scale of community can make some things work better. The force that keeps individuals from laziness or greed seems to be shame, which seems to work as a force only in smaller communities. In a small community, a person can be shamed into working harder or into being less greedy, but in larger communities shame does not work as well. Maladaptive behavior may be less visible or the malcontents may form a subgroup that justifies their behavior. Hardin suggests that most utopias do not consider such a change in scale when describing sizable communities.

Many archaic cultures mismanaged their natural resources, but got away with it because their impact was relatively small. Some cultures were not as lucky, the people of Ur, for instance. Luck, as well as size, has a lot to do with the success of some human cultures. Many other cultures mismanaged the affairs of communities, but they were able to survive because of brute control.

The industrial cultures are mismanaging their resources and affairs, but may not be able to control or organize—or luck—their way out of their problems. Modern society has benefited from modern means of management. In fact, management has made industrial operations, from science to agriculture, possible. But, to continue without disaster, it needs to re-empower local voices, especially indigenous peoples, poor or displaced people, and women. It needs to encourage unique local management solutions, such as the water management on Bali. It needs to adjust to optimum scales that are more efficient and just.

8.4.1.1.2.1. *To Guarantee Fair Distribution of Food & Necessities*. With the complexities of civilization, with various levels of responsibility and duty, politics has to make sure that necessities are distributed in a timely manner. The infrastructure, that is the bureaucracy, the coordination, storage areas, trucks, and other things, has to be in place and functioning.

Government has to manage the Commons, resources and private properties. Traditionally, a commons was a territory managed by a community so that individuals could share the land for grazing or farming. This form of use characterized many tribal groups for 40,000 years. The commons was only open to the members of the community, and perhaps to a few who asked permission. Community beliefs or a kind of ecoethics discouraged overuse, in that overusers were shamed with informal sanctions or forbidden to continue using the land. In a sense, any territory not explicitly claimed by one community is a commons. That would include the atmosphere and oceans especially, or rather air and water in any form, since these are global things and can move between systems, and their character is determined by the globe itself. Some global economic or ethical method of management, not just for human use but for nonhuman use, must be devised.

Hardin extends the idea of the commons to be the carrying capacity of the territory, which is a very dynamic concept, susceptible to change by the weather, season, food preferences, or other things. When the commons is not tempered by rules, then an individual user gains all the advantage and the disadvantage is shared by all users. Ecological degradation is assured and the system collapses, a tragedy due to the "remorseless working of things" in Hardin's words. In a limited system, the self-interest of one person cannot decide the public good, or the ecological good. So, the "invisible hand" does not provide a long-term solution. The hand needs to be visible. Necessity needs to be recognized by freedom, as Hardin restates Hegel.

The misuses of commons, some of which are alluded to by Hardin, include: Uncontrolled human population growth, depletion of biodiversity, transformation of fossil fuels, pollution of waterways and the atmosphere, logging of forests, overfishing of the ocean, private vehicles jamming public roadways, tossing of trash out of automobile windows (littering), graffiti, poaching, noise pollution, and email spamming. Each of these misuses places a burden on most of the other users.

Privatization is one possible solution. However, unless individual ownership includes some regional cycles or global resources, then there might not be incentives for sustainability. One problem is that global things cannot be enclosed like land. Regulation is possible, as is payment by the polluter, a form of taxation. Hardin considers these as forms of enclosure also. One solution would be the return of many commons to the cultures that adapted to them and have had cultural rules governing their use. Hardin's suggestion was "mutual coercion, mutually agreed upon."

Many of our less wholesome behaviors, such as rapid technological change or wars, can disrupt tradition and lead to misuse of the commons. If the commons were presented as a prisoner's dilemma for a community, then individuals would have two options, cooperation or defection. Defection, or private mismanagement of common areas, can lead to economic madness, as Paul Shepard indicated. If there are unavoidable costs to defection, then it would be the less likely choice.

The tragedy of the commons is not that the traditional commons system did not work—it did, because it was controlled ethically in a community—it is that other kinds of commons have no such rules governing their use. The tragedy occurs especially when there is a transition from an ethical community use to a free market system that encourages overuse.

In a larger sense the whole planet is the common, and its limits are obvious, between the sun and the greater vacuum of interstellar space. A photograph of the whole earth made a logical connection between the common earth and the necessity of conservation. So, if the earth is a commons, and humans are threatening the health or existence of the commons, then humans need a common ecological ethic, or some set of rules that they can respect.

In another sense, most problems are local not global. So, at the same time, we have to take responsibility for our local environments, and respect the cultural carrying capacity, as a term for the whole integrated concept of capacity that includes human luxury as well as minimal eating and nutrition.

Government also has to control or limit goods. People made their own goods in foraging societies. For the Desana, goods from the gardens support people, although small numbers of extra goods are traded for clothing, machetes, soap, salt, aluminum pots, fish hooks, and rarely a gun. With farming came specialization, and more goods that could be made and accumulated. Goods became a form of wealth, especially in groups like the Kwakiutl. In Crete, written records show how goods were directed to the palaces and redistributed from there. The demand for goods between Europe and China resulted in the introduction of the camel in the Trans-Saharan trade and boosted the amount of goods that could be transported. Donkey caravans from the Mediterranean brought obsidian and other goods to Mesopotamia, and ivory combs from the Indus river. The value of goods was determined by supply and demand.

Industrial farming depended on a new kind of market, a large market for cheap goods. The English encouraged trade to increase the number of goods. The industrial revolution decreased contact with the natural world and objectified what was left. As a result of drastic changes in the production of economic goods, other political, social and even psychological changes occurred. Other kinds of order were de-emphasized. Human relationships became based on economic allegiances instead of kinship ,– and were formed in societies, not communities. Money became a symbolic representation for the value of labor and land. Land and labor became commodities.

As the automated production of goods became more efficient, goods-producing jobs declined. The goal of production moved from the production of goods to efficiency. Needs are almost completely defined in terms of commodities. Once a need is defined and partly satisfied, such as air travel, it becomes treated as a right.

The material goods of human societies has been increasing. How many of us can carry everything we own on a bicycle or horse? Goods are privately owned. Items that used to be shared in neighborhoods or communities, such as lawnmowers or radios, have many separate individual owners. While this is good for the modern economic system and for the idea of convenience, it weakens socials bonds, dependencies, and trust. Private goods, like gardens, are also public goods, especially in a city where gardens renew the air. Private good, like a loaf of bread, can be owned and not shared. Public goods are those that can be enjoyed in common, since one consumption does not subtract the possibility of another consumption. Air is a good example, although there might be a time when air is rare.

Stung by the suffering of people with new unsatisfiable needs, modern governments have offered to produce more, safer goods, instead of ecologically analyzing the relationships of needs to satisfactions. People have to imagine and construct new frameworks so that they can develop satisfactions that are not dependent on commodities.

Surprisingly, once basic needs are met, for food shelter, respect, and confidence, according to Abraham Maslow, then happiness is not increased much by additional material goods or money. The things that make people unhappy are when their higher needs, such as self-esteem, are not met. Lack of love or security, and lack of communication or appreciation, can lead to unhappiness. People try to balance their lacks by acquiring more money or things. The culture has to become meaningful, as well as secure and equitable, with lower extremes between wealth or status.

8.4.1.1.2.2. *To Guarantee Fair Distribution of Power & Rewards*. Power in physics is the capacity to move. Socially it is the capacity to act. Power is the capability of making things move or happen. Power is not only making things happen, it is a way of controlling which things happen. Having power determines who gets to decide. Power allows dominance. If power is concentrated in one person or a few people, then there are fewer opportunities to challenge or limit it. Concentrated power can lock or gridlock patterns of movement; this is not always healthy, since many problems need many different solutions. Absolute power is no longer accountable to lesser power.

In archaic societies everyone has some power. Power is given to those who have better abilities, at hunting, healing, or coercing. The real power is the ability to persuade others. First persuasion yielded power, then strength, then knowledge. Power can come from strength or a connection to another form of power, ancestral or holy. Power can be derived from the permission or weakness of others.

The creation of large dense communities required new forms of power, due to size and organizational problems. No matter how big the bureaucracy, for a while it only controlled human muscle power. That limited their reach, regarding armies or builders (of pyramids). Traditional states had trouble controlling regional potentates or their armies completely. New forms of energy expanded human power and control.

Scale of governments or corporations gives them more power. Management techniques, or technology, can augment power. Power allows more waste, but power diminishes the ability to see or feel, or suffer, the consequences. Power often reduces the perceptions of those who have it, such that they use power to simplify ecosystems rather than imagine working inside the systems. Having rewards gives people more power. Such power can be expressed in buying patterns as well as bribes.

Corporations increase their power temporarily because of our failure to grasp their nature. Misunderstanding of power or nature can allow a temporary expression of power. The competitive way of life distorts the meaning of power and demand, and it causes imbalances of power and demands.

Governments with concentrated power can be tyrannical about redistributing power or rewards. Inequality in rewards is maintained by the concentration of power. Rewards and power are treated as primary needs, which results in imbalances. Power can lead to detachment from primary needs and natural wealth. Rewards give more power, so that the two form a positive feedback loop that sometimes cannot be controlled, by the user or the less powerful. The cycle becomes self-reinforcing.

If power is spread more evenly, through many leaders and many kinds of leaders, then they can check each other and power is balanced. Under many constitutions power is dispersed by dividing it into separate branches. Humans are momentarily powerless to replace or transcend the circuitry of natural or cultural systems. People often have the power to deny using the power, especially for activities that can destroy place or human values.

8.4.1.1.2.3. *To Promote Safety & Security*. Without safety and security of the primary needs of food, clothing, and shelter, there will not be a cultivation of secondary needs that promote higher culture. Ultimately security is the availability of food, materials and energy. There are levels of security, starting with a healthy ecosystem, and the ability to use it, protect it, and restore it. Security also requires that resources be available to be used, conserved and substituted. Socioeconomic security requires a healthy culture that can distribute basic needs equitably and efficiently. For people to be secure in their own skins, all of their needs, such as self-actualization, have to be encouraged.

Safety is a basic human need, physiological and psychological. Safety is increased when people accept limits on their social behavior, when natural disasters are anticipated, and when technological extremes, such as nuclear accidents and wastes, are safeguarded. Safety does not mean wiping out large predators, such as alligators or sharks, to ensure than no one ever gets bitten or eaten; it means reducing exposure to wild animals, by reducing the overlap or reduction of territories. Animals have to balance their own safety with migration and food-getting. Safety does not mean killing every form of bacteria or virus; it means limiting exposure, being healthy, and preventing the spread of pandemics through accelerated travel and sharing. Ecologically, safety means leaving functioning ecosystems outside the circle of human domination.

Safety is increased with higher standards for sanitation as well as for technology. It means minimizing the potential for harm in a work or play situation. This occurs when governments and corporations take higher risks than the communities and cultures, accept a burden of proof for new developments, and accept higher margins of error and certainty. Safety is increased with laws, such as those concerned with cheating, thieving or killing. Laws that limit dangerous things, such as alcohol or guns, expand safety.

8.4.1.1.2.4. *To Adapt to Internal Forces of Change*. The principle of change indicates that nature is in flux, culture is in flux. Politics is concerned not only with how power and authority are exercised but with how these relationships get transformed. We are interested in the forces that sustain consensus as well as in the forces that bring about change. Intensive change is the development of consciousness or social sophistication; it is characterized by consciousness, connection, and communication. This should apply to cultures also. Extensive change results in the development of cities and technology; it is characterized by conquest, colonialization and consumption.

As humans stayed in place, they tried to extract more resources from the same area. This required new ideas and technologies, which resulted in denser settlements and expanded social organization. This is extensification. Innovation is influenced by the growth and intensity of population, by the expanding and intensified activities of states or cities, and increasing trade and commercialization. The ease of communication also increases rates of innovation. Perhaps that is why it went east-west in Europe and Asia and north-south in the Americas. Accidental innovation became a culture of innovation, that is, a part of the culture that was encouraged and used.

Civilization is shaped by extensification and intensification, and complication and complexification, although on a local level there were booms and busts of individual civilizations. Why do countries lag behind in industrialization? Why do they need to join the race? Economists argue that their policies or attitudes are at fault, or that their environment might be poor, that they are unorganized or that they are fearful of change or exploration. This does not seem likely though, since often the problem can be resources or domination, but sometimes it is the social predisposition to change, as a result of historical or cultural factors.

8.4.1.1.3. To Represent Citizens

In archaic cultures, when people could not present themselves at every meeting, it was useful for someone to represent them. Some degree of household autonomy was sacrificed to some larger order group in return for greater security against attacks by enemies or from starvation. Their government promised to judge disputes in values and to protect its citizens from external attack.

The people of a nation-state were first given full sovereignty officially in 1648, with the Peace of Westphalia. Representative governments still use that sovereignty today to claim responsibility for their actions, without recognition of any international body. They also use it to represent citizens in matters of economic opportunities and trade, to attempt to guarantee access and fairness.

8.4.1.1.3.1. *To Educate Citizens Scientifically & Morally*. Thomas Huxley thought that people in nature were Hobbesian, unfit for civilization unless culture educated them. The same essential belief was held by Sigmund Freud, but the contexts were, and are, different. The thought of Huxley was dominated by ideas of competition and fitness, and that of Freud by individuals in society, from hysterical women and conflicted children to selfish businessmen and power-blinded leaders. The context is expanded to drones in an industrial flatscape.

The modern state has an educated bureaucracy to manage information. It requires compulsory education, resulting in mass education and mass literacy. Mass literacy disenchants the cosmos by undermining traditional and magical ways of thinking. Testing traditional knowledge became a habit. Difficulties of dealing with a half-hearted half-educated public, of dealing with a hard-hearted, hard-headed professional elite, only add to the problems of a culture.

Education may be a necessity, but it has to be a freely offered broad education, based on rich philosophies and sciences. It has to be adaptive. Tribes in the Brazilian Amazon, for instance, have stopped using chainsaws and tobacco, to live more traditionally. They also set up educational centers to show others how it is done.

8.4.1.1.3.2. *To Protect the Rights of Citizens*. In a traditional English village, inherited bundled rights provided commoners with rights of grazing and gathering fuel wood non-destructively "by hook or by crook," which indicated the way wood was gathered by shepherds. The form "commons" is plural, and refers to the whole group of commons, subject to effects.

As rights have expanded, they have also been made more explicit in laws and codes. There is a form of an International Bill of Rights, covering human and ambihuman rights. All citizens expect to have equal rights and opportunities.

8.4.1.1.3.3. *To Outline the Duties of Citizens.* In addition to having rights, citizens also have responsibilities to participate in government and to live as wisely as possible, to make good places. Often, duties have to be made known through education and communication from the government. In a panocracy humans must represent other species, who have a say in the rule (humans already represent the handicapped and corporations).

8.4.1.2. External Functions of Politics

External functions are those outside the boundaries of the nation, but those functions may have dramatic influences on the shape and course of a nation.

8.4.1.2.1. To Coordinate Interactions with Other Nations and Cultures

There are only a limited number of behaviors that people can take to interact with others in their culture or nation. They can: Ignore each other; exist separately with trade or contact; compete for resources and people; cooperate with each other; fight for dominance or territory; or destroy the other.

For interactions leading to violence, a number of trends that can be seen. These are feedback loops that loop around to the beginning, also. For instance, the failure of neighboring economies can lead to the failure of trade, or the failure of negotiation. The failure of defense, the failure of contextual system, and the failure of a structure for individual participation can lead to the collapse in the meaning of participating. The fragmentation of social responsibility can led to an isolated self-image (unrelated to the external), to lack of self-confidence, and to a decline in participation. Conspiracies for societal control can lead to international conflict, government intervention, guerrilla warfare, and massacres.

On the other hand, alienation can lead to selfishness, gangs, and anarchy, then neighborhood control by criminals, psychological stress of urban environment, substance abuse, family breakdown, lack of control, and violence. Prejudice can lead to segregation, discrimination against indigenous populations, destruction of cultural heritage, ethnic disintegration, an inadequate sense of identity, psychological alienation, and violence.

Conflict starts with people, but extends to animals, natural events, and nations, leading to the unfortunate metaphor of war. What is a definition of war? Does it have to do with the number of battles or dead? Or with having a professional army? Does it have to have a beginning and an end? Does it have to be a certain scale? Does it have to be agreed on by both sides or all parties? The whole process and its effects are complex. As violence and conflict occurred on larger scales, they were called wars.

8.4.1.2.2. To Decide Matters of Emigration & Immigration

National governments have the right to determine their own immigration policies, even though the policies are influenced by many other factors, from disasters to invasions, outside the control of governments. Governments need to balance emigration and immigration in a context of a satisfactory population suited for its environment.

8.4.1.2.3. To Adapt to External Forces of Change

Extensive evolution is the horizontal spread of species. Extensive change is the spread of cultures through many ecosystems. Human migration was a form of extensification. That is, when the size of foraging communities made hunting and living problematical, some humans moved away. Only when they could not or would not move, did it become intensification, which required different strategies to live, such as intensive food-gathering strategies. Exploitation of new areas shows the ecological power of the species. Intensive development of a place shows the creativity of the species.

Politics has to adapt a culture to deal with external forces, from climate change to invasions of exotic plants and animals. A culture cannot escape the rhythms of nature. Some events, such as earthquakes or floods, can be anticipated with plans and architectural designs.

8.4.2. *Ecological Politics & New Functions*

Ecological, economic, social, and religious phenomena are part of the broad responsibility of politics. The basic goal of such a politics is the "survival of the community" as William Ophuls identified it. Politics is the interactive means of providing the basic food and necessities of a community. As survival is survival in nature, politics rests on an ecological foundation. The organization of a community must be in accord with natural laws and limits. Political participation depends on information, much of which can be provided by observers and scientists.

Politics occurs, it is now recognized, in an ecological context. There can be no separation of politics and ecology. Every political act has ecological consequences and every ecological decision is a political demand for control over use of the environment. Ecological consciousness can complement political consciousness. Politicians need to think about the hunger and squalor of billions of human beings and the destruction of habitats with billions of ambihuman lives, before concentrating on missiles and private fortunes.

The ecological, social, and political problems of today do not have simple disciplinary solutions. The problems are cosmological and must be solved on that level. But a single cosmology cannot solve all problems in all places. Where human understanding is still underdeveloped, humanity cannot afford to suppress the diversity of thought necessary for adaptation to the diversity of environments, or to eliminate ecosystems and the societies adapted to them, which explains why archaic cultures are valuable. Practicing a holistic or metapolitical approach is the recognition that humans are part of a larger community, a larger whole that includes all humanity and all the earth, with its species, habitats and resources.

8.4.2.1. Deciding Goals for Ecological Politics

The government of a community is a framework to maintain the lives of people. For the original archaic peoples, tribal teachers were adequate. In our representational republic, representatives are relatively uneducated, except in law, and less capable of institutional change. The functions of government are to support the functions of politics with specific actions, such as: To make laws; to decide the meaning of the laws, how they are applied and related to a Constitution; to lead the country and to make sure the laws are obeyed. These action specifically include: To protect the nation; to command the military; to manage internal affairs; to coordinate national activities; to manage external affairs; to represent the nation to other nations; to coordinate trade; to coordinate information; and, to coordinate education.

8.4.2.1.1. Expressing the Purpose of Government

Central government has lost sight of its own purpose, which is not the sum of special interests or its own desire for perpetuation. Government has always had other reasons for existing. Some of these reasons are to:

1. Hold a vision of the common good, where 'common' means common to all beings in the ecological community as well. Make goals conscious, with some flexibility to enhance the vision over time. Balance public and private interests (again, of all beings).
2. Coordinate the means to satisfy the long-term needs of the community, balancing freedom and regulation. Tie rates of consumption to the limits of the system—this means controlling resources and land use, in essence determining the physical shape of the community.
3. Regulate the community. Link it to cultural values. Determine the closure and openness of the community; rates of increase or decrease, through births, deaths, or immigration. Encourage or discourage some forms of technology or trade. Provide work opportunities to members.
4. Protect the community from internal and external threats: natural disasters, criminal elements, and other communities. Most of these threats are unavoidable. Some are long-term and rare; others are constant and of low intensity. Some are part of the human condition; others the result of historical balances that cannot be restored easily or quickly. We need to be aware of them and minimize the damage.

8.4.2.1.2. Increasing Participation

John Dewey believed that personal face-to-face communities were necessary to a free and open government. The local communities need not be isolated as they have been in the past; they are more open and active, connected to other larger communities. Government requires trust and goodwill; these arise more easily in communities of acquaintances.

Citizenship is too complex for television or even electronic global villages; it must exist in the community, in person, in place, where individuals can learn about each other in context. Government by local meetings assumes the common sense and wisdom of the common person in an open exchange of belief and need.

Often this kind of involvement takes more time than just voting annually or having one person decide for many. The effect of presenting a problem before a traditional American Indian council was to slow down response by passing it to the entire constituency and getting a consensus. This ensured due consideration.

To encourage the participation necessary for effective democracy, or communism or socialism for that matter, government should solicit public opinion. Land-use agencies do so. Government should offer real power to people—power should devolve to the lowest level—by changing the local political institutions to start. Montana and Vermont in the U.S. offer examples of how to change local participation.

8.4.2.1.3. Taking & Yielding Powers

Central government must shrink in order for local government can expand. Some things must be done at a national level, such as the protection of watersheds, rivers, and the atmosphere, to make sure of minimal protection. Some protection must be enforced at the international level, also.

Following the federal model, delegated powers go to the highest level, and reserved powers to the community. So, a national government would coordinate internal and external defense and security; maintain law and order; and, set ground rules on economic exchange to ensure fairness. The most important responsibility of government is to set standards for itself and its institutions. The constitution would instruct the courts to interpret clauses as narrowly as possible.

The nation would have an administrative department to handle taxation, budgeting, and purchasing. But, it might allow local communities to coin local money, perhaps on the model of the Local Employment and Trade System—LETS—on Vancouver Island in Canada, which records credits and debits on a computer, and which can then only be used locally. There may be departments to protect the civil rights and liberties of the people and a department to protect the environment. Environmental disputes could be resolved by mediation, as was developed in Seattle in the U.S. in 1980s. The nation would also conduct foreign policy, provide technical services to communities, and maintain regulatory offices.

To avoid insularity, being set against the rest of the world, each nation could create an office of global communication, which could set up connections similar to sister cities program. It might be beneficial to join confederations, especially those that could offer complementary crops, or a larger union, such as Canada, for preferred trading.

Spending on education, roads, welfare would be done at local level. There is some risk, especially with education or wilderness restoration, but the breakdowns and errors would not be as devastating as with centralized planning. Citizens will need to do some of the work of government as well as make the decisions. They should have total control over some things. The judgments of the people are more important than the efficiency of those judgments. It may not be necessary to have many separate authorities or committees; it might be better to integrate policy-making bodies so they are not too specialized.

With centralization of functions, money has become the primary source of security for most people. Welfare, giving money to those who do not have it, may reduce homelessness or disease, but it cannot restore the family, which needs a supporting community context—institutions. Decentralization, and the power it would return to local communities, may also help the family as a source of security. Money is an enormous simplifier, but many things cannot be simplified. Decentralizing would make government and economics enough of a small scale to be understandable and manageable.

Decentralized communities fitted to their ecological location are more suitable and livable than urban spreads. Some cities may still be fairly large and dense like those envisioned by Paolo Soleri. Some may be smaller and rural like those suggested by Murray Bookchin. Their relation to support areas would be more explicit and include large amounts of natural and domestic vegetation. As much as possible, the cycles of materials would be closed.

As cities become more sustainable, their forms may change. They may become more compact, with more multiple-use streets, as a focus for human activity, and less involved with cars. Cities could refit buildings to use solar power, efficient heating, perhaps integrate roof-top crops; they could integrate older buildings into new groupings to integrate services, play, and work, with living. Local public spaces and services could be expanded. Derelict land could be regenerated, as green areas or new construction.

Preconditions to a sustainable, steady state, economy include pollution control and the redistribution of resources more equally. The redistribution of resources and improvement of environmental quality are more important than increased production by sophisticated technology. This strategy calls for social and educational organization more than technological style. Styles of technology must be determined by culture and context. Such development requires a local authority working with suitable economic and ecological conditions. No authority can be effective without the participation of the people.

8.4.2.1.4. Prescribing an Optimum Size

To restore participation, we have to consider the limits of participation. The current large populations of many places may be too large for direct democracy, as do projected optimal populations.

Twenty five thousand people is large for direct democracy. Many of the cities and towns are approaching this size; thousands have already exceeded it. The size has to be small enough for people to meet and "exercise government" in James Madison's words. Kirkpatrick Sale concludes that the optimum size for a direct meeting is five hundred, since participation becomes more difficult as the size increases. Bryan and McClaughry suggest 2,500 as a maximum, since in larger groups people cannot all know one another and the assemblies tend to become a debating forum for a few.

Putting these figures together, we could design neighborhood sizes to be from 500 to 2,500; these neighborhoods would make up communities of 5,000-25,000; and the communities would bring a regional or even national population to 400,000-500,000. Differences in size seem to be close to powers of 10. Each Community legislature would be 40-60 people. Perhaps these sizes are close to the optimum; and, these numbers are similar to those in Christopher Alexander's A Pattern Language. About 3,000-4,000 people are needed to support an elementary school. The Swiss are a good model for government levels—with a national government equivalent to the Swiss national, communities equivalent to Swiss cantons, and neighborhoods to Swiss communes.

There is a point in critical mass reactions where the mood of the mass becomes indifferent. As long as the size is small enough for recognized identity, people will behave with concern. At a larger size, the ideology, which is capable of anything through indifference, can take over, according to Leopold Kohr.

Small communities are essential to the democratic ideal and other ideals. The uniqueness of a place gives belonging and identity. The whole community gives meaning and richness to life. The population density of some places may cause some difficulty, however. People will not be within walking distance, but may have to travel 20-30 miles to meetings or communicate remotely through telephone, computer, paper, or friends.

An ecosystem, if not a watershed or region, is a good candidate to be an independent political unit. It is a governable size. It has relatively clearly defined boundaries, as an ecosystem, that is the ecological community including humans, and not a state or county whose boundaries have been determined by rectangular grids at human whim. The first step would be to form an independent government for each ecosystem or watershed. This kind of government, more clearly defined, might look different.

8.4.2.1.5. Protecting Ways of Life

Compartmentalization (or zonagraphy) avoids the need to compromise every ecosystem for human use. Multiple use systems should only be part of the picture. First, the government could ensure a protected environment of mature ecosystems, then productive systems, and then multiple use, and urban areas. This could be done through function (not activity) zoning. The landscape needs to be zoned (compartmentalized) to provide a safe balance between protected ecosystems and used ones. Restrictions on land and water are one means of avoiding overpopulation or overexploitation.

Long before the limits of food or space are reached, or the ecological balance is lost, or a vital minimum is exhausted, phosphorus for example, the quality of life will sink lower. Regardless of how much protein or energy can be provided to support human life, human happiness will be problematic in large, insecure populations. The question is not how many people agriculture and technology can support in one place at once, but what kind of life is possible for those who have no choice but to live in that place. The limiting factor is that condition in the environment that approaches the limits of tolerance of individuals. The population density may be the limiting factor. It may be living space. It may be wilderness. It may be beauty—aesthetic space.

At a limit, the cost of change accelerates. We seem to understand technological limits, such as sailing ships and computer chips for instance, but not individuals or group, not environmental or ecological limits. Calculating these kind of limits is difficult—too much data and too much uncertainty.

Peter Drucker points out that economists, from Adam Smith to the conservative F.A. Hayek, argued that it is impossible for governments to control or manage the economy, especially in an information age. Recognizing, on the basis of mathematical models of complexity, that detailed management of the biosphere is beyond human capacity, a government should minimize its management, to coordination of communities or larger alliances. The biosphere is dominated by natural communities of which we are largely still ignorant. Detailed planning of complex open systems is not necessary. Planners are not in a position to attempt detailed models of future situations because many relevant parameters remain unidentified, and many of those known cannot be quantified. Plans can be made within the limits of variables, although it is not safe to be limited by lethal variables, as Gregory Bateson recognized. Closeness to limits reduces flexibility, that is, uncommitted potential for change. Vagueness and lack of detail are acceptable in planning, because people will fill in the details. Furthermore, it is almost impossible to plan every detail of a dynamic chaotic system. That does not mean stagnation, that a rice field must always remain a rice field or a town a town. What the government should preserve is the pattern, not the details, its limits, not directions. The limits are to be applied to scale not development.

Therefore, we must limit human intrusion in every system. Government should zone some segments to be free from human activity and tailor human systems to approximate the form of the natural systems replaced. Interference is a broad term for the negative side of human activities. There are numerous forms of human interference: Overexploitation, introduction of exotic species, pollution of air and water, and the subsumption of habitats, in shape and size. Interference is caused by large human population growth, with its requirements of poverty, inadequate metaphors and images, which are too anthropocentric or short-term, uncontrolled change or transformations, as a result of colonialization or revolution, and political or economic failures, from wars or market internationalization.

8.4.2.1.6. Paying Costs & Leveling Extremes

Relative to European communities, many nations have less funding for public services, such as parks and public transportation. Some nations have traded public support for higher levels of private affluence, which has not made people any happier. In fact, they are more insecure; and they can become far poorer, and then second-class and neglected.

Many cultures should try, like Sweden, England and Japan have tried, to weaken the connection of material reward for achievement. Income distribution is too unequal. Full internationalization through trade would bring only greater extremes, which most populations can least afford. One response might be to limit internationalization to some forms of trade or cultural exchanges.

The communities could levy taxes on property, but there is a discrepancy in the wealth of communities. The nation could collect income taxes, and communities could claim a percentage of taxes collected. The community and nation could both tax the same bases: Income, sales, meals, property, and fuel, as many nations are now. The nation would set a ceiling on each tax; the community rate could be zero on some. Or the communities could do all taxes and give the national government a percentage, although differences in wealth might be maintained; then the state could return a percentage to make up equality in education and environmental protection. The important thing is that taxes are used to direct development and reflect the true costs of the society that people want.

Government could change taxation procedures to reduce growth instead of stimulating it. Talcott Parkinson suggests that taxation beyond a certain point yields declining marginal returns. Government could use a single flat rate tax at some percentage, perhaps from 10 to 25; and then pay everyone a fixed income for basic needs, from 3,000-10,000 USD.

Similarly, property taxes could be appropriately scaled to use. One way to keep farms as farms is to tax land by use. The more important the use, farming for instance, the lower the taxes. Buying farmland for shopping centers would result in discouragingly high taxes. It is difficult to persuade people to pay more in taxes, to vote to keep less of their income. But, through education or understanding, a culture could expand the understanding of the self and expand self-interest in that way. Some catastrophe might work towards equality, but that might have other high costs to society.

Of course, most of these taxes could be eliminated entirely, if only environmental uses and losses were taxed. Some taxes, such as luxuries or heroic income, might be maintained temporarily until the extremes of ownership and wealth are leveled.

8.4.2.1.7. Meeting Limits of Government

When a place has a reputation for being small and livable, it attracts more people, until it is no longer small and livable. But, imposing the limits and stopping growth are problematic. Government could impose limits on birth through licenses, perhaps risking rebellion, through limits on housing and public services, possibly causing shantytowns, or through peer pressure, which could contribute to social disorder. Nature is self-organizing, and society is self-organizing, but we need to recognize some limits and define others, and take responsibility for keeping to those limits in order that the self-organizing process not break down. Limits are fundamental to understanding nature and life.

8.4.2.2. Limits of Ecological Politics

The basic goal of politics is the 'survival of the community.' Politics is the interactive means of providing the basic food and necessities of a community. As survival is survival within nature, politics rests on an ecological foundation. The organization of a community must be in accord with natural laws. Political participation depends on information, much of which can be provided by ecologists. There can be no separation of politics and ecology. Every political act has ecological consequences and every ecological decision is a political demand for control over use of the environment. Ecological consciousness must be identified with political consciousness. The ecological, social, and political problems of today do not have simple disciplinary solutions. The problems are cosmological and must be solved on that level. But a single cosmology cannot solve all problems in all places.

Misguided politics arises from the wrong relationship of worlds and symbols. Things are regarded as symbols for words in totalitarian states, which have the advantage of reducing individuals to stereotypes, which can be tortured or disposed of without involvement. Such semantic prisons confine and warp thought. People become prisoners of an order that rejects new knowledge and solutions.

Ecological politics may not be enough to contribute to redesigning or 'managing' the planet. Our genetic make-up predisposes us to some things and pushes us in some directions. It makes limits on our plasticity. It could promote behaviors that damage the environment, and hence our long-term interests. If we are limited by stone-age genes, then some progeny behaviors may be ineffective, and others effective. For example, maybe we must have contact with the natural environments where we evolved—or suffer psychological and physical harm.

There may be fundamental human limitations that could derail it. What if humans have genetically-based urges for sex and reproduction that cannot be limited and cause overpopulation (as Paul Ehrlich expected)? Politics might be successful after a certain density has been reached; the Chinese experiment might furnish some enlightenment, both on the sort of density and on the time lag for reduction. Or, what if humans have a genetically-based "short-term egoism" that leads to environmental Tragedy of the Commons (as B.F. Skinner considered)? What is human egoism is tempered by genetic tendency to live in groups and to behave altruistically towards kin, but only the kin, and not others (as E.O. Wilson wondered)? That limit might guarantee unending conflict. What if a genetically-based denial caused us to always underestimate the probability and severity of environmental threats (as Garrett Hardin expected)? That might mean we would be caught regularly by catastrophes. What if our old brain is not adaptive and does not perceive or respond to gradual environmental deterioration (as Robert Ornstein worried)? That would mean that we would be surprised by slow, invisible or long-term catastrophes. Have we been surprised? And, finally, what if the human brain cannot comprehend current complexity of our own social systems, even ecological politics, which might act in counter-intuitive ways (as Jay Forrester suggested)? What should we do then?

Ecological politics could be derived from our ecological identity, but that identity may not be comprehensive enough to be effective in politics. Maybe our perceived dominance over nature will be a problem that politics cannot solve. Certainly ecological politics is going to be more complex than traditional politics, which was after all designed for the human city. Perhaps we could create an open, self-conscious ecological politics.

For this politics to be global, it would have to address all cultures and all interests (nonhuman and human). A panocracy, a 'rule' of all beings, would like a democracy result from a human legal system, where humans represent all interests. A global ecological politics would have far more restraints on it, and limits to it, from the complexity of the emergent global connections and structures. Global ecological design could offer advantages through designing good societies based on healthy ecological places.

8.4.3. *Designing a Good Society*

As the basic goal of politics is the survival of the community, politics has to strive for a good society—that is, a society that is based on the properties of a good culture in a good place. These basic properties develop into the properties of a good society (Table 843-1). We need to design for limits for conflict; maybe that means a limited arena for conflict or maybe a form of competition that would resolve conflict.

Table 843-1. Contrasted Properties of Different Levels of Patterns

— Nature —		— Culture —		— Design —	
Field	***Ecosystems***	***Place***	***Culture***	***Good Places***	***Good Society***
Process	Course	Dynamicism	Conduct	Action	*Method*
Autopoesis	Self-making	Identity	Wholeness	Individuality	*Extension*
Differentiation	Diversity	Uniqueness	Flexibility	Richness	*Variety*
Integration	Construction	Investment	Adaptation	Conviviality	*Cooperation*
Constancy	Stability	Regularity	Endurance	Consistency	*Loyalty*
Development	Productivity	Renewal	Vitality	Health	*Harmony*

8.4.3.1. Method

Method is a way of considering process, course, dynamic change, conduct, and action. More than just courses or actions, ecological designs are methods to create good societies in good places. A science like ecology may be limited by its method, but in ecological design, method is a way of addressing limits to create the conditions for a good society. Play is the method of learning for most juvenile animals, but in ecological design, play is a way of creating imaginative experiences that can describe and test experiences scientifically and aesthetically.

8.4.3.2. Extension

Design combines the self-making of a place with the wholeness of a culture, in context of the identity of an ecosystem, to create good places and extend those properties into a good society. Humans identify with places. Identity becomes an extension of the self to a place. This identity is a form of rootedness in place. The extension of identity creates an ecological democracy that fits the self to the larger Self that extends through local animals and plants and supporting ecosystems. The creation of good societies can be expanded to include all residents of the territory of supporting ecosystems, including people, domestic plants and animals, wild associations, and even plants and animals that can not live well with people, such as large carnivores. The uniqueness of place gives belonging and identity. The whole community gives meaning and richness to life. The human component means all of the people, not just the majority, or the friends and families of the representatives. All people have to represented according to minimum standards. People do have shared common interests, including a healthy environment, meaningful employment, education, security, and health standards, but they also have personal interests, such as roads or factories, that may not be shared by a minority or majority.

8.4.3.3. Variety

Variety is based on differentiation, diversity, uniqueness, flexibility, and richness. Diversity at the ecosystem level and uniqueness of a place promote flexibility at the cultural level and richness in good places. Animation and ecological value change the differentiation of the field to the diversity of the ecosystem. The addition of communication and cultural values to that characteristic of the ecosystem results in the richness of place. And, the addition of social values and awareness of the uniqueness of a place leads to variety in a good society. The design of a good society requires the property of variety.

How do we incorporate this variety into design? Should we ban interference activities entirely? What do we design for? Wild animals? Good domestic or industrial systems? Because the operation of the universe tends to change systems, the design of a good place and good society should be open to the types of processes that could, if ignored or denied, destroy the ecological design. Maintaining community diversity means maintaining or restoring, in previously degraded areas, the variety of ecosystem types that result from natural disturbances at a variety of scales through short and long time frames in a landscape. Because energy and material cycles need to fit the ecosystems, designers need to increase and scale the variety of energy sources.

8.4.3.4. Cooperation

The construction of an ecosystem contributes to an investment, which encourages the adaption of a culture to place. A culture uses conviviality to make a good place and cooperation to design a good society. The culture and the ecosystem (environment) co-adapt. The process of adaptation involves a self-presentation that offers the possibility of new symbiotic relations. If our old human brain is not adaptive and does not perceive or respond to gradual environmental deterioration—as Robert Ornstein worried—then that may explain why we are surprised by slow, invisible or long-term catastrophes. Cooperation, which can be enhanced through design, can increase conviviality so that we start to shape a good society that diversifies in response to catastrophes that are regular and disruptive.

8.4.3.5. Loyalty

The stability of an ecosystem contributes to regularity, which sets the opportunity for the endurance of a culture to place. A culture uses consistency to make a good place and loyalty to design a good society. Most environments, however, are characterized by fluctuations, irregularities, and uncertainties. As an adaptive system, a culture can change as its ecosystem changes. If a place is regular and displays structural constancy, design can increase stability by creating intermediate structures in a series of levels in an order of complexity—what Arthur Koestler calls holons. Human intervention can make a place more regular and thus predictable. Designs for a good society have to be based on the regularity of a place and the endurance of a culture in the context of ecosystem stability. Design takes the consistency of a good place and lets loyalty emerge from the process of dwelling. Dissent occurs within the context of loyalty, and freedom is expressed within a context of law that limits it and protects it. This avoids runaway feedback.

8.4.3.6. Harmony

In Chinese medical tradition, the highest good is harmony, especially social harmony or good relations. A good person is one who creates and maintains harmony. Harmony is related to wholeness—indeed, health can be defined as harmony in a whole context. The flowing movement of the implicate order (David Bohm's word) is harmony. But, since the flow and order of the movement are imprecise and uncertain, perfect health or perfect harmony is not possible. We recognize breaks in harmony as disease or disorder. C. S. Holling considers that local pockets of chaos keep ecosystems stable by forcing the evolution of new forms to create new niches. Ecosystems reach their fitness near the edge of chaos, therefore crashes and explosions occur.

In medicine, that chaos seems to be a feature or a sign of ill health. That is to say, health is a form of harmony, not a characteristic of things or bodies. A culture uses the health of the system as a basis to make a good place and the harmony of the system to design a good society. Health is the overall ability of a system to maintain itself under a normal range of environmental conditions. Ecosystem health is one of the goals of design, not an end point that can be reached once, but a continual striving and balancing. This means we need to consider long-term balance in order to have any kind of sustainable pattern. Natural processes are concerned with long-term harmony building, as a fundamental property of that design at that level of value. In ecological design, harmony is good fitness with the environment that results in a meaningful and flexible order on the time frame and scale of living processes. The wisdom of harmony, harmosophy, requires respecting the limits of control and certainty, and striving for the most satisfactory balance possible.

8.4.4. Harmosophy: Imperfect Design in Incomplete Harmony

Human survival is not guaranteed. The perfection of a place or society is not possible. The properties of a good society—method, extension, variety, cooperation, loyalty, and harmony—are indefinite and incomplete. Although the properties can inform ecological design, which can improve our situation on a developing planet, they cannot be used to create ideal, permanent utopias.

Cultural system health is a measure of the harmony of the overall physical and ecological degenerative and regenerative processes, which may recycle thousands of human dwelling places, especially those badly sited in earthquake or tsunami zones. The ecological designer should take care to create good places, but be aware of short or long-term destructive processes at work.

Design has to participate in the political actions of a society. Every political act has ecological consequences, and every ecological decision is a political demand for control over use of the environment. The restriction of freedom, either through tyranny, cultural uniformity, crowding, or mutual constraints, results in a decrease of variety, which is created by spontaneous play, and which is necessary for flexible and enduring social systems. If we wish to advance through design, to harmonize on higher levels of development, we must preserve and promote variety. Ethical, aesthetic, and utilitarian reasons all support efforts to conserve the variety in nature.

Local ecological design is the creative modification of ecosystems to repair or enhance their ability at self-organization and maintenance of their complexity and diversity. The pattern has to be small cells under a unit larger than the largest cell. That allows harmony and management by ensuring a physical and numerical balance. Then, central authority, for design or politics, can be relatively weak.

8.5. *Local Design Factors: Cultural Solutions*

Intelligence, for Edward Hall, is paying attention to the right things at the right time. Western culture uses a highly specific classification system to deal with the specifics and details to the exclusion of whole patterns. Other cultures depend on myths to comprehend wholes, but they have less success with the details of invention. Can cultures learn from each other?

What can modern cultures learn from traditional ones? First, they can learn or relearn how to have children based on limits, not on some abstract right to reproduce. Next, they can learn the art of sustainable living in fragile ecosystems. They can learn how to share and distribute the goods of a society equitably. And, they can learn how to resolve conflict by resolution, or at least how to fight personally.

Traditional cultures can learn some things from modern cultures, also. For instance, larger networks of trade—archaic cultures have always known how to be specialists and how to trade. They can learn the use of appropriate technology. They can learn some forms of larger communication. And, they can accept common rights and standards of universal human cultural behavior.

This is not a complete list. Both traditional and modern cultures will have to learn new things. Some cultures do better at the prospect of greater challenges, in part due to their history, but in part due to their ability to change. But, to be able to learn, cultures have to be healthy and resilient.

8.5.1. *The Health of Cultures*

To be truly healthy, a culture (or a global cultural institution) has to address the issues of growth, development and maturity, especially as related to size and scale. We know that life is geared for overproduction and that cells and bodies of organisms have corrective actions, such as signals to trigger cell death. We know that growth is the first phase to maturity, and when maturity is achieved, growth stops, although the organism can continue to develop. In cases where the signal to stop growing is absent or lost through interference, growth continues until death results from collapse or cancer.

Ecosystems can act in similar ways, where growth can stimulate overproduction, which can establish an environment for new, less pioneering species. The new species corrects the growth of the old by making conditions adverse. Maturity is a correction in general as a mature system closes itself to invasion by other invasive pioneering organisms. Cultures grow also and received signals from environment. Usually, the environmental signal slowed growth. After the application of agriculture, however, with all of its technological advances and social changes, such as permanent dwellings, signals were either ignored or overcome by technological or social changes. The human population has been free to grow tremendously, although large-scale disturbances, such as earthquakes or long droughts, have acted as signals and caused many cultures to collapse.

Cultures now, and especially any pancultural global institutions, have to address the situation of exponential human growth and its effects on institutions and ecosystems. They have to find a way to signal human populations to stop growing beyond the ability of institutions to manage them or of ecosystems to support them. Cultures can do this by modifying how they imagine places, in terms of their images of the planet or cosmologies. Cultures can apply their understanding of ecosystems and the cultures themselves to use ecological designs and political processes to fit their health and prosperity within the health and vitality of ecosystems.

All cultures need to have certain conditions to keep being healthy; if one or more of these conditions fails, then the culture may fail. An incomplete list of conditions is in Table 851-1. For a discussion of health, refer to previous sections (8.4.4.6 and 7.2.3).

Table 851-1. Conditions for a Healthy Culture

Condition	*Meaning*
Sources of energy / material	External, internal provide basic needs
Groundedness (boundedness)	Locality, isolation, security
Identity	Unique patterns, stability, resistance
Vigor	Productivity, health
Participation	Relation to other cultures, systems
Adventitiousness (continuity)	Ability to adapt / absorb
Sophistication	Self-maintaining, developing, aging
Complexity	Development of diversity
Heterogeneity	Toleration of diversity
Comprehensiveness	Acceptance of everything
Flexibility	Looseness, capacity to change
Renewability	Self-creating, self-renewing
Balance	Harmony of limits / extents

8.5.2. *Cultures as Ecosystems*

Cultures have a lot in common with ecosystems. Both are open, productive systems. Both have an identity that is bounded by limits and is adaptive to place. And, both can achieve flexibility and stability by maturing in place. The properties of an ecosystem include: Identity and it factors, boundedness, limits, size, definition and shape, and wholeness; Openness, related to energy and efficiency, structure, and connections; Productivity, the self-generation and maintenance of systems; Adaptation to place; Vitality; Stability; and Flexibility. By comparison, the properties of a culture are almost identical, in terms of how they describe the system. Both systems have essentially the same properties.

8.5.2.1. Needs of a Culture

Now, compare the needs of a typical human with the needs of their culture. Human needs, according to Abraham Maslow, range from the Physical—food, shelter, and clothing—to Safety, which involves law, order, and security; Psychological, which is about belongingness and love; Esteem, with its reliance on strength, self-sufficiency, competence, freedom, attention, and prestige; and finally, Self-actualization, which is expressed through health, achievement and creativity. The needs of a culture, which include physical resources and security, are much more formal and include emergent needs: To have a dynamic order, for human health; to be complex and sophisticated, with checks and balances; and, to be comprehensive, to allow change and diversity. Both patterns need physical resources and emergent properties that let them find, benefit and enjoy using resource to make better individual or group lives. Of course, this is logical, since human beings make culture.

8.5.2.2. Responsibilities of a Culture

Notice the contrast between responsibilities and possible interrelationships with other cultures. Cultures can relate to each other in a variety of ways, beginning with the strict avoidance of others and competition with others, including violence and war. But, cultures can cooperate with others on several levels, including partnership and symbiosis. A responsible culture has to fit with the environment and display ethical treatment of all others as insiders or outsiders. Cultures may preserve themselves and possibly miniaturize their image or those of other cultures. Each of these possible relations has certain benefits or costs to a culture. Over time, it seems that cultures are becoming more cooperative and more ethical. Overall, there may be a decline in violence, and that may be related to education and travel. One perspective that has been allowed has been the concept of the outsider, which is often part of the history and cosmology of a culture.

Cultures have always had responsibilities to their members. Many of these have to do with identity, continuity and protection. Cultures have several responsibilities that may be assumed or voiced formally: To have consistent rules; to keep ecosystems healthy; to be economically healthy; to keep their people healthy; and, to keep the culture itself healthy. Health figures significantly as a responsibility of culture. Not only do the people have to be healthy, but the economy and ecosystems have to be maintained in a state of health. One important aspect of health is the size of the culture relative to its place.

8.5.3. *Imagination & Metabolism*

As the adequacy of a habitual view of the earth is questioned, imagination offers alternative ways of seeing. Yet, human imagination is limited, as is human knowledge. An aesthetic object should not offer a reassuring vision, which interprets or identifies nature, but a naive vision, which surprises, shocks, fascinates or seduces the senses, which awakens desire and stirs the imagination, and which furnishes a feeling of the invisible. Play is imaginative experience, natural learning entered into freely; education should be more like play than work. Vico pronounces that imagination is a turning out of one's self. An imaginative metaphysics shows how a human can become all things by not understanding them. The creativity of the imagination diffuses the world from the center of its being, creating a plenitude. Metaphor enlarges the imagination. Perception and expression are embodied in the flesh, but imagination is what makes the flesh visible; it is what allows inquiring beings to see into Being.

We must find a way to affirm the metabolism of nature as our own. Each individual is part of a world that extends around the self. There are different, partial worlds. We may see trees on a house site as encroaching, where a Dakota person may see them as standing peoples, with equal rights to the land. The self is related to each world in different ways. We may see plowing fields for seeds as an act of mastery and exploitation, where another may see it as act of tender involvement, bringing forth potential. These perspectives can be accommodated in a holocosmology.

Since the origins of the environmental crises are in human traditions, it should be possible to select—and create a new holocosmology—from what is valuable in those traditions. If the world becomes as humans imagine it, then a larger frame will make a larger world. When cosmologies and societies were small, the amount of control and security needed was small. Although societies have grown, security has not. It should be easy to give up control that we never had; giving up trying to control may be more difficult. We need to fashion our behavior to our local systems and the planet, not the reverse. Since complete security is impossible, since complete power is impossible, why try? We are already participating in the cosmos; our images need to reflect that. We are already in relationships; those are what we need to learn.

The human desire to refine the focus has neglected the frame of reference. An adaptive holocosmology would place human values within a global framework, attaining a balance of human and ambihuman nature. The sciences, humanities and other ideologies could be balanced in a holocosmology. Perhaps human behavior could be put in tune with nature through a popular literature or poetry—or music. Humanity is not aware of limits, of its inability to fully comprehend the universe. We have never made earth completely home; until we do, no place will ever be home.

We need to create a new holocosmology that can be a framework for traditional cosmologies, to appreciate the wisdom of those cultures. These cosmologies are being rediscovered; their tools are dance, song and history; they are open to nonvisual communication. Everything is vital. The consequences of these cosmologies would alter the character of modern life, making it closer to human and ecological reality, counteracting the tragic consequences of war against ourselves and nature. We do not need to inflate a traditional cosmology to use for global design. That would not work. Brian Morris suggests that the worlds of St. Francis, Buddha or Black Elk, have been destroyed by Newtonian science. He recommends an ecological viewpoint and understanding. But, no world has ever been destroyed by science. Science cannot even discourage astrology or bad eating habits. Technology has ruined many habitats and aggressive cultures have smothered many smaller cultures, but that is not an indictment of the cosmologies.

A holocosmology could incorporate an ecological perspective to address the emergent features of a local and global effort for design. The issue is not conservation versus exploitation, but an experience of the planet distinct from these two alternatives. A sense participatory rather than manipulative, a sense as presence rather than object; a universe moving in vast cycles and rhythmic harmony instead of serial stages of beginning, progression, decay, and end.

A holocosmology could justify the wide diversity in nature and accommodation to natural laws. It could even allow a deeper understanding of the utilitarian. For example, what is the use—or the beauty—of a burned forest, as related to the function of lightning or the planetary carbon cycle? The whole idea of irreversible history sanctifies behavior, making it moral. If a life or species cannot be repeated, then it is special.

A holocosmology could show our relationships and our debts to other species. By considering only humans, and inflating them out of proportion, we diminish other species, and ultimately ourselves. Responsibility considers the interests of ambihuman nature. The interests of other beings is the same as human interests: To live and experience, then to reproduce that their heirs may, as Whitehead said, "to live, to live well, and to live better."

Such a global framework for cultures would also consider important principles drawn from ecology. A holocosmology cannot be limited by the scientific facts of any science, even ecology. The insights of mystics and the wise should be included. Individual world views penetrate each other in a transepistemological process. Each mystic or scientist tells of a way the world is; together, these ways make a holocosmology. It is a framework for all truths.

The proper attitude of a holocosmology would be care, a positive spontaneity, but also a 'letting be,' a reverence toward the wild alienness of nature, a willingness to comply with the limitations of natural systems, and a willingness to reduce the dominance of natural systems and to set aside wild areas. In addition, a holocosmological perspective might define: An authentic concept of humanity, rational economic development, with respect to health, a holistic education beyond that of a native culture, a description of the responsibilities of societies to themselves, others, and the earth, and a respect for all cultures.

8.6. *Local Design Factors: Legal Protections for Ecosystems*

Political systems are impotent to stop the massive interference with the environment by corporations. The simplest and most direct way to give the local place a voice in its own development is to incorporate it following international law. The place, with its biochemical cycles and nonhuman communities, would become one legal body. Since corporations are human constructs, however, humans would have to represent the locale, with its habitats and the wealth of living organisms. For instance, we could incorporate a Hardwood Hammock (hilly area with counties and towns) in central Florida in the United States.

8.6.1. *Incorporating an Ecosystem (Hardwood Hammock, a Florida Corporation)*

In early civilizations, the advancement of the state was expected to contribute to the welfare of its people. Corporations are recent devices created by states for public purposes. Most early American corporations, for example, were concerned with travel (turnpikes and inland waterways) or safety (fire insurance)—they resembled public agencies more than profit-seeking associations. In fact, the exclusive privileges and political power granted to corporations were based on the implicit promise of social services.

The association of economic development with national wealth allowed incorporation laws to be broadened. The corporation was given the constitutional rights of an individual. A corporation is a legal entity, independent from its founders, with its own rights, privileges, and liabilities. It is, however, required to obey laws and pay taxes; and it is accountable for its deeds in courts of law.

Unfortunately, as private good became identified with public good, corporations became larger, more acquisitive, and less concerned with social services. The quest for profit now has the effect of violating social amenities, such as clean air and clean water, instead of ensuring them. No responsibility is taken for environmental degradation since no right of contract or fair use of property has been breached.

Changes in societies, from rural to urban, from sparsely to densely populated, from culturally diverse to monotone, have transformed corporations and the societies themselves. Business corporations now provide the bulk of goods and services in many states. The scale of these corporations, the processes of production, and the size and needs of human populations, have altered and degraded many ecosystems and biogeochemical cycles.

Successful modern corporations create an identity based on their purpose in providing goods or services; they define their business in terms of profitability, growth rate, cash flow, and competitive position; they develop a corporate vision, with specific objectives and strategies, including long-term vision, collection of ideas and creative implementation, aggressive manufacturing, and reliable finance.

The purpose of a corporation often transcends simple financial gain—the corporation seeks to maintain its own existence, even before profit. Financial objectives (sales, assets, and profits) exist to sustain its existence. The goals that most motivate corporate managers are survival, independence, self-sufficiency, and self-fulfillment. Yet, these motives are consistent with the financial objectives of the corporation: to maximize corporate wealth. The responsibility of managers is to maximize the value of the company. Furthermore, because corporations are long-lived, that value should last a long time—a good reason for looking beyond the ten-year monetary horizon and the lives of its managers.

Although current wisdom (Milton Friedman et al.) holds that a corporation's only responsibility is to its stockholders, corporations are being pushed to include social purpose in their strategies, again. Alas, they are doing poorly at it. They do not know how much responsibility to take, or where to put limits, or whether to pursue policies that diminish their profits. Corporations have proved spotty in doing social and environmental good. It would be more appropriate to have them deal with the environment as a corporate entity concerned with maximizing its own values. Of course, that would mean no more "free" resources or environmental services.

The important advantages to incorporating a locale are the same as for incorporating a business. (1) Managerial flexibility: the stockholders are separate from managers; responsibilities are assigned by needs of the corporation. (2) Limited liability: the corporation borrows and repays. It shields its members from hazards to which they would otherwise be exposed. (3) Financial advantage: the ownership of assets can benefit stockholders and the corporation. (4) Tax advantage: investments in the good of the corporation may not be taxed by any nonlocal government. (5) Estate planning and longevity: the corporation exists indefinitely beyond the lives of its participants. (6) Central management and representation: a large and complex business needs operational and managerial efficiency. Many of the participants have no direct voice in the operation—they must be represented.

One way to represent all voices and interests in an ecosystem would be to incorporate it. The locale incorporated would focus on a core business: To ensure the integrity and continuity of life and all its connections and to secure the opportunity for development free from undue interference. It would operate to optimize values, like any good corporation, but the values would be ecosystem values (fungus values and earthworm values, as well as human values).

A temporary Board of Directors (the undersigned) would adopt bylaws, elect working officers, approve stock certificates, open accounts, and arrange a stockholders meeting. The stockholders would elect new directors, possibly from local representatives or directly from elections, and decide on dividend declarations.

Stockholders, as citizens of the area, would turn over common and state (or regional) property to the locally-based corporation, for example, the Hardwood Hammock Corporation, in Arcadia, Florida, which would issue stock certificates to the stockholders. The corporation would allocate the purchase price of stock to capital at par value. Most of the shares—the percentage to be determined by the board as necessary to the operation of ecosystems—would be treasury shares. Anything more than par value would go to capital surplus, and only capital surplus could be distributed as dividends. Stockholders have the right to receive these dividends equitably, without resort to preferential distributions.

Stock certificates denote ownership of the corporation. Although the stockholders own the corporation, they do not own the property of the corporation, the named locale, which is owned by the corporation itself. Stockholders, as individuals, communities, or cities, could make agreements about how business would be conducted, about what resources would be used or traded.

The elected board of directors would make decisions of distribution and limitation. Percentages would be deducted from the interest for the operation of the corporation and for equitable distribution to areas less favored by chance with biological or geological wealth. Furthermore, since the dividends would be distributed among people according to net ecosystem productivity and resource availability, no advantage would be gained by areas having large populations.

The basic functioning system would be considered capital, thus limiting the amount of human use of resources and probably the size of human populations. Interest would accrue in the form of net ecosystem productivity and diverted percentages of materials, such as gold or water.

The Hardwood Hammock Incorporated would solve the problem of having to value ecosystems in monetary or quantifiable terms; its systems would be untouchable capital. The human value of resources like copper, air, or water would be equated to the technological cost of recycling or producing them.

Raw material and energy are only two facets of the capital of a corporation—another is human ingenuity. Thus, human wealth would not be limited by restrictions on the availability of resources, but rather by a shortage of ingenuity.

An incorporated system would be instrumental in conditioning international corporations to their social responsibility and in internalizing all costs. This corporation and governments could use traditional means, such as credit access, low interest rates, and setting priorities on equity issues, to evoke public interest in smaller and healthier human endeavors.

The suggested articles of incorporation are:

FIRST: The name of the corporation shall be The Hardwood Hammock, Incorporated.

SECOND: The purposes for which the corporation is formed shall include: The protection of functioning ecosystems and their living beings from destructive interference.

The conduct of inquiry into the operation of such systems and the role of humanity therein for scientific and educational purposes.

The taking of appropriate legal steps to carry out these purposes.

The maintenance of all real common property, including all lands, seas, and atmosphere, subject to the restrictions and limitations hereinafter set forth, to use only the interest from income therein, reserving the principal thereof exclusively for the aforesaid purposes, it being intended that the corporation be organized and operated for preservational purposes and not for pecuniary profit.

The corporation is organized as a voice for nonhuman beings and systems. No part of the income of the corporation, if any, shall inure to the benefit of any trustee or officer of the corporation or to any private individual having an interest in the corporation (except for reasonable compensation) and no trustee or officer of the corporation or any private individual shall be entitled to share in the distribution of any of the assets of the corporation.

The corporation shall not be authorized to carry on propaganda, influence legislation, participate in any political campaigns, or discriminate against human cultures.

In furtherance of the foregoing purposes, the corporation shall have the following powers:

To accept and hold by gift or judicial order any real or personal property of whatever kind, nature, or description, wherever situated.

To sell, transfer, or dispose of the interest from any such property, but not the principal or any part thereof.

To make, accept, endorse, execute, and issue bonds, promissory notes, bills of exchange, and other obligations of the corporation for monies borrowed for the purposes of the corporation.

To invest and reinvest its funds in stock, bonds, or in such other securities and property as its trustees shall deem advisable, subject to the limitations and conditions contained in any grant or gift.

In general, and subject to such limitations and conditions as are or may be subscribed by international law, to exercise such other powers which now are or hereafter may be conferred by international law upon a corporation organized for the purposes hereinabove set forth.

THIRD: The operations of the corporation are to be conducted in the surface of the locale but the operations of the corporation shall not be limited to such territory (and should necessarily address the atmosphere, geology, hydrology, and local cycles).

FOURTH: The principal office of the corporation is to be located in the City of Arcadia, State of Florida, United States of America.

FIFTH: The number of directors, who shall be known as trustees, of the corporation shall be not less than 3 (a minimum number associated with this locale), nor more than 5 (the number of habitats).

SIXTH: The names and residences of the persons who shall be trustees until the first annual meeting of the corporation, are:

A. E. Wittbecker, Tallevast, Florida 34270
Precious Woulfe, Bradenton, Florida 34207
Anonymous, Arcadia, Florida 34243

SEVENTH: All of the subscribers of this certificate are of full age; all of them are residents of settled places in the locale.

In witness whereof
(Signed 27 April 2003)

8.6.2. *Putting an Ecosystem in Trust*

Perhaps the form of a nonprofit corporation is not the proper approach to protect locales. Perhaps, a local property might best be represented by some sort of legal trust, as private properties have been. This might solve the dilemma of ambihuman species as well as future human generations, which require a much longer time frame than most plans. The Sweet Beauty Strawberry Farm has a third of its property planted and the rest in native vegetation (in the Hillsborough River watershed in Florida, USA).

8.6.2.1. Local & Regional Commons

The use of river water or aquifer water by the Farm is a good example of commons management. During the dry season, the Farm uses a large share of water, not only for the berries but to spray on them for protection from freezing weather; other upstream users, a cattle ranch and a tomato farm, also have high water demands. These demands not only can interfere with one another, they can interfere with the river, lake and aquifer, which need a minimal waterflow to provide for downstream users and to keep the hydrological cycle healthy.

Garret Hardin, after criticism of his article on the “Tragedy of the Commons,” pointed out that the problem was not common ownership as much so open access to a common without the limits of social structures or rules. Tragedy occurs especially when social structure breaks down, as in the Mayan case after 900 CE, or when the scale increases beyond the control of any local organizations, as with involvement with atmospheric and oceanic cycles. New technologies, of course, change the equation with high requirements and need new rules; power plants is an example. Overpopulation can put pressure on the commons. External corporations can put even more pressure on any target commons.

The commons can be productive where there is a common culture with rules and laws. Switzerland and its alpine pastures, or the rice fields of the Philippines, are examples. The commons needs to be under local control. Local managers know the local resources and their uses. As participants themselves, they know the numbers and needs of all the other residents and participants. The residents and cultures have to recognize that the commons provides for all equally and have to have rules.

8.6.2.2. Local Trusts

In common law legal systems, a trust is an arrangement whereby property, including real, tangible and intangible property, is managed by one person, or persons or organizations, for the benefit of another. A trust is created by a settler (or trustor, grantor, donor, or creator), who entrusts some or all of his or her property to people of his choice, the trustees. The trustees hold legal title to the trust property (or trust corpus), but they are obliged to hold the property for the benefit of one or more individuals or organizations as the beneficiary (aka cestui que use or cestui que trust), usually specified by the settler. The trustees owe a fiduciary duty to the beneficiaries, who are the "beneficial" owners of the trust property.

The definition of a trust allows it to maintain an asset for future beneficiaries. For example, the Pacific Forest Trust protects private forests from clearcutting and development, through conservation easements that limit the kind of use that might harm the ecosystem. Private landowners can harvest some trees sustainably. The Marin Agricultural Land Trust buys development rights to farmlands. The Oregon Water Trust restores water flow to endangered streams by acquiring water rights. In each of these cases the owners hold the land and can benefit, within limits, from it. A Sweet Beauty Strawberry Farm Trust would protect the land, with all its nonhuman residents as well. Possibly, the local commons management could address regional and global interactions with the atmosphere and biogeochemical cycles.

8.6.2.3. Establishing a Trust

The trust is governed by the terms of the trust document, which is usually written and in deed form. It is also governed by local law, although it could be governed by some new global law. There are a few basic principles for a trust: Property of any sort can be held on trust; the uses of trusts are many and varied.

Trusts can be created by written document (express trusts) or they can be created by implication (implied trusts). On a global scale, the trust would be created by one of the following: (1) a written trust document created by the settler and signed by both the settler and the trustees, and this is often referred to as an *inter vivos* or "living trust"; (2) a court order (for example in family proceedings if it were a local trust). Due to the legal limitations of the ability of nonhuman species to communicate legally, a court order might be the best way to set up this trust.

There are formalities for establishing a trust. Generally, a trust requires three certainties: (1) Intention; there must be a clear intention to create a trust; (2) The property subject to the trust must be clearly identified. Trust property can be any form of specific property, real, personal, tangible, or intangible. In local trusts, for example, it may be real estate, shares or cash; and (3) The beneficiaries of the trust must be clearly identified, or at least be ascertainable. In the case of discretionary trusts, where the trustees have power to decide who the beneficiaries will be, the settler must have described a clear class of beneficiaries. For this trust, beneficiaries could include any living beings alive or not born at the date of the trust. Alternatively, the object of a trust could be a charitable purpose to be held by another concerned organization, such as The Nature Conservancy, rather than specific beneficiaries.

A Trustee can be either a person or a legal entity such as a company. There can be multiple trustees (there must be a minimum of two for a trust, usually in relation to land. A trustee can have many rights and responsibilities, which could vary from trust to trust depending on the type of the trust. A trust generally would not fail necessarily solely for want of a trustee; if there is no trustee, whoever has title to the trust property will be considered the trustee—in this case the Farm owners. Otherwise, a court may appoint a trustee. Trustees are nearly always appointed in the document (instrument) that creates the trust.

The Trustee has a huge responsibility. She may be held personally liable for any issues that arise with the trust. There are two main types of trustees, professional and non-professional. Liability is different for the two types.

The trustees are the legal owners of the trust's property. The trustees administer all of the affairs attendant to the trust. This includes investing the assets of the trust, insuring trust property is preserved and productive for the beneficiaries, accounting for and reporting periodically to the beneficiaries concerning all transactions associated with trust property, filing any required legal documents on behalf of the trust, and many other administrative duties. In some cases, the trustees must make decisions as to whether beneficiaries should receive trust assets for their benefit. The circumstances in which this discretionary authority is exercised by trustees is usually provided for under the terms of the trust instrument. It is then the trustees' duty to determine in the specific instance of a beneficiary request whether to provide any funds and in what manner. By default, being a trustee is an unpaid job. However, in modern times trustees are often lawyers or other professionals who unwilling to work for free. Therefore, often a trust document would state specifically that trustees are entitled to reasonable payment for their work—perhaps an amount equal to the average income in the area.

The beneficiaries would be the equitable owners of the trust property. Either immediately or eventually, they would receive income from the trust. The extent of an individual beneficiary's interest depends on the wording of the trust document. The settler has much discretion when creating the trust, subject to limitations imposed by law.

The Trust could be a protective trust, since there might be inheritance or debts. The idea of charities might not apply well to the Farm, since every being is endowed with life and some skills. Asset protection sounds like it might be useful, with the possibility of divorce between owners or gifts to creditors. The local trust could have elements of a constructive trust, since it would be imposed by law as an "equitable remedy" against those holding the assets as a matter of luck or discrimination. It might resemble a unit trust, in the sense that all beings would possess a certain share of the interest of the land. A public trust might serve best; it would have the object of protecting the planet and keeping it healthy, as the source of most capital. In general, a public trust (also called a charitable trust) has some charitable end as its beneficiary. In order to qualify as a charitable trust, the trust must have as its object certain purposes such as alleviating poverty, providing education, carrying out religious purpose, *or protecting the land*. Charitable trusts are entitled to special treatment under the law of trusts and also the law of taxation.

Co-ownership, as a trust, could be divided between species first—that is, the ownership of the home land is shared by all living beings, and all living beings should have some legal representation. If it were a hybrid trust, the amounts of the trust interest could be paid out at the discretion of the trustee; this might be used to settle long-standing grievances and inequities. It could resemble an incentive trust, in part, because it would encourage some behaviors, such as inventiveness and frugality, and discourage others, such as waste or inequity.

Obviously, there would be many benefits to setting an ecosystem up as a trust. The greatest benefit would be legal protection of many areas for ambihuman species. In fact that would be a major purpose of a trust. A second major purpose would be to equalize the income from interest so that it would be divided equally among participants.

8.7. ***Wild Design: Creating Local Designs***

We have had great success designing toasters and pencils. We have even had some conscious success designing parks and forests, but for the most part, designs, especially of cities and regions, and of humanity itself, have been aggregated or assembled from all of the small individual and group decisions. They often do not work well together; they do not work well with ecosystems and biogeochemical cycles. In fact, sometimes they disrupt local politics or interfere with local systems and cycles.

8.7.1. *Designing Cultures & Continuous Turning*

Cultures were assembled out of sets of behaviors that worked in specific environments. Although a few cultures developed behaviors that did not adapt them to their constraints, many worked well for thousands of years. Most cultures do not consciously shape their actions and behaviors. Less fitting behaviors simply drop out. Behaviors that worked were repeated.

Design has to consider culture. Cultures are adaptive mechanisms that can change quickly that can embrace new courses under threatening circumstances (even if the threats are slow, invisible, large-scale, long-term threats). Human society has been getting more complex, and many actions are now global. Culture has to control the impulse to irrational, selfish or violent behavior with cultural rules. With the awareness of connections and greater ways of cooperating, people can control their behavior. The new technologies of communication and calculation, of observing and trading, can help the management of global commons, to combine conservative ways (of living frugally) with high-technology improvements of energy, food production and waste.

What kind of culture could we design? Can we go back to hunting and gathering, foraging, and fishing? Some of those cultures remain vital. We could set aside areas to reinstitute that kind of culture. Obviously, foragers are much more flexible in terms of movement within their territory. If territories were extended north and south and upland, then threats from climate change would be minimized, relatively speaking. Can we design a cooperative transition to a network of eutopian nations? Can we design new global human group norms? That is, can we incorporate new behaviors into a culture consciously?

Design needs to consider the entire frame of human history, to recognize that anthropogenic environmental change has resulted in catastrophes to some human cultures, and that those cultures disappeared or were radically altered (usually simplified). Design will have to consider the size of the human population, and show ways that the populations can be lowered to those indefinitely supported by ecosystem limits.

Design can present visible limits on the size and consumption rates of the human demomass, as a global phenomenon, then suggest ways for us to respect those limits while still producing enough material food and goods for human needs. Many of these limits will be global as well as local, so the local will have to be defined as a percentage of the global. Should we design for a maximum of local inventiveness? Or a maximum size to be sustained?

We can affect the cultural uses of materials and energy. Design can create soft energy paths to reduce the dependence on fossil fuels, Amory Lovins argued. It might consider the hard technology of nuclear fission or fusion, if standards for safety and continuity can be set and met, as James Lovelock and others have urged. Certainly soft energy paths can be used to reduce use of fossil fuels. Conservation alone could cut demand by half or more. Otherwise the immense flows of renewable energies will cause additional problems. Part of the problem of energy use is that too much energy is put into the system, which did not develop to handle so much energy. Although technical expertise can provide new sources of energy, it has to be combined with limited use.

We need to design or redesign every physical aspect of a culture from size and behaviors to buildings and transportation styles and grids. Design can reduce demands on energy and materials through vernacular building designs. These designs could also reflect important parts of tradition and channel desired kinds of behaviors. People have to be convinced to forgo doing everything that is wanted or possible. This is a moral consideration, and design has to suggest ways that a culture can convince its members to want to limit their use and its impacts on other species.

8.7.2. *Coevolution of Design and Wildness*

Design should coevolve with wild nature (or xemes). Local ecological design has to evolve with its context. Thinking ecologically makes us aware of interrelationships. Design recognizes these local processes in their regional and global matrix. Design is a primary element to stimulate possibilities for human creativity.

A framework for design can work at any scale, from a small building, at one end of the scale, to preparing an urban design framework for an entire planet (or possibly solar system) at the other. Models at global scales may be insufficiently realistic. That is why we need local designs, to hang on the design skeleton (a framework). The Potsdam Institute for Climate Impact Research, for instance, is constructing a unified, global-scale model that is tractable and isomorphic. It employs one set of quantitative functions to describe all human impacts, all human adaptations to environmental changes, and all impacts of environmental change on humans—this is where design is important, to limit or modify those impacts with an adaptive kind of design. Within a framework for planning, we need to be able to accommodate the unplanned and the unimaginable. The framework will be incomplete; it will lack detail and definition, but it can be used by all the participants to coordinate actions within physical, ecological and mutual constraints.

8.7.2.1. Wild Design

Thoughtful rational design works well with many kinds of tools and buildings at a small scale. It may not work with wild systems on a local scale, much less a global scale. Human agency may be limited, but it could incorporate into its design natural processes that could be effective at the planetary level.

Design works out challenges and problems in an artistic way. Art is wild. We cannot control the effects of art, or even anticipate all of them. We cannot anticipate the changes it might make. That artistic way is a wild way of thinking and can mesh with large-scale design better than a simple technical approach. Design needs to become wild. Wild design is not human-centered, as most all design in the past has been human-centered. Wild design is based on radical ecology (Wittbecker 1978)—it is the push, beyond human interests, to consider the character and patterns of ecosystems. Not to subvert or interfere. We can guess what the system 'wants' or how it is developing with reference to its past behavior. Well, we know what it wants: To exist, to regenerate. We need to create the conditions for the system to flourish. And, if we use any of it, that use has to be limited to that level of productivity that does not interfere with the survival of the system. We are reintervening in a natural system at different levels, rather than using or interfering for human benefit exclusively.

The word design is modified in this sense to be power with natural processes, not power over them or control of them. Wild design is a conversation across time. We listen, ask, and contribute. We inscribe human stories on the larger stories of the system. Participating means living in the systems. We can reciprocate by giving our bodies back to the system. It cannot hurt also to give our minds to the shape of the system. It is knowing what not to do, as well as what to do, when to do it and where, if we do it. The future is already connected with the past through the present. It just gets complex and unpredictable away from the present. Too complex.

Wild design has to be heroic, especially due to the scale of working on an ecosystem or larger level. Heroic design and extravagance in life is needed (within the limits of scale and connection). It is not contradictory or antithetical to frugal lifestyles or to restoring a healthy environment. Life is exuberant; energy is used, lives are lived and used, not saved. Wild ideas are needed for monitoring natural systems, for closing local loops in energy or matter, for working in closely linked webs, and for initiating connections and collaborations. Our cultures, made more intense in cities and by technology like the web, can be the incubators of new forms of wild design.

8.7.2.2. Restoring Balance

As the natural balances are upset by human settlements, the settlements also suffer. C.A. Doxiades noted the need for ecological balance. He suggested a scientific analysis of such a balance to replace the luck, and trial and error limits (or as Buckminster Fuller states, the "trial and error error error"), of traditional and modern cultures. But, we cannot wait until we learn, or become too large and entrenched to adapt.

To achieve an ecological balance, we need to set goals for each kind of ecological spaces. We need additional concepts and goals for the overall system, also, to have the local ones make sense. We also need to have a global coordinating body like the UN to design and implement a global ecological balance. And, at a regional level, nations and communities can go further balancing regions and local system. Design will have to balance the gains and losses on a local scale. It will have to do it in an equitable manner, with attention to past and current inequities between cultures and peoples, between regions and economies.

Obviously, redesigning local systems means redesigning human structures, paths and influences. Trying to change the patterns of consumption to conserve the capital of nature. Trying to limit human influence. Trying to contain human mass to a limited area of a local system. Simple conservation makes the most sense, as we just reduce the flows, and have less to bury or deep-place in the ocean, or to avoid with solar screens or aerosols. Efficiency alone promotes more consumption; therefore conservation must limit quantities and uses as it promoted more frugal and fair styles.

We can create thought experiments for all likely situations. We can create possible scenarios for dealing with them. We can create ways to reduce possibilities for disaster or collapse. We have had catastrophes. We may always have them. Bacteria and earthquakes are part of the entire system, as are asteroids and irrationality. And, we have adapted to change. We can adapt to almost anything, Rene Dubos worried, from overcrowded slums to a desert hot world. Design has to define and refine desirable goals and paths. It makes no sense to aim for or accept a minimum of existence or expression. These approaches will be the best way to reduce the patterns that may influence global warming, extinctions, and ecosystem conversions. And, they may lead to better places for human beings as well.

8.8. *Designing Places Politically*

Humans have never designed complete ecosystems. They have never designed cities, cultures or nations, either. Basing designs on traditional cultures and on the properties and limits of ecosystems should make such designs useful. Any design also would have to consider political functions at the appropriate levels—personal, community or nation—and maybe regional and global as well.

8.8.1. *Community Responsibilities*

The community (and maybe nation) is experienced on a smaller frame of reference than global unity or groups of nations; people live on the local level. Local knowledge is knowledge in place, earned in place by generations of inhabitants, through visions and trials, experience, and stories. Thus, individuals are preserved in societies that are preserved in places that are preserved by individuals and societies. Laws, politics, architecture, sports are things of place. They are shaped with local knowledge. A local area is limited by the limits of vision, a horizon. As protectors of place, communities have five explicit functions.

8.8.1.1. To Conserve Local Ecosystems and Places

Communities have the responsibility of keeping their environment healthy. Human activities cannot be isolated from societies or ecosystems. Cultures must adapt to ecosystems or watersheds to survive. All beings modify and exploit the earth to some extent. Humans do. For successful, long-term exploitation, however, power must be limited and density controlled. A human ecology must provide each living human being with a satisfactory environment that must be in equilibrium with the rest of the system.

8.8.1.2. To Manage Local Resources with Appropriate Technology

Every community has the power to use its local sources in any manner, within the limits of regional and global damage and pollution set by international rules. Every community has the duty to conduct activities in a manner respectful of their effects. With information available now, from a more extended resource inventory and with optimal ideas about renewal, climatic conditions, traditional land-use patterns, local cycles, and ecological requirements (limits), conservation activities are more effective. The goal is to support a steady state economy within optimum ranges based on natural and human limits. Every community that claims sovereignty must accept responsibility for keeping its population within the ecological limits of its place—that is, within the carrying capacity. Technology can be used to increase carrying capacity to some extent, but not infinitely. Although, technologies tend to homogenize people and places, the same technologies may be used in different ways, especially adapted to local requirements, for instance, the use of tin cans as cases for radios.

Heterogeneity is beneficial to all countries; it enriches the cultural resources, provides niches for individuals, and supplies many patterns that may be adapted. It also increases the speed of cultural evolution or the richness of exchange. A community could promote appropriate technology for its place. Dangerous technologies would be reduced through wholesale substitution, if not of materials, than by labor-intensive solutions. Traditional housing, for instance would be preferred; its form and design are integrated into the culture, it is adapted to the local climate and is usually less expensive, due to use of local materials. Much traditional architecture is authentic and unselfconscious; its forms fit the context of place and develop in response to place. With arcologies (the urban ecologies designed by Paolo Soleri), the city can change its relationship with nature; an arcology is a good solution for an urban culture, as it solves the problems of waste, resource-use, scale, obsolescence, and segregation.

8.8.1.3. To Maintain the Health of Cultures & Individuals

Traditional cultures provide personal security, respect for the individual, responsibility for actions (self-discipline), social integration, concern for others, and reverence for nature. Traditional social structures, with networks of marital relations, inheritance, and rationalizing myths, are closely adapted to the local environment. Preservation of identity appeals to qualities inherent in established ways and to people's desire to maintain their distinctive customs against change. There are also esthetic reasons for preservation: To preserve styles, merit, and achievements. Ethnic identity and consciousness of gender make finer grids of groups. Devotion to groups, clubs, corporations, teams, co-ops, can provide a better individual identity. Distinct cultures allow different frames of accomplishment. The sum of cultures provides a greater sum of accomplishments. Cultural identity is necessary to the benefit of places. Nations educate their members; they are responsible for the imagacy, ecolacy, numeracy, and literacy necessary for individual survival and actualization within the culture. The emphasis would be local: Local culture, history, geology, botany, and economics. But, it would be grounded in the regional and global. Cultural education should not emphasize competition or excellence for economic or political purposes, as is so often done in industrial cultures.

8.8.1.4. To Provide Power for Individuals (Political Self-rule)

Politics can start at the community, over community issues, like housing, transportation, or pollution. People need to save their own identities and places first from corruption and degradation. Power can be shifted to local levels through self-reliance and participation. The function of politics is to ensure that decisions are taken at the right level. A community protects individual freedoms, guards regional culture (values and identity), and holds groups accountable for their use of power. The size of Communities (as well as of nations) would be defined by place and culture. There can be no separation of politics and ecology. Every political act has ecological consequences and every ecological decision is a political demand for control over use of the environment. The political restriction of freedom, either through tyranny, cultural uniformity, or crowding, results in a decrease of variety, which is created by spontaneous play, which is necessary to flexible and enduring social systems. It is not necessary to prescribe forms of government and administration for peoples.

Many forms of government that are size-specific, such as democracy or communism, could be possible in scaled communities or nations. Although the smallness of cultural units would not guarantee freedom, with a smaller scale tyranny and the tyrant are visible and corrective action possible and more likely. In a eutopian approach, groups may pursue anarchistic isolationism or disinterested inter-republicanism. What matters is not perfection, but the basic value orientation of the polity. The developed countries may prefer Jefferson's republican simplicity to Hamilton's national power and commercial complexity; other countries may prefer Gandhi's vision or Marx's communism. China or Greece may provide some alternatives; others may be invented. The logic of individualism creates conditions that require constraints. Politics has to make them palatable. Although we realize that nothing in nature is without some limit or cost, we may dislike giving up what we now consider (wrongly) as rights. Some nations may have to accept that they have too many people, wanting too much, and that we have to change our wants and numbers to achieve them. People may have to expect much less than they want, though expectations are rising. Planning and regulation does not necessarily reduce individual freedoms, certainly not as much as poverty and crowding.

8.8.1.5. To Provide for Needs of the Individual (Economic Self-reliance).
One necessary condition for the preservation of finite resources is sovereign power. To share resources without the discipline of power invites a tragedy of the commons. The limit of sharing has to coincide with the limit of sovereignty; otherwise runaway destruction could result. Every community or nation has the responsibility to conduct its economy without causing damage to its ecological base or to that of others. Environmental risks and damages must be identified and solutions found before economic processes can be implemented.

Every community strives for self-reliance. Communities can be self-reliant by producing enough food and shelter, by limiting their population to what can be produced, by sharing tools, by recycling and repairing, by using handicrafts rather than manufactures (shoes, furniture), by using local products and raw materials (soil, minerals, plants), by using general and not specialized machines, by having multipurpose factories, by networking with other communities, and by doing without things that are not needed (bombs, food additives, plastic bottles). Food would be produced and available within local groups, so there would be no reliance on large-scale food production and distribution. Local production would eliminate transportation cost and waste and diminish dependency.

Many leaders of nonindustrial areas have attempted to reduce links with over-industrialized areas (with varying degrees of success). They have attempted to balance population and resources on a local level; they have placed local values before international ones. Julius Nyerere in Tanzania promoted an African socialism. Mao Tse-Tung placed the peasant before the urban dweller in China. For India, Gandhi envisioned a familiarization of society, where property had a common ownership. Each village was a complete nation, independent of its neighbors for vital needs, characterized by self-rule and self-restraint.

Community control would mean the localalization of transportation and communication, the administration of social services by a smaller and more responsive bureaucracy, and the resurgence of more direct forms of economic interaction, such as labor-gift and barter exchange in local neighborhoods. Nations could coordinate worker controlled industries and producers cooperatives (forged from kinship or cooperation). Credit unions and mutual insurances could replace big banks and insurance companies. The nature of work could change with a change in scale; it would be self-determining and nonexploitative, resulting in greater harmony between worker and employer.

8.8.2. *Individual Responsibilities*
The planet is experienced on a smaller frame of reference than global unity or nations; people live on the local level. Local knowledge is knowledge in place, earned in place by generations, through visions and trials, experience, and stories. Thus, individuals are preserved in societies that are preserved in places that are preserved by individuals and societies. Laws, politics, architecture, sports are things of place. They are shaped with local knowledge. A local area is limited by limits of vision. The individual has rights and responsibilities. The individual is the basis of decision. Each individual has responsibilities that cannot be evaded or given away.

8.8.2.1. To Cultivate the Self
Each individual is responsible for her body, for her health, and for the direction of her education. An individual can achieve self-realization through participation in place, that is, home. Education is a life-long project, involving the investigation of and respect for other points of view. The idea of a right to health and education is less important than the moral obligation to preserve one's health and to educate one's self. The possibility of transformation and peace

stands or falls on the success of the realization of the individual. The individual is responsible for the style and simplicity of his life and for its effects on nature and society. The individual is responsible for being tolerant of others, and is free to choose cultures, mates, or places.

8.8.2.2. To Find Good, Meaningful Work (Buddha's right labor)
Every individual should choose work that is interesting and positive, using proper technology and recycling waste. Work should be respectful of resources, foster a cooperative approach to economic problems, and promote self-help and self-sufficiency.

8.8.2.3. To Practice Simplicity
Individuals should share with others, practice stewardship of domestic landscapes, and be frugal. Simplicity also involves not interfering with self-governing nature (in general) and not imposing one's personal morality on others. Physical enjoyment and cultivation of the inner life are valuable. The desires for superfluous material goods, for praise and power, for moral superiority and fixed opinions, are less valuable. The manifest goal of all activity could be the attainment of felicity, a subjective state. Meaningful satisfaction comes from enjoyment rather than the consumption of commodities: Walking through a forest, listening to birds, enjoying flowers, watching sunset, without destroying any of them. One goal, shared by all living beings, is richness of experience. We must minimize the destructive results of our participation in the process. Choosing for oneself involves knowing an ecology, knowing a politics (being astute), and protecting what is valued. Simplicity can be carefree and joyous, without being a form of self-punishment or asceticism. Each person has the responsibility to change the self, to abandon behavior if it is inconsistent with acceptable practice. Every person has an obligation to make the world livable, not only for themselves, but for other beings.

8.8.2.4. To Share in Governing Process
Individuals are automatically involved in government and change; they must focus on local political efforts. Everyone should work to decentralize and debureaucratize institutions; work to make laws to equalize representation, encouraging the poor as well as the highly privileged, who are less likely to accept far-reaching changes, to participate; work to create new goals and purposes for society; and offer services to others, by volunteering for civic groups and challenging discrimination and prejudice.

8.8.2.5. To be Peaceful
Individuals should practice nonviolence (Gandhi's lesson) towards people and towards the ecosphere. One should be vigilant against military intervention, practice conciliation, and resolve differences face to face. Individuals could try to deinstitutionalize legal confrontations by taking responsibility for communicating and cooperating.

8.8.3. *Considering a Realistic Argument*
For most people in agrarian countries, even freedom from hunger and sickness is utopian. For most people in industrial countries, the choice of a fulfilling profession is utopian. Grinding poverty, economic dislocation, homelessness, are more painful than a transformation to a new eutopian order would be. Already most cultures have been transformed by cash crops, mining, tourists, highways, high-rise housing, and condominiums. These changes are almost always as unsatisfactory as they are dramatic.

Industrial cultures have replaced older patterns with great suddenness. A new local government cannot seem more sudden or upsetting than the loss of a home or place. Industrial cultures have reduced people's control over the means of production and power. A new local framework would not offer less control. Whole communities have been destroyed by industrial scale. Our social structures are already changing rapidly and impractically. Let us just make the changes conscious and more practical. An ecological design framework would offer movement towards common, achievable goals. Its variability would insure that we could reject any of the local visions that fail. There will be questions regarding the breakup of political patterns into more natural cultural divisions. Some will want to decide boundaries by ecosystem; others through culture, watershed, or political power.

There will continue to be problems. Cutting trees in Nepal will continue to cause floods in Bangladesh, and floods will continue to cause deaths because overcrowding has forced the poorest people to live on flood plains. The poor in the highlands everywhere affect those in lowlands, often adversely. The quest for ecological balance means that some ecosystems must be maintained by systems managers, who often overmanage. The larger the human impact, the more control is necessary.

People cannot be given material equality instantly. But, things can be leveled within a culture; cultures with excess may be taxed by regional or global bodies. Providing work for everyone is one way to narrow income differences. Communities, and families must provide the work. Worthwhile work requires imagination. The large work force employed by military contracts in industrial countries will be dislocated at first, but that employment is supported by taxes, which could be reallocated for construction and deconstruction of the many local highways, manufacturing plants and abandoned buildings.

Crime and civic unrest will not disappear. A regional rule could reduce many kinds of victimless crimes with new policies. Because most cultures have strong policies regarding drugs, abortion, and prostitution, among other things, any larger framework would not impose rules on every crime. Dangerous weapons, from automatic guns to tanks, and dangerous products, including nuclear reactors and biocides, would be strictly regulated.

People will still choose badly in a new situation. But, if a form of government is bad or ineffective, they could alter it more easily. In a new local form, people can learn from mistakes or unintended side-effects—as when doing good causes evil. The scale is small, so the catastrophe is small. There will always be some injustice or unpredictability. Large political and economic institutions have only made it worse. If a local union or regional organization turns out not to be the proper way to solve these problems, it might lead to a better way.

People may object to giving up too much or not gaining enough. Natural environments and human societies are wobbling. Opposite impulses are leading to imbalance; some communities or nations want to consolidate powers and others want to secede into independent units. Human civilization will tear itself apart unless we slow it down and direct it.

The need to maintain our comfortable status for as long as possible, fatalism that nothing can be done or it is too late, prejudice, ignorance—all are keeping us from moving. There are other unnecessary reasons not to move: Failure of knowledge, failure of communication, failure of imagination, and failure of nerve. Much human suffering is caused by self-deception, which leads to isolation and then anger, reaction, and more suffering. Real change is difficult in this state, but change is more difficult for people who are starving or oppressed.

We need to address the inadequacies of the present system and pursue a drastic system change from the institutional gridlock of elitism, but not so drastic that the feasibility of acceptance is too low. The benefits must be worthwhile to justify the costs. The benefits cannot be vague and unsatisfying when the costs are immediate and painful. Communication and education must prove that the benefits exist, so that the alternative can be developed. It must be a participatory movement, and it must appeal to a large segment of the local society. Since not all interests will be satisfied, there must be opportunities for transformations or for alternate paths.

We have to invest and cultivate our inheritance. We must enlarge our human identity, to include other beings and the earth, to include our own posterity and its image of the future, without which we lose the will and capacity to solve problems. Creating the future is necessary to maintain the present. It is meaningful to construct a world that we will never live to see, to plant trees that take two hundred years to mature, to save some of the forests and soils—not for the oil and timber elite or even for the backpacking elite, not for social abstractions or for personal profit, but for our heirs and the other beings we share the planet with. The best way to accomplish this might be through a eutopian framework.

8.8.4. *Local Eutopian Actions*

To avoid fanaticism and violence, Karl Popper has suggested that utopians should try to build an open, progressive, partially planned society, instead of a finished, closed, completely planned society. Indeed, this is how general systems theory would describe a working, successful society. Such a utopia would accept the imperfect nature of humanity and the changing ambiguity of nature. A utopia has been a dream of reason. What is needed is an immediate, comprehensive approach to this situation—not a utopia of past or future no-places, but the other, less-known meaning, eutopia, a way of designing good places. Eutopias is the dream of small traditions and communities, reasonable or not. Utopias are the inventions of great visions—Eutopias are the inventions of small, good actions; perhaps later there will be enough time for greatness. Where an imagined utopia offers revelations promising a desired future, eutopias offers references from selves and cultures for producing good places on earth now. There is no mechanical prescription for making good places; there is no blueprint or timetable. The current political institutions have not created good places; the market has not been able to create health and equity; even radical ecologists have not been able to create a way to conserve and preserve wild systems—Eutopias is a fourth way. It is not an institution that benefits only the rich; nor is it a schedule of temporary handouts. It is a plan for a framework for local self-reliance and global exchange, that is respectful of traditional cultures and ecological networks. So far, there is only the idea or poetic image. The will to power starts in the will to imagine, and then to speak and become. What is our moral responsibility for this power? We can choose to alter our world with new images moderated by new ideals. Eutopias should offer knowledge and power with charity.

As a framework, Eutopias is a paratraditional nostrum for preserving what is good and useful in human cultures and sciences, and for reserving what is necessary for nature to keep regenerating itself, while addressing the cascading problems of the modern expansion and development with an emergency approach. Eutopias is a practical framework for allowing the creative anarchy of traditional-size cultures to be able to implement appropriate technology to deal with their resources and with other cultures through a revitalized and empowered international body that has the power of taxing global resources and properties for its own support, as well as the power to disarm and neutralize the unhealthy influences of large nations and corporations. Eutopias is a framework that limits human expansion to domestic and artificial areas, by specifying responsibilities and duties, while permitting the free operation of nature on the majority of the planet. It saves neopoetic areas and reserves wilderness. It encourages respect for natural and cultural capital. It recommends recognizing limits and planning for them using an ecological perspective and a metaphorical approach—it is metaphor-based as well as science-based, and limits-based as well as culture-based. Eutopias is concerned with saving human cultures and the environments that human cultures have come to fit in comfortably.

Eutopias fits in the traditions of human thought. The approach is both descriptive and prescriptive, which allows people to interiorize the system and appreciate the details. Eutopias is a thought experiment to apply real alternatives, derived from the baseline of cultural experiences, to the problem-ridden monolithic applications of industrial civilizations. Local and global issues would be differentiated; the myths of global communities and one-world people would be explained and discarded. Pretending to be a world people is a mistake based on a misunderstanding of human limits. People are the products of places and cultures, of land and nations.

The eutopian framework is more than is a simple perspective; it is a design for a self-renewing process using proven cultural methods to improve human situations and environments. The frame is not a final goal but a way to allow the many small useful, culturally determined (or limited) changes that we need for our survival on the planet as we like it. Eutopias is a cheap solution because it uses the parts already in place. It is within reach of any people in any culture, regardless of how fast or technological. And, it limits the ways of big, expensive solutions. Eutopias is not a big law, but it is a big story, large enough to allow all other stories. It is changing and open-ended. It is conservative, but that becomes an instrument to create peace and justice everywhere. It keeps human rights connected with species rights and land rights.

Eutopias is a framework that holds all the other pieces of solutions and makes them part of a whole thing. It helps us to understand the whole thing, the whole set of relations with people, land, and other beings, with other cultures and the ranges of technology. Eutopias is a framework that holds many centers, beginning with the centers of different human cultures and including the centers of nonhuman communities and guilds. Eutopias addresses the whole, because the health of the whole depends on the health of the wholes that make it up—the health of wildernesses, the health of civilizations, and the health of ecosystems, that is, inhabited places that are made through living.

By being attentive to the characteristics of place, and to those of a good society, a eutopian framework can replace the industrial form with a minimum of dislocation or violence. The realistic properties of eutopias, based on real cultures living with the ecological knowledge of local places, promise the possibilities of successful implementations. Eutopias are: Grounded, dynamic, adventitious, sophisticated, complex, heterogenous, and comprehensive. These characteristics are quite different from the properties that can be observed with utopias or industrial designs. We can get to eutopias by finding workable sizes and divisions of nations, by recognizing local and global differences, by transitioning to a comprehensive one-scale (local and global) politics, by adopting a psychology of catastrophe, by taking immediate action on all scales, by balancing the ecological budgets at all levels, by implementing income from taxes (use taxes, element taxes, loss, adjustment taxes), licenses, fees, penalties, and balancing it with outgoing vouchers (medical, income, and resource) and costs.

Eutopias exists in the extended present, incorporating past traditions and future values. It would concentrate earthward (down) and inward. Eutopias is a new comprehensive philosophy to make sense of the world. A broader frame of reference is assumed. It is concerned with evolution unfolding and producing new emergent forms, not just a static description. Eutopias is grounded in environmental concerns. Its values must be proven cultural and natural values. It must develop from existing social and political forces. Eutopias is vitally concerned with the well being of society. It regards society as an organic entity, not just an aggregate for analysis. Conservation is a means to an end, which is human fulfillment in harmony with nature. Human happiness depends on a balance between needs and commodities. In a throughput process it is not possible to economize all inputs simultaneously. There are many criteria for inputs to be preserved. Options must be site and culture specific. Eutopias recognizes and preserves slow cultural knowledge. A social base may be partly developed through ecological education. Social diversity may have cross-cultural appeal. Eutopias would retain the capacity to change and innovate environments and human values.

Eutopias would detoxify state and national rivalries. Racism, sexism and ageism would lose their importance in a cooperative society of advanced communication, automation, equality, humane scale, and meaningful preservation. Eutopias is politically aware. We make political statements by the way we live. Every tradition is only one tradition among many. The higher sanity requires of philosophies and therapies is open, planetary dialogue between modern experience and sacred tradition. Eutopias requires a planning process that bridges all cultures and sciences. It must be a participatory political movement. It must appeal to a large segment of the total human society. Since not all interests will be satisfied, there must be opportunities for transformations or alternate paths. Eutopias would be a framework for eutopias, where different human experiments are tried. Its variability would insure that we could reject any of the local visions that fail.

How can we form society with an ecological perspective? By following the principles of ecology and applying them to the characteristics of good places. According to David Orr, certain design principles work with ecosystems and nations: Small units dispersed in space, redundancy, short linkages between modules, simplicity, diversity of components, self-reliance, decentralized control, large margins, quick feedback. Eutopias would allow this. Eutopias is a total reconsideration of the current pattern of technologies, cultures, value systems, and behaviors, evolving into a low-profile technological ethic suitable for a renewal of ecological understanding. It is a code for preserving those parts of the earth that are needed for renewing the holecosystem and for habitats for the billions of animals, plants and living beings that are part of the earth. It is a code for allowing fair use of that part of the earth that is human. It is a code for human equality in opportunity and worth. It is the demand for a margin from catastrophe, so that if humanity is unable to live peaceably, the rest of the earth will not become extinct as well.

To create eutopias requires a change of attitude. We have to change the framework so that we can change our minds. We can no longer have an external point of view. We are inseparable from the environment and each other, but we differentiate. Eutopias has a connotation as a panacea or questionable remedy. This is appropriate since a panacea is a cure-all, a remedy for disease, and a solution to catastrophe. Eutopias is a self-conscious panacea. It requires an understanding of the anatomy, physiology, and diseases of the body in question, now the entire set of local ecosystems and the human and wild planet. Furthermore, eutopias can: Eliminate bad approaches and actions; reduce losses, thefts, and failures; integrate technology and design; increase understanding of wild natures and cultures; start making good places at all scales and explore ways of governing; start making a framework for cyclic revolutions; provide paths for nations and local communities; and, promote health for all systems and inhabitants.

8.8.4.1. Seeing & Thinking with a Long-term Ecological Perspective

Groups often seek to aggrandize their own benefits with traditional violence, combined with traditional blindness to long-term consequences or negative impacts on other parts of the system at various levels. This lack of attention to scale leads to catastrophes or collapses. Every civilization encounters a risk spectrum of some kind, which may push the civilization to find new increases in food or energy or may push it to collapse. The need to solve such risks pushes the system further from its original state sometimes at increasing speeds. The conjunction of long-term risks can be called a crisis. Human communities often begin by adapting themselves to the dynamics of the environment. Over the long term, however, they modify these dynamics to suit themselves. They appropriate the environment by reducing its complexity in exchange for the increasing complexity of their societies. There does not seem to be a way to return from complexity. In this sense complexity is a trap. People cannot stop investing in knowledge and the system that they have modified. Yet, collapse could be avoided when ecological issues are addressed over the long-term.

8.8.4.1.1. Thinking Short-term Leads to Collapse

The earth was white with salt, so that even barley would no longer grow in Mesopotamia by 3800 BCE. Salinization was a relatively slow process that became a problem over the long-term (hundreds of years). Many processes, such as salinization, are long-term problems and do not become evident for several generations. They are also very difficult to reverse. For a society than needs surpluses to continue, with growing dependents and growing people, there is little flexibility to change. The only way to avoid the problems was to let the land be fallow for long periods until the water table fell. This strategy was impossible due to food demands.

Many nations still rely on irrigation, despite problems with salinization and pollution. Pollution is a symptom of imbalance and improper resource utilization. A serious problem is our lack of understanding of the extensive, long-term effects of pollution on the soil or on the atmosphere. More recent technologies have found ways to separate out valuable components of waste. Others have found ways to neutralize toxic wastes with chemical treatments. But, these efforts are not keeping up with new forms of pollution. There is minimal reorganization to deal with pollution.

In this age of reorganization, Simon Chew considered the chief implications for the environment. He suggested that reorganization is a long-term mechanism of self-organization in the system. He said that concentration is corrected by forces generated by the stages of reorganization—perhaps ‘rebounding’ might be a better word than reorganization, due to the problems that imbalance of this age of concentration. His analysis predicted an approaching limit to urbanization and population growth, which would relieve pressures on the environment. He also suggested that modern reorganization is likely to assume the form of a dark age because of the processes of globalization.

The largest, most unimaginable part of our recent predicament is the scale of change in the past 200 years—the human ‘big bang,’ that is, the explosive expansion of the human economic and political systems. Based on cheap, abundant energy, in unique and high concentrations, machine power increased, and the factory system increased efficiencies and productivities, buoyed by capitalism and nationalism, and justified by the ethos of a mechanical nature and progress. All this led to the process and worship of growth, so that through positive feedback and ignorance (or greed), growth became automatic and uncritical. Human numbers increased 6-fold in 200 years, but the size of the economy increased 10 times faster than population, over 60-fold; and energy has blossomed 80-fold. The concentration of wealth allowed more dramatic effects on the planet with luxury vehicles, yachts and private air travel. The past 50 years has created more change than the previous 500 generations. The explosion of the big bang has propelled us past anything any human being has experienced.

There are dangers from this bang: Slow catastrophes, such as extinctions and conversions (ecosystem loss) and sudden surprises, such as dead zones in the ocean or holes in the ozone layer as a result of overfertilizing (or overenergizing or overpoisoning). Other dangers, such as human ignorance of change and uncertainty, make it hard to respond to very long-term changes (as opposed to short 2, 4 or 9-year limits).

Why are we not responding to the challenges or catastrophes? Is it because the catastrophes are effects of our civilization, and we do not recognize them? When we do recognize them, we think the same mindset and tools can correct them at some later point, when it is more convenient and politically feasible. The reality of short-term elections for temporary security tends to suppress the unpleasantries of long-term problems, such as human suffering or a chaotic planet.

8.8.4.1.2. Why do we Think Short-term?

Trading sustainability for short-term security leads to fewer survival options and less flexibility. In fact, it leads to a trap. Part of the problem is our inability to think long-term or over long, long time lines. So, we adapt to short-term catastrophes and challenges, but become more vulnerable to long-term ones. Politicians and corporations tend to be myopic, limited to their 2 or 4 year horizons. Because everyone seems focused on this horizon, it seems to be a collective trap.

Herbert Simon says we are not omniscient rational optimizers, but blundering satisficers. We satisfy our needs well enough before moving on to next challenge. We do not see the full range of possibilities, nor do we see the impacts of our immediate activities on the system. Thus, we tend to make a choice we can live with now rather than work for some long-term optimum. We do not correctly interpret imperfect information. We misperceive risk, assuming some things more dangerous than they really are. We focus on current problems, ignoring past or trends.

Stewart Brand reasons that the resulting economic crises will mean less money and attention to stewardship, but, again, this assumes the industrial model. With no long-term thinking, wars become more likely and therefore environmental damage more likely. This short-term view assumes the young are more conservative and peaceful, and the old are short-term violent.

The kind of enlightened self-interest that leads people to cooperate requires an ability to think long-term and to visualize long-term forms of systems traps, such as addiction, policy resistance, arms races, drifts to low performance, and the tragedy of commons.

8.8.4.1.3. How can we Learn to Think Long-term?

What has been mostly absent in this recent dialogue, according to Simon Chew, is a consideration of information from the long-term past for our understanding of the projected challenges that humanity faces in the future. If the long-term past is a guide, then past patterns of human choices and structural configurations made during and after a prolonged period of crisis transition can offer sets of details, alternatives and some hope for our common future.

Perhaps instances of long-term planning were influenced by special challenges or relatively long periods of cultural stability. Swedish long-term planning may have been affected by long winters; planning in Israel may be supported by the long-term goal of survival. Several longer-term plans in China may be the result of its cultural stability. Some nations, such as Costa Rica or Switzerland, have created long-term plans for conservation or village growth. It may not necessary to be rational optimizers; we can still be blundering satisficers and still consider the full range of impacts and possibilities. We can live with uncertainty and misperceive risk and still survive in a satisfactory way, as long as we understand and are attentive to the lengthy past and to long-term trends.

If we think of long-term trends in terms of growth, as cities have grown, or long-term trends of collapse, the trends do not seem sustainable for long. It may be that we can think of the current ideas of development, rather than growth, as a new switch to maturity for human progress. In other words, our species may be becoming mature and will start consciously developing instead of blindly growing. Development makes long-term thinking easier and more predictable.

8.8.4.1.4. Thinking Long-term

Long-term pressures affect life, and are often concluded by a sudden event, collapse or extinction. This seems to be the process. Nature tends to build harmony and cooperative behaviors in the long-term, by filtering out less adaptive behaviors and strategies. If we understand the dynamic interactions between human societies and their environments, from the perspective of long-term patterns and processes, then we see that nature works with pulsed exchanges, in the short and long-term, with regular and irregular patterns. Pulses have to be intrinsic to design, that is, the design has to accept chaotic energy patterns. The scale has to fit. Maybe strict conservation is the best path. Long-term solutions to water and food shortages may require strict conservation at first.

If only we were capable of long-term thinking, as well as denial and satisfactory development, we could make more effective, anticipatory designs. Design may take a long time—longer than human lifetimes. So, designing and planning has to be a long-term thing. We could start with a long-term ecological perspective, assuming traditional strengths. But could we plan the future in detail? Or should we just start the framework then shape the trends, especially gigatrends.

By emphasizing quality, ecological design contributes to long-term products and patterns. Design can make models of quality environments. By embracing ideas from ecology, design participates in a movement of consciousness, concerned with equality, diversity, and health, as well as with humane methods, and a holopoetic cosmology—and is affected by them simultaneously.

The ecological design of tools considers tools in every aspect as an extension of the human mind. Tools and things are extensions of human ingenuity. Design examines the effects, short-term and long-term, of the tools, and attempts to balance the trade-offs. Tools have environmental effects, as well as physical, biological, and cultural effects on their inventors and users. Tools have different levels of involvement, as well as levels of intensity.

Thinking in the long-term is a form of play. Although early ethological definitions of play emphasized its activity as an 'outlet of surplus energy,' later definitions enlarged its importance in learning and information gathering. For example, play is an experimental dialogue with the environment, with rehearsals, performed in a nonfunctional context, of the serious activities of searching, hunting and mating; it is behavior that functions to develop, practice, or maintain physical or cognitive abilities and social relationships by repeating or recombining sequences of behavior outside their primary context. It is activity for its own sake, where emotion and reason are harmonized. And, it can be fun, as well as useful.

8.8.4.2. Acquiring a Psychology of Catastrophe (Long-term & Short-term)

Catastrophe has its own psychology. Humankind possesses incredible scientific evidence of environmental wobble, biological imbalances, and the unfitness of many domestic species, but knowledge moves few to action. Catastrophes, on the other hand, concentrate attention forcefully. When a dam breaks, millions of people mobilize to meet the emergency. When the earth quakes or volcanoes erupt, the emergencies are met quickly. The psychological effects of a hurricane—fear of suffering and dread of loss, accompanied by exhilaration—have admirable side-effects. The definiteness of danger and the immediacy arouse women, men, and children to great heights of cooperation. People react admirably. They choose sensible directions and agree to practical expedients. War also produces relatively fast, far-sighted—if wrong-headed—policies. War is actually stimulating to many individuals and often produces a national determination and purpose that peacetime does not. War unites whole peoples in a common cause. There are times when human beings face rapid and catastrophic change without chaos. Social systems can adjust if there are popular reasons.

Immediate foreknowledge provokes a greater response than indefinite expectations: For instance, hurricanes occur periodically, but not always in the next three hours. Probably nothing will be done until catastrophes become common experiences. As choices become more important, more urgent, errors become more disastrous. It should not take catastrophes to precipitate corrective measures. Millions of people starve every month in India and Africa, and others in Europe, the Pacific, and the Americas. This is a catastrophe, although it is slow, constant, and distant, and perhaps because of that, it is neglected. Perhaps distance limits the ability of people to react to problems.

Furthermore, whole species are disappearing, and whole ecosystems are wobbling, from exploitation, desertification, and pollution. Environmental deterioration proceeds so slowly that the change is invisible, that is, until a catastrophic threshold is crossed. Those catastrophes, in places from the Tigris and Euphrates to northern Africa, seem to be long-term. The trouble with complex, self-regulating systems is that very small changes have large consequences—shifted rainfall patterns caused whole cultures to disappear. In some cases, where conditions, like drought, are cyclic, in the Sahel region of Africa, humans expand during the good times, only to perish when the drought returns. In other cases, human activities, such as deforestation or overgrazing of herds, can cause rapid climatic changes. The scale and rate makes our situation seem natural, but that is because it has been a slow catastrophe, just now approaching the threshold.

If we could precipitate a disaster psychology for slow environmental catastrophes, then the priorities and motives of people might be changed. But, how should everyone be convinced that there is a crisis? The change is so slow: Fewer eagles, fewer salmon, more people, more beverage cans. The causes are so complex, and responsibility is so difficult to assign. Unfortunately, a theory of catastrophes does not engage us. People need to feel situations before they act, and people will need to feel themselves as part of a delicate web of relationships before they act with ecological wisdom, as once they had to feel the earth was round by going around it, as lately they had to see the earth was an oasis in space by leaving it. Random, uncontrollable fate or slow, inexorable degradation causes little anxiety.

Humanity is enormously adaptable and resilient. We can probably survive most physical or social conditions by adjusting to them; for example, overcrowding and smog are acceptable in some areas. But, adaptation has its own dangers. We might become less humane, less creative, less concerned with starvation, suffering, crowding, or destruction. Our goal should not be to survive under any conditions, however difficult and unpleasant. Our goal should be to create an optimal life in an optimal environment. We need to adapt consciously to slow catastrophes. The environment is changing too fast for genetic adaptation, so our change will have to be psychological and social. Social changes can occur very rapidly when the time is right. Oil-producing nations, for instance, became financial equals of industrial countries within months. Pressures are building for radical change.

8.8.4.3. Acting Immediately to Implement Measures

A eutopian framework could be implemented immediately, although most global studies state or imply that change cannot be fast, that people cannot adjust, that social disruption would result, and that chaos would finish what ignorance and technology could not. Their most serious drawback of standard plans is the time of implementation. The first Club of Rome report claims a 20-year feedback lag. The Ecologist plan cites a social inability to adapt to rapid change; the attempt would be self-defeating. Everyone assumes the time scale remaining before collapse will be long enough for their plans to be implemented. But these studies also propose slow, long-range plans, while warning at the same time that the earth is facing imminent, drastic change. If their plans are implemented too slowly, and if the population or pollution doubles again, surpassing some unrecognized critical level, there would be much worse disruption.

A long view seems meaningless when so much suffering or destruction already exists. An immediate, realistic, coordinated program of action is needed, capable of being implemented by communities and global agencies. We must face our responsibilities directly, declaring that there is no place in a eutopian society for monopolistic and multinational corporations, for the maniacal religion of merchandise, for genocidal military establishments, for urban explosion, for state socialism, for overbearing bureaucracies, or for technocratic politic—we must act to end them. The declaration must be political, through cooperative networks or leaderless consensus, by persuasion and example. The problem of human existence on the planet must be approached without deference to artificial boundaries of states, races, or castes. Poverty, pollution, and repression are concerns of every human community. We must stand and state that nature has limits, and that we cannot have all that we want.

The application must be immediate. The crisis of exponential growth and destruction cannot be solved just after some final limit is approached or passed, or before a final exponential doubling. We must act without regard for imagined losses. We know that whole countries have lost a generation and continued. We know they have rebuilt again from ruins. We could build from recycled materials alone, so there is nothing to fear from stopping. Immediate social reforms, the reallocation of resources, and the preservation of wilderness are necessary, because of the nature of the problem; we cannot predict climatic or ecosystemic catastrophes. Substantive change cannot be delayed until academic controversies are resolved.

We need to protect places immediately. We need immediate action about economic unfairness. We need immediate, coordinated actions. Protecting my forest may not save global cycles if continental forests are cut or if the ocean dies. Time is important. The losses continue and accelerate and grow. Species die; habitats unravel. We should always do the right thing immediately, like reduce consumption and driving. Then we must also work to change power structures to favor less damaging approaches. Also, radical actions can shift the political spectrum, much like ultraconservative actions. Then the less radical can be effective. Eutopias needs to make hot triggers, the actions have to be immediate: saving kilowatts, planting grasses or food, lowering the thermostat. There are immediate fixes available. But, we need to do all of it together, because one or two steps will not be sufficient.

8.8.4.4. Acting Everywhere All at Once

The transformation must be complete; it cannot be done partially. Local political and economic institutions have to change, as do regional and global ones. Holistic change will permit the reorientation and balance of local institutions. For example, air pollution is not independent of industrial processes, transportation, and employment patterns. Communities must be of a size that their members can feel responsible for them. These changes are demanded by new situations, ecological balance primarily among them. New institutions must be compatible with these new values.

The approach must be pragmatic and flexible. The readjustment to the realities of our new intricate involvement in the whole order of nature and her ecological balance will cause social strains. Some capital of energy and materials may be wasted. Population will be matched to solar budgets or net ecosystem productivities. Production will be redirected to communal needs in transportation, housing, food, and recreation.

The changes may need to be coordinated globally, in a eutopian framework. By its nature, the eutopian frame could reduce some of the stresses of transition, the uncertainty, ambivalence, or reversion. Eutopias could be a framework for local cultures and regions, where different human experiments are tried. Its variability would insure that we could reject any of the local visions that fail. Eutopias may be called anti-human, anti-progress, anti-scientific, anti-technological, or anti-educational, but it is merely a new framework for conducting traditional human activities. Eutopias offer movement towards common, achievable goals.

8.8.5. *Working All Together Wisely*

Taking these steps would solve many of the problems addressed earlier. The satisfaction of physical and cultural needs, as a result of living in stable and small societies, would contribute to the health of people. Fitting economic costs and needs to the limits of ecosystems and monitoring the economic process would reduce wastes and pressures on natural processes. The coupling of agricultural productivity to a solar budget, and the conscious restoration of degraded systems, would contribute to the health of ecosystems. Sufficient wilderness would allow the self-maintenance of global cycles. With the increase in security, wealth, and self-esteem, human populations could be dependent on ecosystem productivities and still be diverse and unique.

With the removal of war capabilities and the equalization of wealth, the remaining issues are not the kind to incite violent passions. Disagreements over the best way to raise wheat or maintain a forest may be more easily resolved than deciding the best nation or truest religion. The death of large-scale dogmatic ideology and national idolatry could also mean the end of organized slaughter. We have to perfect the art of resolving conflict. Mastering it through social debate would free unprecedented resources to satisfy social needs. Perhaps a planetary electronic referendum would open communication. In designing the planet, everyone can participate. We can reduce the violence to nature and ourselves and transmute it to debate. That which has been hitherto left unsaid—what we want to become, what we could become-could become explicit.

Human ills cannot be cured by a return to idyllic hunting and gathering groups or to a quasi-agricultural, ecologically-caring society. There is no possibility of complete return. Most industrial nations are urban; agricultural countries pack their surplus peoples in cities. Nor can there be a return to 4th century B.C. Greece, or to 17th century China, or to 1910 France, or to any time. Many traditional cultures no longer exist; others are disintegrating under pressure from industrial cultures. Nor can there be a jump to a complete technological future, where technology transforms hydrogen into wealth for everyone.

We should not underestimate the evolutionary potential of small cultures. We can afford to 'lose control' of other cultures, to allow their variability and experimentation. We do not need more information or rules, but we need meaningful ideas. Our attitudes and feelings toward nature need to be revitalized with evocative metaphors that let us accept responsibility for the part of the earth that we build, namely human culture and human landscapes. In order to know what is important and what is valuable, we need wisdom. We can start by listening to the pragmatic wisdom of the whole planetary system, with its billions of years of running itself. We can let it organize and evolve itself to create diversity and beauty.

Detailed designing and planning of complex open systems is not necessary. Designers or planners are not in a position to attempt detailed models of future situations because many relevant parameters remain unidentified, and many of those known cannot be quantified. Plans can be made within the limits of variables, although it is not safe to be limited by lethal variables, as Gregory Bateson recognized; closeness to limits reduces flexibility, that is, uncommitted potential for change. To minimize untested conclusions, Eutopias is based on the values and forms of traditional cultures. This could allow rational planning to catch up.

Now is the time to define goals in terms of population, quality of life, and preservation of biomes. Resolving conflict through social debate would free unprecedented resources to satisfy social needs. That which has been hitherto left unsaid—the goals of humanity-could become explicit. Goals are not some final state reached once and for all time, but a horizon. Eutopias offers continuity between goals, designs, and practical implementations.

Science presents us with too many facts, yet we crave to have more. Philosophy presents us with too many values, but we hold too few. Technology presents us with too many things, but we do not know what we really need. There may be too many futures to choose from, but we can limit them to three possibilities: The fake ones, with amenities for some and cute lodges in tame wildernesses surrounded by wastes; the technical ones, with maybe a real fenced-in wilderness, and some kind of technological scheme of a world city; and a eutopian one, based on cultural wisdom, traditional forms and an ecological sensitivity.

Wisdom begins with knowledge of the larger interactive system, which if disturbed, can generate exponential curves of change. Wisdom is the recognition of and guidance by a knowledge of the total system. Lacking wisdom, we must behave "as if" we were wise, as if we had good sense (after the ideas of Hans Vaihinger and Jonas Salk). Humans have no choice but to live by fictions, as if this world is the ultimate reality, as if we are responsible for our actions. Humanity must plan for its future as if its days were not counted (or at least for several thousand years). Wisdom is a new kind of fitness. To survive, we must accommodate ourselves to the conditions of the earth.

Wisdom can be redefined as the disciplined use of the imagination with respect to alternatives, exercised at the right time and in the right measure. But we need practical wisdom, prudence, and intellectual control in virtue, in place of the theoretical wisdom taught by schools. The truths of our unique cultures and the wild earth are apprehended through myths. The poetic language of mythology can fit all the facts and values, things and images, into our hearts so that we can feel them and act upon them—so that we can make good places in regions and in the planet.

8.9. *Rethinking Design*

Historically, we humans have used our skills and images to improve our lives and places. We have used our inventiveness to increase our ability to survive and to reproduce, as well as for our comfort and wealth. We have persevered despite many challenges and problems that have killed or impoverished many people or whole cultures at times. We have survived ecosystem collapses and cultural collapses. We have survived droughts and freezes. We have survived diseases and wars of conquest.

We have used tools to changes places and some of the processes of nature. To protect our plants from insects and our towns from invasion, we have invented new technologies. We have created the possibilities of unprecedented luxuries and wealth. We have made designs for stimulation or profit, more than for safety or elegance.

But, we have failed to understand much of the detail and scale of nature. We have failed to use our imaginations for things beyond luxury or excitement. We have failed to share new wealth with most others or to share much of the planet with ultrahuman beings. We have failed to create designs that would incorporate us within the limits and cycles of ecological processes. We have failed to have the nerve or courage to try, since it would inconvenience some or disrupt the wealth of a few.

We have the conceptual tools. We have religions that bind us to cultures and places—that teach us simplicity and charity. We have sciences that allow us to learn ever more about ourselves and nature—that teach us. We have words and metaphors that can produce strong flexible images to guide our learning and decisions. We have the ability to create thought experiments and fundamental analyses of problems and catastrophic situations. We have the creativity to make ecological designs on a regional and global scale, to protect the ecological services that result from a living planet. We have the ability to expand our consciousness to include an ecological perspective of our situation. We have the possibility to share and open ourselves in a eutopian effort to balance the use of a common planet.

But, we have been seduced by our brilliance. We have become trapped by the changes we made to eating and living—by our close adaptations to agriculture and cities. We have become too comfortable in our habits and pleasures. We have allowed growth and inequity, dominance and slavery, to continue because it has become part of our perceived patterns of economic success. We have allowed intolerance, conflict and war to continue because they are perceived as unavoidable products of our success.

Now, we are beginning to recognize that the scale of problems has grown larger. We intuit that our economic styles may not be healthy or sustainable. We allow corporations to enjoy unprecedented benefits from a minimum of regulations, because we think that they are necessary to continue the growth we think we need to be prosperous and happy. We start to question whether our modern cosmology—in the image of a machine—is appropriate to understand or relate to living beings, systems, and cycles. We are starting to realize that traditional and archaic cultures were more attuned to their ecological places, and to suggested limits that allowed them to fit into their surrounding ecosystems. We are beginning to realize that the scale of our changes is affecting the atmosphere and oceans, that we are making things change out of the range of desirable conditions. We worry that the entire planet is wobbling and fragile and could change into a configuration that is not pleasant for us or for the large charismatic mammals we love—from polar bears and whales to tigers and wolves.

8.9.1. *Wild Design*

We have started to save animals and plants, species and habitats. We have started to design ecovillages and more efficient automobiles. We have started to create standards for more intelligent buildings and roads. We have started to talk about and sketch whole communities or cities that may fit into specific places. But, we are not thinking about all cities or all roads, not the large patterns that overwhelm places and movements of species. We are not paying attention to changes in scale or meaning. We are not considering some kind of economic equalization or the limits to our economic growth. We are not saving entire systems.

We need to understand the spheres and cycles that renew ecosystems. Then we need to start to redesign our activities so that they are in line with these cycles. We need to identify areas to preserve or restore as wilderness, by making sure that they are the right shape and size to continue as self-making entities. We especially need to consider forests and many kinds of animals. We need to understand the factors that may act as triggers of change: Our conversion of ecosystems into domestic lands, the use of commons, or the scale of industrial manufacturing. We need to analyze our adaptive patterns, from agriculture and technology to urbanization and industrialization, and then understand how they developed and became dominant forms of exploitation of places and systems. Then we need to redesign them for the appropriate local scales. We need to design ecological cultures based on archaic one, without giving up the benefits of some urban civilizations.

We need to rethink design, to make it ecological. We need to apply ecological design to local ecosystems, whether forests and streams or cities and fields. We need to consider the design of areas, from common areas that are used for many cultures, and where natural processes, migrations, and exploitations are allowed to continue. We need to design areas that are independent of national boundaries, where animals and plants can migrate or move freely.

We need to rethink culture, to analyze the weaknesses and strengths of traditional cultures. We need to create a framework to fit cultures with the limits of human activity as well as within the limits of ecosystems and regions. We need to redesign economics and politics through an understanding of what their functions and goals really are. We need to create adequate legal forms for human and nonhuman communities. We need a common approach, based on understanding and shared goals.

We need a wild design to solve these wicked problems. We need to be surveying and monitoring so we know enough to design and act. We need to be preserving and restoring as much as we think the planet needs. We need a wild design that is based on traditional wisdom and known operating limits to address these problems all at once. We need a wild design to actually try to create good places using all of our geniuses and strategies. Maybe advertising is a good place to start.

8.9.2. Good Advertising

Most of all, we need to make design and ecology exciting. The other day, tired of writing, I went to visit friends, who were watching a football game. They were drinking, shouting and throwing things to each other. It was nice; I got to play for a while, too. It occurred to me that only with entertainment industries is there so much technical fireworks and coordinated enthusiastic teamwork. Imagine all that energy and enthusiasm directed to appropriate technology for reforestation or the proper use of fossil fuels. Imagine television coverage of wetland restoration work with the same amount of attention and detail. Why not have a competition for the most beautiful productive forest or teams working to restore devastated city areas—broadcast by a major network?

Some have noticed that this remorseless entertainment is an anesthetic against fear, emptiness, self-searching, or death. Continuous entertainment is a kind of guarantee of health, riches, and long-life. Everything that is pleasurable, thought George Orwell, seems to be an attempt to destroy consciousness. Television seems intent on proving him correct. Ecology or design cannot ever compete with entertainment if it raises troubling questions or difficult expectations. As long as the industry can guarantee many happiness and wealth through the arithmetic of fantasy, others of us will always seem to be complainers and false prophets—until it's too late, then we will be blamed for not avoiding the catastrophes.

Good design, good ecology, ecological design, and global designs require new images and new language. Getting new images and new language to engineers, politicians, financiers, and landowners, as well as to scientists and industrialists, is problematic. Perhaps poetry, art and design can help, although they are undervalued as forms of communication, not to mention as ways of shaping and making. Business has transformed much of art and poetry into advertising, to match the style and attention span of the people in industrial cultures. Advertising, quite literally from the Wall Street Journal to college textbooks, refers to its activities as "shaping the American dream" or the World Dream. Like art, advertising creates an image of a way of experiencing. Unlike art, it limits its focus for a specific goal—profit. Like art, it mirrors us. Unlike art, it intensifies and glorifies only the positive aspects of culture, ignoring the dark, negative aspects or the complex nonhuman framework.

The simplicity of advertising is irresistible. Our environment deteriorates according to ecologists, but always improves according to economists (who require it to improve to make a profit). And their pictures are much prettier. People want to hear that it is getting better. Advertising tells them it is. People want to act stupid, greedy, and selfish, and spend the inheritance of their children on themselves. Advertising tells them these actions are rewarded. The real issues of life and death, destruction and hope, make people feel helpless and anxious, so advertising draws their consciousness to comfortable trivia.

Despite the limits of the dreams of progress and growth, of waste and stylistic frenzy, advertising, using sophisticated techniques and narrowing the focus out of context, makes the dreams desirable and irresistible. People in agricultural and hunting cultures interiorize the abstract industrial vision. African farmers are convinced to buy inorganic fertilizers, even though it degrades the soil; women to buy powdered milk for their children, even if it kills them; tractors replace draft animals in the paddies in the Philippines, even though they are costly and less energy-efficient; French winter fashions are found desirable in tropical Brazil, even if they can only be worn in air-conditioned villas. People in industrial societies are convinced that their children will be ruined without personal computers, even if they become isolated game-players, unconcerned with wildness in remote locations.

Advertising has been serving the dream of progress, but progress is leading to catastrophe, a long, slow, global catastrophe. When people experience local, sudden catastrophe, they usually respond immediately, with heroism and sacrifice, aiding the victims of earthquakes or floods, or sometimes famines. Advertising could bring to consciousness the slow catastrophes of erosion and the destruction of entire forests, and, perhaps, invoke the same altruistic responses to them.

Advertising may be the most effective means to reshape desires and reform buying habits, as well as where and how we live. Advertising presents the symbols of modern experience effectively, even if they are just the trivial ones. It could present healthy symbols equally well. Advertising does incorporate traditional values, like family, friendship, and love, although to sell beer and cereal and, sometimes, churches and hospitals. And, like art, advertising lies, although Jules Henry thought it might be a new kind of truth—"pecuniary pseudo-truth"—not intended to be believed, or certainly, proved).

Advertising is beginning to support more informational functions, such as the dangers of drug abuse and smoking. Advertising also can create values—fur coats, fast cars, dark beer, slim cigarettes are certainly recent and artificial values—but it could be used to create positive ecological values and new identities that show that our needs for prestige, esteem, and belonging can be met without stylistic waste at mindless speeds. Advertising could promote new attitudes about appropriate technology, the rights of other cultures, and the place of people in nature. Good advertising could be as subversive and conservative as design or ecology (Pablo Picasso said art was subversive; Paul Shepard called ecology subversive). Good ecological advertising could avoid confrontation with people's values and emphasize positive aspects without negative ones. A good ad could capture and carry the most self-indulgent viewer—after all, most ads do not require effort, literacy, or consciousness, just attention.

Maybe we can present images that rival the industry images. Maybe we too can speak the languages of euphemism that large corporations use to conduct their businesses of larceny and fraud. Positive images and pleasing language skills are everything these days; no one really looks for substance. The devotion to money, beauty and youth is the old focus. Maybe that could be subverted with the beauty and wealth of nature.

To work towards this goal, ecological design groups, with conservation groups, preservationists, sportspersons, politicians, and actors, could define and promote an integrative mythology as the basis for the framework of diverse efforts to protect life and the environment in the whole planet. Ecological organizations could provide a meaningful philosophical foundation, as well as coordination for other humane, social, and conservation programs. But, the approach must be egalitarian: Respect for life cannot neglect human life and suffering. The approach must be eutopian: A new cosmology cannot ignore adaptive cultural traditions that arose in place over centuries. Furthermore, in addition to formal education, groups could fund and provide re-education through the most effective means, such as advertising. Wildlife groups could spend money advertising "humane consciousness," moderation, and the joy of living—instead of just consuming or winning. Ecological design ads would be unique and compelling, simple and effective. They could present our goals and successes, the importance of our efforts to redesign out human structures to protect and restore the planet. They would advertise not a product, but a way, not for a profit, but for a dream.

8.9.3. *Learning to Love a Place*

Do we start by loving the place around us? Obviously, we can love ourselves and families and friends, even other animals and plants, but is it meaningful to say that we love a place, much less a region or the planet? Is it some sense of topophilia, or biophilia, or ecophilia? Are those labels too abstract? Perhaps we can understand them historically or ecologically.

At a personal level, early foragers became one with the animal hunted or seeds collected, to realize that they became part of you, living through you. On the other hand, when the relevant social unit was the tribe or nation, it was possible for the local mythology to represent others outside the bounds as inferior and its local inflection of the universal heritage of mythical imagery as the one, true, supreme image. The young of the group would be trained to love home and hate outsiders. Xenophobia was once adaptive; now it is anachronistic. There are no outsiders, we are all passengers, inhabitants. We cannot hold our loves at home and project hatred outward. The concept of tribe and state is growing toward an ecumene, an inhabited earth.

Our mythology has to grow also, to include the whole planet. There is no practical elsewhere anymore. A global mythology cannot afford to teach of elsewheres. It must teach of a multiplicity of cosmologies. The difference between cosmologies is not due to the number of phenomena taken into account; it is due to the difference in basic postulates of thought. The difference is not a matter of truth or falsity. Truth and falsity are meaningless for cosmologies. Primordial water is no less true than six-dimensional phase space or primordial *ylem*. No one group's image is more true or accurate than any other's. Each group views and reconstructs the world through their unique experiences and values earned in place.

During the Renaissance, Christianity became affected by the spirit of affirmation, especially with the discovery and popularization of the teachings of the Stoic and Epicurean schools: Love of man was the virtue above all virtues. Albert Schweitzer believed that even if we despaired of comprehending the phenomenal world or the plans of God, we would not need to confront the problem of life with utter perplexity, because the ethics of Jesus, reinforced by reason, lead to the 'reverence for life,' whose edict is the rule of universal love. This same reason would find the bridge between love for God, love for man and love for all creatures, and express reverence for all being, however dissimilar to our own, reverence and compassion for all that is called life. Such a foundation for morality forces the realization that when we establish gradations of values between lives, we only judge them in relation to ourselves and that is wholly subjective. How are we to know the importance of each? The principle of reverence for life rejects relativism— "it recognizes as good only the preserving and benefiting of life" he said. Individuals must transform themselves from blind men into seeing ones by following the new commandment: 'Revere life.' The quality of personal existence depends more on it than on laws and prophets; it comprises the whole ethic of love in the deepest sense; it is the source of constant renewal for humanity.

Albert Schweitzer's love was abstract, yet he did not love nature. Part of Schweitzer's dilemma came from the prevailing myth of the opposition of life and death, strife and love. Opposites are necessary conditions for each other, but unless we resolve them, they will just be alteratives to choose—often badly.

Aldo Leopold proposed a conservation ethic, dealing with the human relationships to land, plants and animals. The land ethic Leopold had in mind was a sense of ecological community between human and other species. When we see land as community to which we belong, we will use it with love and respect. Such an ethic would change the human role from master of earth to plain member of it. Predators are members of the community; no special interest has the right to exterminate them for the sake of benefit for itself.

The aim of an ethic must be harmonious with the world's population of living beings. Michael W. Fox proposes a biospiritual ethic as a unifying set of principles, ethics and values that could bring about a nonconflicting state of one earth, one mind. The ethic is based on the biological fact that all humans and living beings are kin and that life is spiritual—love is stronger than violence. It arises from seeing humanity in an ecological perspective (and from knowledge of evolution).

Other modes of knowledge must be accommodated along with science. Theodore Roszak proposed to define true knowledge as "gnosis"—Gnosis is used in a generic way here, not the way the Gnostics used it—of which scientific rationality is only a small part. It is gnosis that is needed to perfect the universe and soul, mutually, with the spirit of love. Gnosis is the whole spectrum: The hard, bright lines of science, the hues of art, and the dark voids of religion. Gnosis is augmentative knowledge (intuition and revelation), in contrast to the reductivity of science. Paul Tillich calls gnosis "knowledge by participation"—and that is what humans need to do—recognize that they automatically participate in everything, and that we cannot unparticipate by choice.

The principle of reciprocity in ecology is that no entity can exist by and for itself; everything is connected to everything else. In religious terms, this is the golden rule (according to Aldous Huxley's *Perennial Philosophy*). Reciprocity is the recognition of mutual obligation. All things are bound in bonds of mutual dependency. Ecology has become a philosophic viewpoint as well as a systematic discipline. The counsel of ecology is caution. Caution is an expression of love. Love is treated as the basis of religious feeling.

There are pictures called anamorphoses, which are fragmentary deformities to the naked eye, but reveal perfect forms in a conic mirror. Like the mirror, culture organizes the fragments of life. The life of an individual, often won at great cost, receives its complement from culture. But the conic mirror is lost to modern cosmologies; the world is fragmented. The pieces of experience can be reconstituted by a gestalt, a perception of the total pattern. Nature, myth or love could bestow the mirror again. Nature has inherent order. Myth creates an order. Love combines orders.

Every cosmology includes ideas of the past, present and future. As mysticism, with its synchronal sight, regards all beings as equal, science, with its diachronal sight, regards all equal through time. A complete cosmology needs science and mysticism.

Gregory Bateson defines wisdom as knowledge of the larger interactive system. Wisdom is a perception of relationships and relativity, an awareness of the wholeness of things without losing sight of the unique particularities. It joins the left and right brains in a union of logic, poetry and feeling. It reintegrates knowledge with values. It implies making judgments in advance, infusing elements of older wisdom into a new expression. The wisdom of cultures forms a perennial philosophy of the human race. Gary Snyder discerned an undercurrent in civilization since the late Paleolithic. He considered Buddhist Tantrism to be its finest and most modern statement: "that Mankind's mother is Nature and Nature should be tenderly respected; that man's life and destiny is growth and enlightenment in self-disciplined freedom; that the divine has been made flesh and that flesh is divine; that we not only should but do love one another . . . these values seem almost biologically essential to the survival of humanity" (in his book *Earth House Hold*).

Myths (with transformations) and metaphors (with structure of integrated differences) are modes for conveying ecological wisdom; they are less concerned with survival than the survival value of a good fit between dualisms of life.

But we fear to try to create a just world order, a new design for living in the planet. And, fear casts out love, and with love, goodness, beauty, truth, and intelligence, until all that remains is fear of other beings and the unknown; fear of the smiling science and technology that take away more than is given; fear of fellow human beings, who are trying to regain what was taken. But what can cast our fear? Love? Love is the problem of an animal who must find the world compelling and symbolic. We confuse our symbols with the natural world, the present with the represented. Sometimes the image of love is loved more than the actual.

Certain elements—care, responsibility, respect, and knowledge according to Eric Fromm—define a loving relationship. The inexhaustibility of a being or of our relationships constitutes much of the nature of love. Human beings are compelled to seek other beings and love is the only approach.

Maslow presents "love-knowledge" as unlimited. Love creates an openness to experience, without judgment. Beings unfold. Contradictions abound in love's completeness. Love expands the awareness of the self and other beings. And its intensification of feeling pulls the frame through the focus, yet preserves the original distance. Love binds space and time in miniature. Its intimacy permits distance. Its duration reaches future generations of beings. Love personalizes the universe, but keeps it free.

The regions in the planet are like living symphonic poems. The score does not fully determine the music, the passion and intensity. The present movement gives no clue as to how it will finish. Each voice fits in with others, but is not limited. We can be aware of the symphony as a whole and the individual voices. When we are attuned to it, control is not a problem. If we can trust ourselves to improvise as the need arises, we can trust nature, and not follow some rigid plan. Every cosmology has limits, of incompleteness, indeterminacy, and of locality. Our new ecological cosmology, expressed through our intentions and designs, recognizes its limits with love, and continues to act.

8.9.4. *Ecological Design of Local Systems*

We are smart and inventive, accomplished and complex, but we are also weak and arrogant, selfish and clumsy. We ignore gigatrends and hide behind bad metaphors and the momentum of recent industrial history—and the financial size of that current human system is $55 trillion in output in 2004. We do not see the long-term, slow, invisible or other catastrophes such as extinctions and ecosystem collapses, although climate change is being noticed. We neglect to question our adaptations to past conditions, such as agriculture or cities, even as they require prodigious amounts of energy that pushes basic ecological systems towards collapse. We chant our desired needs for luxury, money and growth. Then, we complain that the current local and global systems have no historical or cultural analogs. Global environmental change is considered beyond our management or control, so business as usual can continue. The massive destruction of ranges by livestock are considered an unavoidable by-product of economic growth. People sliding into poverty, privation and starvation are considered acceptable losses. The failure of ecosystems and landscapes is dismissed as being less important than discovering further deposits of fossil fuels. The decline of two-thirds of planetary ecosystem services does not get mentioned in the excitement of the behavior of actors and politicians. Nothing makes us happy. Virtually all of our actions are unsustainable in the short-term and the long-term. Human civilization is living on borrowed time and stolen assets and services. The novelty and complexity of global interactions lead to thresholds that when exceeded will trigger unwelcome surprises.

We could start to question things; to learn to apply an ecological perspective to knowledge and processes; to understand and direct trends and gigatrends; to understand fields, systems and limits; to understand flows and connections; to understand the history of the planet, especially spheres and cycles; to learn how elements and materials interact in patterns and how patterns restrain them (and how this produces uniqueness and diversity); and, to understand how communities and ecosystems work. Every person and group needs to understand how challenging events can become problems, especially with water flows on land and air and with atmospheric change; to recognize others, such as cultural collapse, earthquakes, and diseases; to face the global problems of a chaotic changing planet; and, to comprehend the limits and weaknesses of cultures, especially bad images, incomplete cosmologies, maladaptations, drift, and traps. Creating an ecological cosmology, with new metaphors and logic, is an important step.

Local residents of places and cultures have to become knowledgeable about the full spectrum of factors that effect them, otherwise they will continue to be vulnerable to distant political powers and remote economic interests that profit from their ignorance. Traditional and acquired bodies of knowledge have to be coordinated in educational systems that are available everywhere. The flows of interests, materials and information have to be joined.

We need to emphasize science, especially addressing systems and synthetic thought. We need to end the thoughtless, large-scale experiments on ourselves, living communities and the planet, and imagine real thought experiments. We need to reduce our massive interference with ecosystems and landscapes, especially through conversion. We can decrease our demands for energy and materials by 70 percent; we can increase our efficiency 10-fold. We need to reduce and recollect many kinds of pollution, from plastic nurdles to carbon dioxide gas. We need to rethink and rework design at every level, from personal and local to regional and global, through principles and actions, then use design to recover our tremendous losses, to save and restore wild and common areas, especially extents of forests.

We need to create surveying programs to inventory places and the planet, then monitoring programs to keep informed as well as to reconnect many plant and animal patterns. We have to monitor all threats, from earthquakes to meteors. Human populations should be related to ecosystem productivity, as well as to rarity and diversity, even if this means a large reduction in numbers.

Failed cities should be removed or refitted. New cities should be built with psychological and ecological prospects (perhaps as arcologies). Technology could be reduced and integrated to fit needs and limits, instead of being automatic. Many predominantly technological problems, such as carbon production, fossil fuel extraction, nitrogen pumping, phosphorus loss, and pollution, can be solved through a combination of conservation and balancing. New smaller scale forms of technology can be designed using precautionary principles. Industry could be reformed as limited artificial ecosystems. Appropriate technology could be directed and certified.

We need to learn to be healthy individuals in living communities, to reduce antibiotic use and unnecessary luxuries. In fact, we need to place health in the context of ecosystems and global cycles. We need to learn to adjust to our own psychological and social limits. This means addressing problems with patterns of wealth, especially growth, inequality, poverty, dominance, and slavery. We need to link economics to ecologics, especially at the global level. We need to redefine the nature and limits of corporations, especially with new goals and community responsibilities. We have to consider the problems of intolerance, conflict and war within a frame of ecological ethics, and to reconsider the goals and responsibilities of individual nations and a global community. Failed nations and communities will have to be rebuilt. We can implement radical restructuring of political forms.

The design of new forms of human settlements and activities can be accomplished through ecological design. We can design the entire planet as a whole. We can integrate traditional adaptive patterns, from agriculture to technology and cities, to natural processes. We can consider our civilization and planet as part of the solar system and local space. We can strengthen religions with common understanding to bind people to their places and planet. We can make politics conscious and fair, with traditional goals and limits. We can make ecological designs, mostly to restrain humanity and restore balances of systems, but also to coevolve with the development of natural systems. We can create a framework with clearly delineated functions at each level from personal to planet, and a new integrated approach of koinomics. And, we can advertise this to everyone so they can participate. Then we, they, all of us can say what else should be done.

Perhaps our efforts will be as naïve as continuous war, or as utopian as ecosystem destruction, but we have to make the attempt, and to continue without pause or stop. Perhaps the ideas of global commons and small nations are as unrealistic as an infinitely growing economy or as warring for peace, but we have to try new patterns. We have to promote the appreciation of places, to awaken the delicacies and qualities of designs, to plan frameworks for development, and to allow everyone to participate in creating good, personal and social designs. Each single step is easy. Each challenge can lead to an adventure. Each change will have some effect. Each vision could inspire more efforts. And, all we have to do is to start to act, now.

8.9.5. *Anti-Conclusion: But What Should We Do?*

We can do two simple things: Stop and go. *We can stop*—stop growing, stop producing, and stop running. Suspend the race and contemplate a direction. We know that whole countries have built again from ruins. So there is nothing to fear from stopping—if we know there would be no problem going again. What are the dangers of fast social transformation? Lack of justice? Lack of order? Stopping might create a steady state, a period of rest, and time to explore human values and quality considerations. This strategy would avoid the eventual hardening of choices. But it must be instituted at once. The crisis caused by exponential growth and destruction cannot be solved just after some final limit is passed and some ultimate catastrophe begun. The crisis of ignorance cannot be solved by hurrying ahead and creating more problems. We have been asking how the earth will survive its human populations and how they can be lowered. Let us just freeze growth and see what happens. Let us just freeze populations—a year or decade of no births. Let us stop subsidies to industrial agriculture. Discontinue links with the international commodity market. Stop throwing all waste into natural cycles. Suspend destructive searches for remote resources. Start no new buildings. We could make it a year or decade of celebration, an expression of human and cultural unity. By stopping, everyone would have time to participate in design.

And then *we can go*. We can ask questions about everything. Then we can survey every habitat and ecosystem. We can act to conserve, restore and preserve ecosystems to keep them healthy. We can start creating a permanent organic agriculture. We can keep extra materials separate or recycle them immediately. We can restore uninhabited buildings and places. We can monitor all domestic and wild systems. We can integrate human and natural values and represent them legally. We can deconstruct some cities and build new ones. We can plan and rework transportation systems. We can work for equity across cultures and communities, redefining wealth, sharing and leadership. We can create a satisfactory aesthetic civilization, based on eutopian strategies. Again, all we have to do is *act now*!

9.0. Appendix

Notes from the various chapters are listed by chapter. Appendices contain articles, reviews or materials. The glossary contains common words from all chapters. The bibliography combines references from the chapters. An index allows you to find specific terms on pages where they are referenced. Short biographies of the authors have been added by the authors themselves. And, there is a page listing contacts for authors and institutions.

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5616-4. Ibid, p. 6 -7.

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For 7.4.

This paper was written for the International Union of Architects World Congress • Torino, June 2008

For 7.7.

Based on a graduate project in Geography, 1970. Some of the numbers have been updated to 2010.

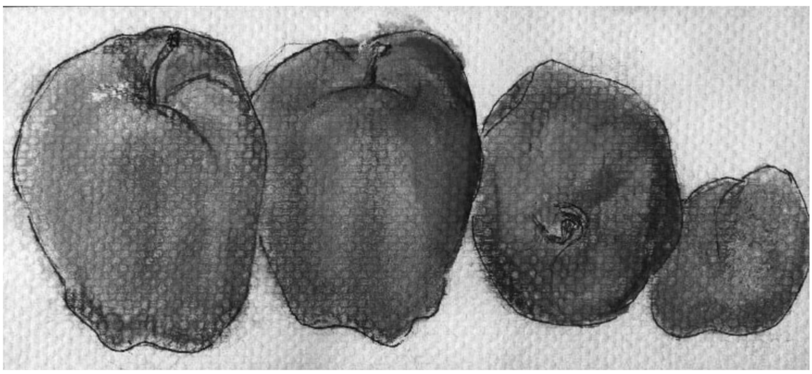

Figure 96-1. Apples (Make-up on paper, Caratheodory 1984)

Colophon

Type: Adobe Garamond Pro, 11/14
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