A Theoretical Foundation for an Alternative Future:

The Promise of Ecological Design

"A nation that destroys its soils destroys itself. Forests are the lungs of our land, purifying the air and giving fresh strength to our people. "

Franklin D. Roosevelt

There are over one and one half million acres of strip-mined coal lands in Appalachia. Coal mining practices have removed mountaintops and filled valleys with the resulting overburden. Such mining practices have devastated landscapes, soils, watersheds, and communities. The primary rationale is that the nation needs coal for electricity. Fifty percent of the USA's electricity comes from burning coal. The result is increasing levels of carbon dioxide in the atmosphere that trigger climate change and threaten the ecological integrity of the planet.

Since 2002 coal prices have quintupled, rising from twenty-two dollars a ton to over one hundred and thirty dollars. Global consumption rose thirty-five per cent between 2000 and 2006. This increase in demand is putting even greater pressure on the coal lands of the world. The pressure to produce more is felt throughout Appalachia.

Over the last few years, however, analysts have begun to think that coal is not the bountiful, post petroleum energy resource that most of its proponents claim (D. Strahan,

2008). The industry has already produced most of the easily mined coal and, despite claims of huge reserves, obtaining that which remains is a significant challenge (G. Chapman, 2008). Some countries, the UK for example, have seen dramatic declines following their post WW II peaks. China, currently the world's largest producer, consumed more than it produced in 2007 and had to import coal to make up the difference. It has been estimated by Energy Watch in Europe that global output will peak as early as 2025, then fall into terminal decline (W. Zeitel, 2007).

We need to debate whether we want to build a future for Appalachia based on an economy that will destroy its natural resources and last for decades rather than centuries. Will continuing to remove mountain tops and fill valleys foreclose alternative options? Is there a genuine economic alternative to strip-mining coal? Might the best approach be to move directly to a renewable energy future, thereby protecting the natural resources still left? Why not explore the possibility of building permanent wealth for the region based on long-term opportunities that will extend well beyond the current century?

This paper explores such a future. The overarching design goal includes building a carbon neutral economic foundation, in which carbon is no longer the atmospheric pollutant known as CO2, but is sequestered in new soils and diverse biological pathways. It also includes the concept of an ownership society in which all the citizens of the region can share in the emerging wealth. The foundation for new wealth will include; broadly based education, remediation of mining toxins, restoration of coal lands, regeneration of natural resources including forestry and agricultural development, implementation of renewable energies for fuels and electricity, enterprise diversification and allied manufacturing, and, as a result of all these, the development of regionally specific infrastructures.

A profound economic change will further require a model of development that has yet to be fully implemented. Such a model needs to be based upon complex and dynamic systems derived from the workings of nature. At its core is a new theory of ecological design. It is a theory that integrates all the sub-elements of an economy and its attendant

landscape into a new and coherent whole. It takes into account not only human enterprises, but also the changing nature of all of the ecological subsystems through time. This time-driving dimension is the equivalent of succession in ecology.

Steps Toward a New Theory of Design

The theory is based upon several orders of ecological design. Each is characterized by a set of relationships that are, in and of themselves, intrinsic to the order. They are also natural building blocks that can be coordinated to provide the foundation for the next level or order of design.

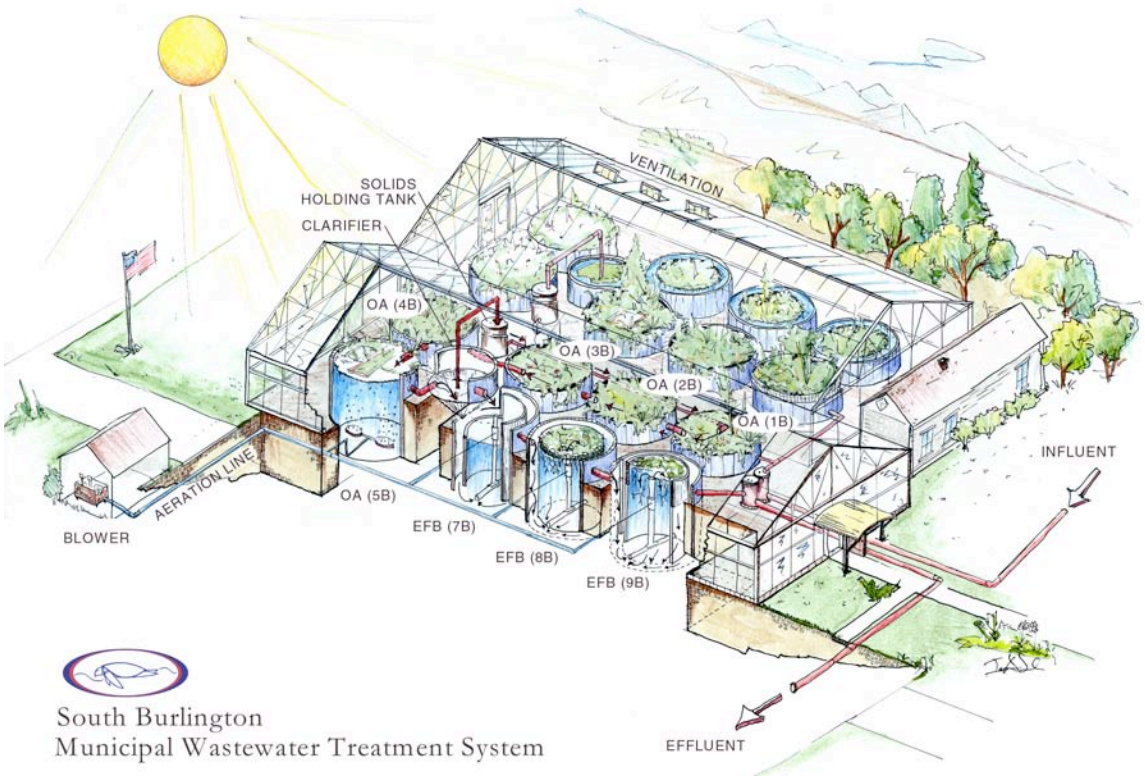
First Order Ecological Design: Task Specific Natural Systems Technologies & Techniques

First Order Ecological Design draw on information and organisms derived from the natural world and directs them towards societal ends. Over the past several decades a number of practitioners have developed a series of ecological design principles based on the dynamics of natural systems. This has led to their inventing and implementing natural systems technologies like eco-machines, which are capable of generating fuels, growing foods, treating wastes, repairing damaged environments, breaking down or sequestering toxic compounds and regulating climate in buildings (J.Todd & B. Josephson, 1996). Over the last decade these new technologies have been employed in many settings around the world (www.toddecological.com).

Such technologies tap into the dynamics of the natural world to self-organize, self-design, self-repair and self-replicate. In designing these systems, the ecological practitioner directs unique elements within environments like that of the eco-machine toward a desired outcome. If, for example, sewage is to be treated, the ecological elements transform the waste into pure water as well as a host of potentially valuable biological products. Species from all five basic kingdoms of life need to be represented in the

design. For optimal effectiveness it also needs to draw on at least three different ecosystems like marshes, ponds, streams, and a variety of soil and terrestrial environments.

Natural systems technologies and eco-machines are characterized by their relationships. All the elements are related in terms of energy, nutrient flows, life forms, biological needs and historical associations. This also characterizes task specific technologies developed through First Order Ecological Design. The species, and process flows are derived from the natural world and operate within an ecological framework shared by a variety of environments and ecosystems. Despite their uniqueness they are nonetheless natural systems.



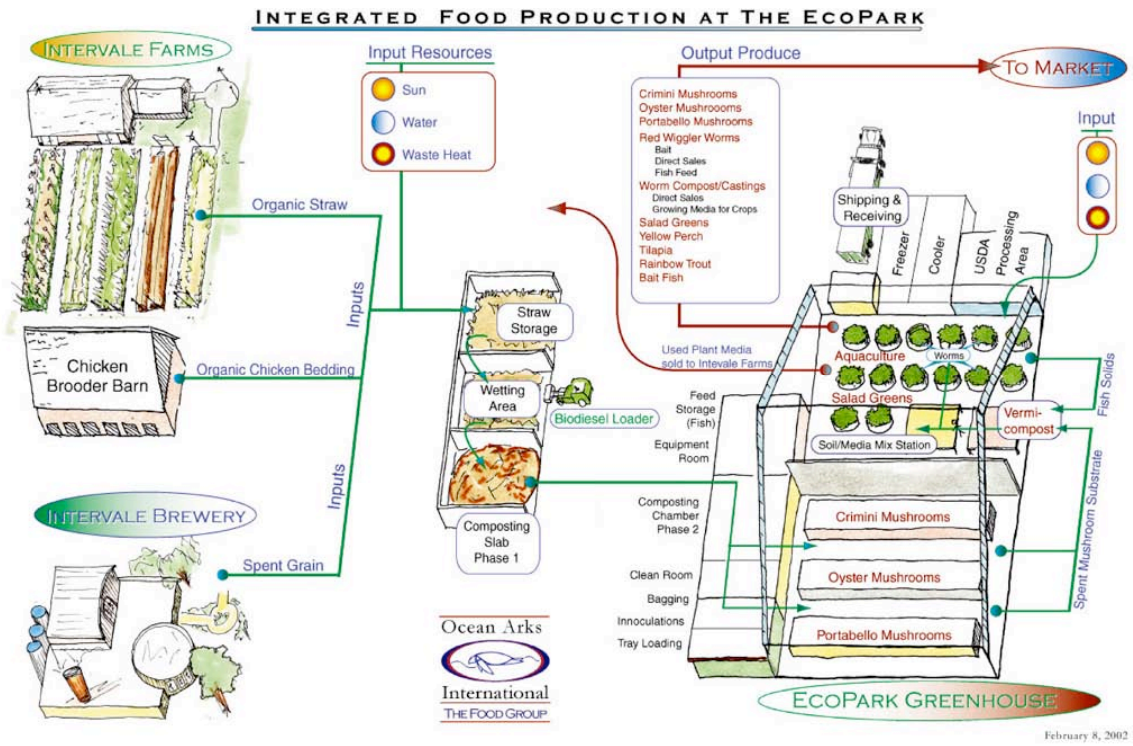
An Eco-Machine for Sewage Treatment

First Order technologies encompass a broader pallet of designs than the eco-machines described above. Utilizing techniques derived from worldwide experience and research, they can create fertile, carbon-sequestering soils, which are recombined using whole systems design. First Order technologies also include ecological design of biomass and forest ecosystems, agro-forests, and farms that integrate traditional and ecological knowledge. Soil building and carbon sequestering are absolute priorities. A region will not achieve sustainability without a central soil- building component.

Natural systems technologies have enormous economic potential. Their diverse capabilities lend themselves to a variety of applications in the food, energy, natural resource, waste treatment, and environmental management sectors. In Appalachia they could provide a major catalyst for economic transformation.

Second Order Ecological Design: New Symbiotic Systems

Second Order Ecological Design is based on relationships not found in nature. They are created by connecting normally unrelated processes. A pollutant or industrial byproduct, for example, may be combined with an energy source like waste heat. Through ecological engineering this order of design can produce valuable new products. Ecological industrial parks represent new symbiotic systems created from normally unrelated activities. Several Agro-Eco-Parks that are currently emerging are among the most highly developed of ecological industrial parks. One early model formulated the design rationale for such systems. It involved using wastes from a brewery to build ecological food webs. These webs, powered by waste heat and solar energy, converted the waste into some dozen valuable agricultural products (J.Todd et al, 2003). It became a model for an agro-eco-park for Vermont as well as for the development of four new corporations based upon Second Order design principles.



Agricultural Eco-Park Schematic

Such models have potential for Appalachia. Agro-Eco-Parks do not derive their economic strength from economies of scale. They derive their vitality from sharing information, resources, technologies, and financial mechanisms among the different economic elements. In this way many of the costs can be borne by all the entities and capital cost per unit of production can be kept modest. It is possible to envision urban and rural systems combining food production, waste management, renewable energy generation, and light manufacturing with businesses like bakeries, breweries, restaurants and farmers' markets. The greatest limitations to the creation of symbiotic economic systems remain the blinders created by traditional single sector thinking and the limits of our imaginations.

Third Order Ecological Design: New Economies Based Upon Bioregional, Carbon Neutral and Renewable Energy Frameworks

If we are to achieve the transition from the present to a future rich in information while constrained in terms of materials and nonrenewable energies, designing for carbon neutrality is one of our greatest challenges. Information, especially knowledge from the natural sciences, will be a substitute for capital and fossil fuel.

Succession or the time-framed emergence of different systems, are intrinsic to Third Order Design. These are supported by different institutions at each stage in their economic and ecological evolution. Succession is almost universal in the natural world, as exemplified by a bare plowed field, which transforms itself through a series of ecological stages over time, into a mature prairie or mature forest.

Third Order Ecological Design is a complex process, based on several stages of development. The first stage provides the foundation for the second, the second for the third, and so on. They are like building blocks. At least five basic stages are involved. Each has its own appropriate institutional, economic and educational support base.

The first stage begins with a barren landscape that is to be restored by introducing mineral and ecological elements to begin the healing processes. It involves both modern scientific soil building knowledge and traditional wisdom. These must be integrated into an Appalachian context. Former mine workers utilizing some of their earth-moving machinery could play a pivotal role.

The second stage involves treating toxic mining wastes like the trillions of gallons of coal slurry held in impoundments. The scale of such activity could trigger the development of a large remediation industry. Preliminary evidence indicates that ecological and hybrid chemical/ecological technologies could treat such toxic byproducts. It might be possible to make useful products from the byproducts of remediation.

The third stage of establishing a natural resource base would include forestry, biomass forestry, agro-forestry, and ecological agriculture. The sequestration of carbon into

timber and soils will be a measure of the success of the project. Annual measure of organic carbon content in the soils will be an indicator. Most North American landscapes are losing organic carbon from their soils. If global climate change is to be checked, this must be reversed.

The fourth stage includes developing a renewable energy infrastructure and manufacturing and processing based on regional natural resources. The list of potential industries includes bio-fuels, plastics, polymers, adhesives, building and composite materials, as well as a host of renewable energy technologies. The wind, solar and biomass potentials of the region are huge.

The fifth or capstone stage will be built on emerging economic diversification. It involves the transfer of the ownership of the land and natural resources to the people who live there, especially to those who have had a hand in its ecological transformation. This phase would require a financial institution, perhaps in the form of a regional land holding organization or cooperative. It would provide land owning mortgages or their equivalents to the new community of natural resource managers like soil builders, foresters, farmers, biomass growers and others. Once the land is capable of supporting a community, a 21st Century equivalent of a homestead act, with appropriate institutions to fund, it should be enacted. In the broadest sense of the term then, the land will be re-inhabited.

Institutional Succession on the Changing Landscape

Each stage of the development of former coal mining lands will need to be supported by appropriate institutions. The earliest stages, like soil building and reestablishing the biota of the region, would best be handled by not-for-profit organization(s). Start up capital would be in the form of grants. Society will have to pay for the renewal of a landscape that has been devastated to satisfy its demand for energy. Private philanthropy also has an important role to play. State and the federal government will have to underwrite the plan. The Federal Conservation Programs have set a precedent. The carbon neutral objective of the project would qualify it for support from emerging global carbon markets.

The early stages will not necessarily be profitable. It should be the goal of the regional land holding trust(s) to support the healing processes and provide the educational framework to educate the population in all aspects of environmental restoration and land use for carbon sequestering. Regional schools, colleges and universities of the region will play a vital role. The ideal would be a culture of people who see themselves as stewards of the land and understand that true wealth is an outgrowth of a well-tended landscape.

The not-for-profit early institutions will continue to have a key role during later stages. Their skills and perspectives for starting new economies can be transferred to other areas. Once soil building and natural resources are established in an area by land holding not-for-profit(s), they can move on. In this way the start up phases are constantly expanding to initiate new healing processes.

The institutional succession process has a logical set of stages. As the natural resource systems begin to mature, many new entrepreneurial corporations will emerge to take advantage of new resources. Processing and manufacturing companies will predominate. Some of the waste remediation efforts will spin out of early experimental settings into new companies, resulting in strong regional industries with highly developed remediation skills.

Land ownership would be held in trust by an entity that transcends private ownership. The early stages will require public support and public ownership. Following the re-establishment of a working landscape and the emergence of the entrepreneurial companies, an institution with financial lending strength becomes key. The goal would be to have those who work on the land and have developed stewardship skills own it. The trust would shift emphasis from a land holding institution to that of a financial organization and provide mortgages for the area. The trust would then divest itself of its lands.

The community would be made up primarily of landowners who work with natural resources on their own land. Before the soil building stage, the land would have had little value. By the time it can support a natural resource economy it will have real worth and there will be the skilled people to tend it. They should have access to mortgages, which would be at the heart of community building. The trust, having become a financial institution, could use the revenue to expand the new economy by acquiring new lands to repeat the process.

The final stage of institutional evolution on the land will involve independent people working together in cooperatives. Cooperatives have a long tradition providing communities with access to services, information and technical support that might not be available to individual farmers, foresters or biofuel growers. Cooperatives are owned by their members and have been successfully used to support natural resource development in the agricultural and energy sectors. They have access to initial support through a number of USDA programs as well as the Rural Electric Development Program. Successful cooperatives can both build community and stabilize a natural resource economy. In a maturing economy they provide institutional structure that supports both individual initiative and the collective needs of the community.

Ecological design as a field is scarcely three decades old. One of its founders was the visionary ecologist H.T. Odum. In his classic book *Environment, Power and Society* he envisioned a society closely integrated closely with the natural world; one which had shifted from an exploitive culture to one that tapped into nature's wisdom to redesign itself along ecological principles. Dr. Odum believed that only such a culture could persist and enrich itself over time. My hope is that the ideas presented here will help transform Appalachia and other parts of the country and the world into beautiful economic landscapes we will be proud to bequeath our grandchildren.