THE BUCKMINSTER FULLER CHALLENGE

Comprehensive Design For A Carbon Neutral World: The Challenge of Appalachia

By John Todd

The Problem:

There are over one and a half million acres of strip-mined lands in Appalachia. Coal mining practices have removed mountaintops and filled valleys with the resulting overburden. Landscapes and communities have been devastated. The primary rationale for this is that the nation needs the coal for electricity. Fifty percent of the USA's electricity comes from burning coal. However, coal combustion is creating increasing levels of carbon dioxide, triggering climate change and threatening the ecological integrity of the planet.

There is an alternative future for Appalachia. It is the antithesis of the current economy of the region. This is a future in which carbon is no longer an atmospheric pollutant but is sequestered in soils and biota. Mining toxins are remediated, coal lands restored, and a new economy is based upon renewable energy, natural resources, enterprise diversification and an ownership society.

Such a future can come about through comprehensive ecological design. Such design integrates environmental restoration, new natural resource development, the associated manufacturing and production of fuels, the development of civic and social institutions and a variety of financial instruments, and the education of local people. Such a cultural transformation will develop through a series of successional stages that mirror ecological succession found in nature.

The Solution:

A New Theory of Design

Over the past several decades I have developed a series of design principles based on the dynamics of existing natural ecosystems to develop living technologies and eco-machines that generate fuels, grow foods, treat wastes, repaired damaged environments, and regulate climate in buildings (1&2). These technologies tap into over three billion years of evolution and use nature's operating instructions to self organize, self design, self repair and self replicate. By creating unique webs of life in a circumscribed environment, the ecological engineer directs the genius of nature toward a desired outcome such as clean water, foods, new products, environmental restoration or a combination of the above. See photos 1-6, (Appendix).

I have named this design approach to technology **1st Order Ecological Design.** It connects elements that are related in terms of energy, nutrient flows, life forms and biological needs. Most eco-machines are examples of 1st order Ecological Design through integration of life forms and process flows.

In recent years I have designed and built components of agriculturally-based eco-industrial parks (2). In doing so I have begun to see another design process that is different from 1st Order Ecological Design. I have named it **2nd Order Ecological Design.** It involves connecting processes that are typically unrelated often combining industrial processes with natural resources and ecological cycles.

An agro-eco-park is a good example of 2nd Order Ecological Design. There industrial waste products and heat, and food raising and processing can be integrated into productive and complex systems that can support many businesses and enterprises in an environmentally and energetically responsible manner.

I am currently attempting to design a blueprint for a post coal era and carbon neutral economy for the coal land regions of Appalachia.

The key to its future lies in a carbon neutral culture and an ownership economy in which the people of these regions owned their own lands, resources and enterprises. I knew 1st Order and 2nd Order design could create some of the building blocks and solutions. Still lacking was a design model for the whole region and for change over time. The land must be healed and the wastes treating and this takes time and changes over time. Local people will need education, financial strategies, and institutions that reflect the evolution of a new economy. The design goal of a carbon neutral culture forced me to conceive of an approach that dealt with succession through time on the landscape as well as with human institutions.

I have named this process **3rd Order Ecological Design.** It is comprehensive design at the level of the region and integrates the various sectors of the society. This order of ecological design is not a vague concept. It allows a view of society and a region from the unfolding of activities appropriate to an early successional stage, such as building rich soils on a large scale, through to creating an economy on the land. The latter in turn would support manufacturing activities in the towns, leading to building an ownership culture, the wealth of which is derived from renewable energy and natural resources. It is the designed equivalent of a bare field evolving through nature's self design to become a meadow, then a field dominated by shrubs, then a young forest of fast growing trees. This is replaced over decades by slow growing hardwoods, creating a mature forest of great beauty and value. Succession through design is a missing component in most regional planning, but is the key to reclaiming the landscape and building an economy.

Implementation

The implementation of such a successional plan is outlined in my white paper for the Lewis Foundation (3). Although removed mountaintops and valleys filled with overburden can never be replaced, the strip-mined lands can be made productive again and form the basis for a new economy.

Stage One: Healing

The first stage in the transformation of the region will involve the implementation of 1st Order Ecological Design. This will include the huge task of detoxifying the trillions of gallons of coal slurry that is held in reservoirs throughout the region. This will involve eco-machines designed to render the material harmless to the environment and local inhabitants as well as to create beneficial products from the treated slurry solids. We have evidence that both of these objectives are possible. The scale of the project is so big that the region could incubate a whole new industry around the conversion of slurry to clean water and new products.

Stage one would also involve the ecological restoration of coal-mined lands and the building of rich new soils on an unprecedented scale. This too is a 1st Order activity and involves the integration of ancient and modern soil building techniques from around the world. Coal miners and some of their machinery could be employed in the process.

Stage Two: Carbon Sequestration and the Creation of a Working Landscape

Once deep soils and ground cover are established, the next stage will involve creating a working landscape through a series of successional stages. This will include a regional reforestation initiative, which has already been researched and is in the planning phase. It involves new forests, agro-forests and planting short rotation, fast growing woody crops for biomass production for subsequent conversion into fuels and other energy sources. The agro-forests will be models of succession with each stage having unique products and materials of economic value. 1st Order Design will predominate in stage two. Carbon sequestration will take place in the soils and in long-lived orchard and forest trees.

Stage Three: Creating a Renewable Energy Future

Coal can be replaced with renewable sources of energy. Already suitable Appalachian wind sites have been discovered that can provide competitive sources of energy. The drawback to wind

energy is that it must be backed up by alternative standing stocks of energy. However, if it is paired with another renewable energy source like woody biomass from willows and poplars, a viable energy system can be developed. Land to support the woody biomass production is available. Woody biomass can be used for generating electricity, for refining into fuels, and for manufacturing a wide range of products ranging from plastics to polymers and adhesives. Developing resources to create an infrastructure will involve 2nd Order Ecological Design strategies.

Stage Four: Institutions and a Shared Ownership Culture

Through 3rd Order Design it is possible to create a multi-phase institutional model. They can be designed at scales ranging from a watershed to an entire region. There are three broad steps.
Step 1: Philanthropic
A not-for-profit or quasi-public entity purchases the land, establishes restoration systems and develops broadly based educational and training programs.
Step 2: Capitalized Corporations
Undertake forestry and farming with ancillary activities as well as processing and manufacturing.
Step 3: Cooperatives for Divesting the Land and Expanding Services
Land divestiture to employees and qualified land stewards. Provide services to new landowners.
Step 4: The cycle is repeated on newly acquired lands.

Replication

Replication within the region is described in Step 4 above. Replication more broadly throughout the world is possible through the ecological design theory proposed here. At the present we have a smaller but comparable pilot project in Central America.

Financing

There are a number of financial pathways for this project, including state and federal mining land remediation programs. There is the Federal Conservation Reserve Program, the Federal Renewable Energy Tax Credit, States' Renewable Energy Portfolio Standards, and the emerging Carbon Market. Cooperative's have access to the USDA business and industry program, the Rural Economic and Development Loan and Grant Program and the Rural Electric Development Loan Program. There are new private equity sources that have shown interest. NGOs and philanthropic organizations are driving this project forward.

References

1: Todd, J. & B. Josephson, 1996. The design of living machines for wastewater treatment. Ecological Engineering 6, 109-136.

2: Todd, J. et al. 2003. Ecological design applied. Ecological Engineering 20, 421-440.

3: Todd, J. 2007. A new shared economy for Appalachia. A Report to the Lewis Foundation, 55pp.