INTEGRATION VS. CONSERVATION
A Renewable Energy Building Block for the 21st Century

Pliny Fisk III, M.Arch., M.Larch
Gail Vittori
Center for Maximum Potential Building Systems
8604 F.M. 969
Austin, Texas 78724

ABSTRACT

A fundamental distinction in the nature of technologies--solar or otherwise--hinges on their ability to become components in what might be called industrial ecosystems. Much of this potential depends on their inherent capacity to be integrative with other technologies or simply resource conserving in and of themselves. In ecological terms, the cycling of essential elements in the biosphere is an indicator of life's basic need for materials and its responsibility to ensure continual material flows.

Similarly, energy efficiency should be the result of highly efficient systems working together, rather than as disparate machines optimized for a single purpose. Largely because human processes are viewed as individual machines rather than as integrative systems, the dominant anthropocentric world view holds a distorted, one-sided perspective of metabolic activities. The resulting integrative paralysis threatens the capacity of the human species to sustain life as we know it.

KEYWORDS

Integration vs. conservation; open vs. closed systems; material cycles; energy flows; metabolic planning; biosphere vs. synthesphere; human vs. natural; biomes; waste; bioregionalism.

INTRODUCTION

Examples of how this thinking relates to the field of renewable energy, particularly to passive solar, are numerous, but are stymied by a lack of confidence to extend them far enough. It can be argued that solar displaces non-renewables materials and energy and thus reduces the need to introduce material cycles into the biosphere that cause $C0_2$ build-up, but we rarely go so far as to admit that residential construction alone in the U.S. uses approximately 1 million acres of virgin forest every year[1] knowing that these trees are the critical absorbers of this same $C0_2$. Moreover, by uprooting these trees, soil nutrient erosion occurs on slopes. This natural plant system, which is the means of nutrient-cycling through decomposition, would take many generations to reestablish. Simply replanting trees fails to give the soil the important detritus critical for biological activity and water retention. This is but one instance of the enormous ramifications resulting from an absence of cyclical thinking in human endeavors.

Strategies for water conservation, energy conservation, and material conservation are proposed without the faintest idea of their full impact on larger systems. For example, is it better to produce energy conserving appliances such as refrigerators or integrate the old clunker with water heating, or slow cooking of food, or drying clothes, or....? Is it more important to have a water conserving commode or cycle more water through a whole system creating at every nutrient exchange a potential new use in constantly evolving integrative efforts? Rather than optimize integrative potentials, stop gap measures are devised to conserve energy and materials that virtually eliminate the potential for integration.

LESSONS FROM NATURAL SYSTEMS

"...it may be said that the one way flow of energy and the circulation of materials are the two primary principals or 'laws' of ecology and thermodynamics. Since these laws apply equally to all environments and all organisms including man."[2] So what are these principals or laws that could be models for human activities that have seemingly been disregarded? For example, a mature climax ecosystem offers an ideal model for efficient energy flow or community metabolism. The following list summarizes this condition relevant to energy based on renewable energy sources:

1) The number of individual roles (species) increases until relatively late in the climax period (How do we capture the essence of mature systems early on within our planning efforts?).
2) The number of individual roles (species) develops from linear chains to complex webs (How do we bring more community diversity such as micro-manufacturing also early on within our planning endeavors?).
3) The total population (including all individual roles) supported per unit of energy increases, showing that we might need both conservation and integration.
4) The rate of flow of energy is a more important indicator in determining productivity than the amount present at any one place at any one time.[3]

The following list summarizes this condition relative to materials and is based on renewable energy sources:

1) The rate of cycling of materials is a more important indicator in determining productivity than the stock of materials present at any one place at any one time (i.e. the turnover time of material cycles increases.)
2) Material cycles become more closed (i.e. in a mature system fewer materials are lost or wasted.)
3) The role of waste products in the overall health of the system increases.[4]

---

[1] National Association of Homebuilders
[2] Odum, Eugene. *Ecology*. Holt, Rinehart, Winston, 1963, p. 38.
[3] Odum, Eugene. *Ecology*: The Link Between The Natural & Social Sciences, Holt, Rinehart, Winston, 1975, p. 156.
[4] ibid

The role of individual metabolic process (i.e. the argument again here is that these metabolic processes could be the human extension called machines or any other humanly controlled transformation process):[5]

1) The capacity to live together becomes increasingly mutualistic.
2) Communities of metabolic processes progress from rapid growth to developing mechanisms for self-regulation and feedback control.
3) Individual roles or occupations become increasingly specialized relative to fitting overall community sustainability.
4) Information regarding past events as they might influence the future increases within the system.
5) Quality and health of organisms (individually and as a whole) increases.[6]

HUMAN "SYNTHESPHERE" VS. THE NATURALLY EVOLVED BIOSPHERE

To believe that human systems and natural systems can become one and the same perhaps is misleading; after all, a healthy natural system without the exploitive component called mankind injected into it as an industrial animal has no net export. Thus primitive man as a scavenger became part of the system. Several differentiating characteristics develop:

1) All energy in this biosphere system was renewable.
2) The metabolism of living organisms is executed by multistep regenerative chemical reactions in an aqueous medium at ambient temperatures and pressures. (One can count innumerable processes that do not follow this condition even if one is not a technologist.)
3) The biosphere as a whole is extremely efficient at recycling the elements essential to life that has evolved over millions of years.[7]

The mining of raw materials is one of the largest energy users in industrial society. The U.S. economy extracts more than 10 tons of *active* mass (excluding atmospheric oxygen and fresh water) per person per year from U.S. territory alone.[8] If one includes the processing and manufacturing components of these materials it represents industrialized societies' largest energy user.[9] The annual accumulation of durables in U.S. society is only 6% of the total manufactured; in other words, 94% is converted into waste residuals almost as fast as it is extracted.[10] In biological terms this amount of waste would correspond to a young, immature population. However, there are some encouraging realizations that could reverse this trend.

<u>The Dawning of Industrial Ecology</u>

Benzene is a by-product of the petroleum industry with over 14 billion pounds produced each year in the U.S. It Is a highly toxic substance to humans: If 10,000 people are exposed to 1 ppm in one year, one In four will develop

---

[5] Fisk, Pliny. "Metabolic Planning", Northeast Sun, 1989.
[6] ibid.
[7] Ayres, Robert U. "Industrial Metabolism", *Technology & Environment*, National Academy of Sciences, Washington, D.C. 1989, pp. 23-49.
[8] ibid
[9] Chapman, D. *Energy Policy*, March 1975.
[10] Ayres, Robert U. "Industrial Metabolism", *Technology & Environment*, National Academy of Sciences, Washington, D.C. 1989, p. 26

leukemia.[11] Its disposal became such an acute problem that in the course of scientific Inquiries of what to do with It, a use was accidently discovered in a lab. The use was Styrofoam™, one of the best energy conserving insulators. The plastics Industry, this nation's fastest growing industrial sector, generates mostly unusable by-products, though acceptable uses are being discovered as the industry's waste disposal problems mount.[12]

Fly ash, a by-product of coal fired power plants, can be collected with reasonable efficiency using electrostatic precipitators. The problem has been the 50 million tons that need to be disposed of annually. Much of the fly ash, however, is suitable for cement production, especially that resulting from the burning of high calcium coal. This fly ash can be substituted for cement right from the power plant. The U.S. mandates states to replace 30% of the Portland cement used in highways with fly ash. The Center for Maximum Potential Building Systems has successfully used fly ash in building projects, which is used extensively in other nations.

In most cases, however, there is no purposeful materials balance or input-output plan for energy or materials; most decisions are made for immediate economic reasons or under crisis conditions.[13]

Since final products result from a linking, or "necklacing" of processes, overall energy efficiency is determined by the arithmetic product of the conversion efficiencies at each stage; a logical direction is to shorten this necklace bringing forth the following results:

1) By clustering metabolic units, energy and materials are more trackable and therefore controllable, particularly in small business environments.
2) Miniaturization of processes can make them more adaptable to local conditions.
3) Each node or metabolite can in itself be regenerative (i.e. use sunlight to produce more stuff than had originally been in mineral or raw material form through photosynthesis.)
4) Combined nodes working as a whole system within an ecological context can become fractals that can borrow information from similar biological zones throughout the world.

EXAMPLE OF METABOLICALLY DESIGNED REGENERATIVE SYSTEMS

Several domestic and foreign examples of individual businesses or whole communities have purposely designed solar-based systems which enable them to become more productive at each metabolic point. Unfortunately, nearly all these examples are food related incorporating few industrial processing examples. An excellent example was experienced firsthand on an organic farming kibbutz in Israel, Sdeh Eliyahu. In this setting, each metabolic point in an integrated organic farming community became not only necessary for the next to operate due to the need for the others' by-product material, but each was regenerative enough to become a lucrative business in itself. For instance, the compost needed for the organic gardens was used internally and sold; the insectuary produced benign insects for crops and was the largest of its kind in the Middle East with a global sales network; the organic food was of such high quality that it was exported to Europe for top price, as was the milk from the cows that produced the manure which provided one of the essential ingredients for the compost.

Other examples in the U.S. are becoming more well-known, such as bioshelters in the fish and protein supplement

[11] Berger, Melvin. *Hazardous Substances: A Reference*, Enslow Press, 1986, p. 31.

[12] *Design News*, Cahner's Publication, Des Plaines, IL, January 1991.

[13] Fisk, Pliny, "Multi-Level Production of Low Cost Community Produced Passive Solar Systems in Crystal City, Texas", *American Solar Energy Society Proceedings*, 1979.

industry. Unisyn of Hawaii specializes in the production of spirulina protein and consults on integrated material and renewable energy systems.[14] Some small business examples are in the northeastern U.S., where AquaFuture Inc. Inland Fisheries Systems in Montague, Massachusetts has created a breakeven business within a 4,000 square foot module, and the Three Sisters Farm and Nursery in Pennsylvania has successfully integrated food production with a restaurant and nursery.[15] Interestingly, we are unaware of whole community efforts in the U.S. comparable to those in Israel and China.

INFORMATION BASE FOR METABOLIC SYSTEMS DESIGN

Input-output data needed to design integrated systems for biological or material systems is difficult to obtain. The integration of businesses is difficult as the data focuses on final products and possibly by-products, but rarely an itemization of input requirements. Even with these shortcomings, approximately 12 states publish provincial and regional waste exchanges.   For example, California publishes a bi-annual catalogue that matches waste generators with waste buyers, and, as a result, has redirected about half a million tons of hazardous waste that otherwise would have gone to landfills.[16]

At the town or city scale, solar operated material cycling is virtually non-existent except through biological activity of microbes in large scale composting facilities, which are noticeably absent from most urban landscapes. Efforts combining the inorganic with the organic and are solar operated can be found in village development projects in Third World countries. Thus, there is an enormous gap between the First and Third Worlds, with working examples of what can be done under relatively simple conditions in the latter, and a virtual void of examples in the former which is in desperate need of a new approach to infrastructure development (Sanford Ovshensky's solar photovoltaic manufacturing facility run by photovoltaics presents an example of regenerative manufacturing.).

So our only major information base for integrated planning is the experience gleaned from Third World examples. The only way we have discovered to tap this information is to develop a database which respects local ecological conditions while pulling raw information from the biosphere.

INTEGRATION THROUGH BIOM-METRIC INFORMATION, PLANNING AND METABOLIC DESIGN

The biome system was originally developed for purposes of preserving plant and animal species according to whether or not these plants represented all global ecological zones.   In developing the system, patterns of noticeable repetitions emerged, i.e. one ecological association being represented in different continents, termed “provinces” by biogeographers. This meant that if one associated their local condition to its biome, a pattern would develop of similar conditions worldwide. As one collected information on a variety of technologies associated with different local materials uses directed towards human life support, i.e. food, potable water, renewable energy, waste treatment, building materials, one would be able to borrow technologies and practices developed under similar or identical ecological conditions.   Over the years, we have found that large database sources covering, for example, renewable energy, could be physically located according to biome and used as a basis for networking information.   We use the resulting information points as the basis for networking concerning any particular job we undertake and develop regional tool kits that in a sense are biom-metric tool kits.

---

[14] Unisyn. 1203 East Street, Tacoma, WA.
[15] Schuller, Phil. "The Bioshelter: Energy Efficiency in Food Production”, *Pennsylvania Energy*, December 1988.
[16] "Strategies for Manufacturing", *Scientific American*, September 1989, p. 151.

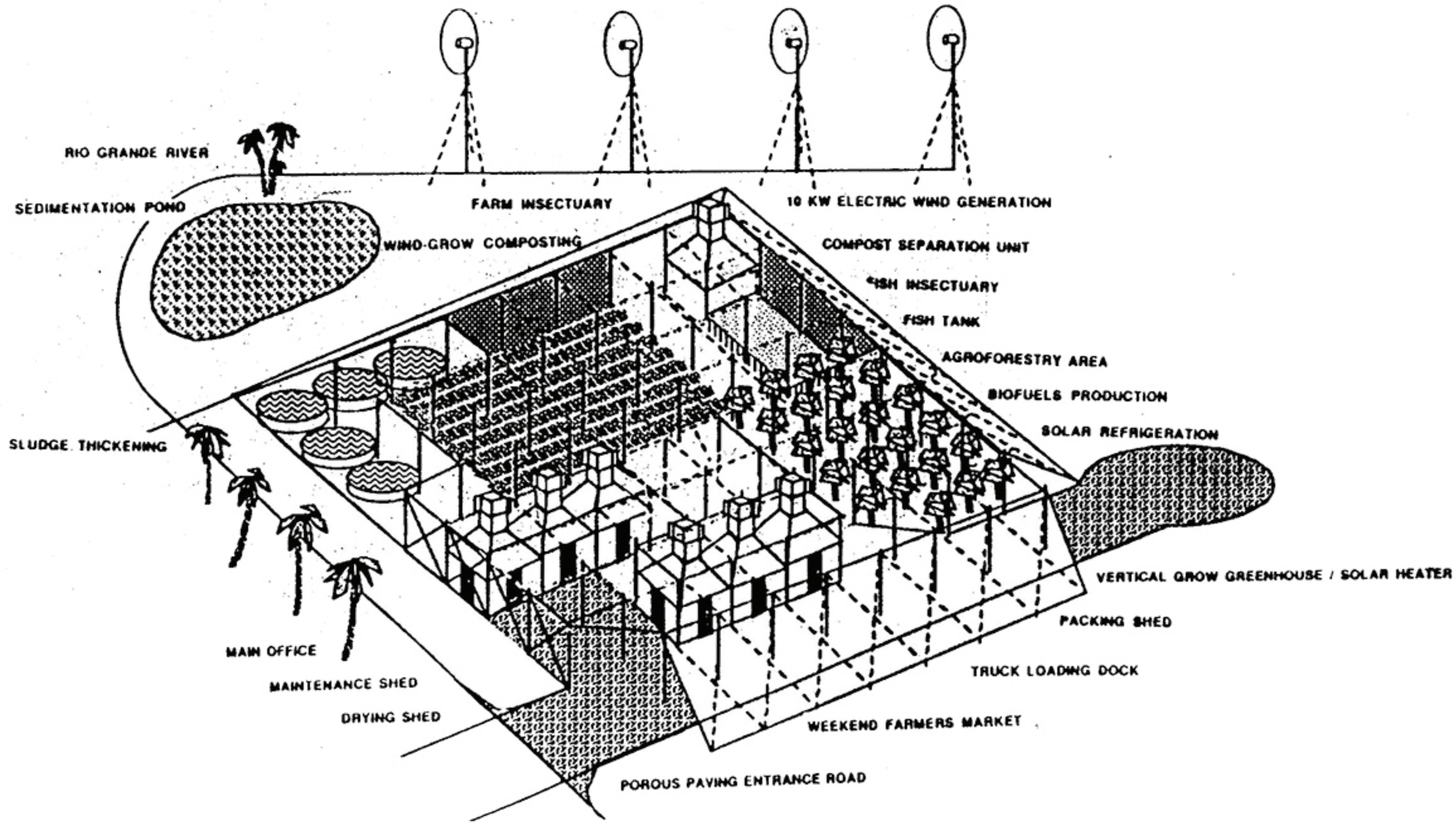
Biome planning and metabolic design is also a process of both admitting to and working within a global perspective of trends, such as desertification. Once immersed in these trends, one can design artifacts in an energetic and material sense and help correct wrong trends induced by mankind and make this apart off a regions metabolism at the local level. In other words, the artifact is looked at as if it were a nodal process in a series of regional processes, all presumably linked together. The Biom-metric database is one tool that identifies methods that help nurture linkages with regional resources and, thus, the regional metabolism.

This procedure should gradually develop into an accounting at various design stages, ideally making each building component a fractal or metabolite representation of how to design or, at least, an option of how to design within regional parameters. The design represents various increasingly larger scales of understanding up to the point of the global biome. Energy and resource conservation results from integration at the regional and global levels. In a sense we try to mimic nature and say *no such thing as waste can exist* through the use of metabolic planning.

ACKNOWLEDGEMENT

Thanks to the American Solar Energy Society's Sustainability Group that encourages open thinking on to our common future.

LAREDO "BLUEPRINT" DEMONSTRATION FARM



AREA RÉSOURCES

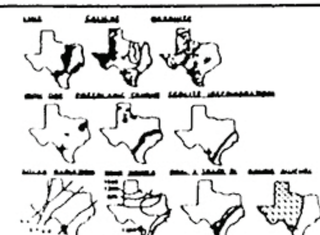
THE BIOME

WORLD WIDE AREAS SUBJECT TO DESERTIFICATION

THE PROVINCE

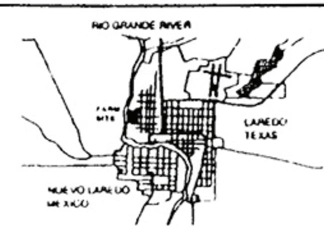
DESERTIFICATION IN THE NEARCTIC PROVINCE

THE REGION



REGIONAL RESOURCES -TEXAS AS DATABASE

THE SITE



THE CITY / FARM