Environmental Policy for the University of Florida

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In the following sequence the overhead transparencies are given from a talk October 28, 1999, on the greening of the University.* This talk considered the several scales by which a university should be enjoined with environment. First, the nature of universities was explained in terms of principles of energy, material, and information hierarchy that control all systems. Then specific questions and opportunities were suggested for greening each scale. The following are in order from global to individual scale:

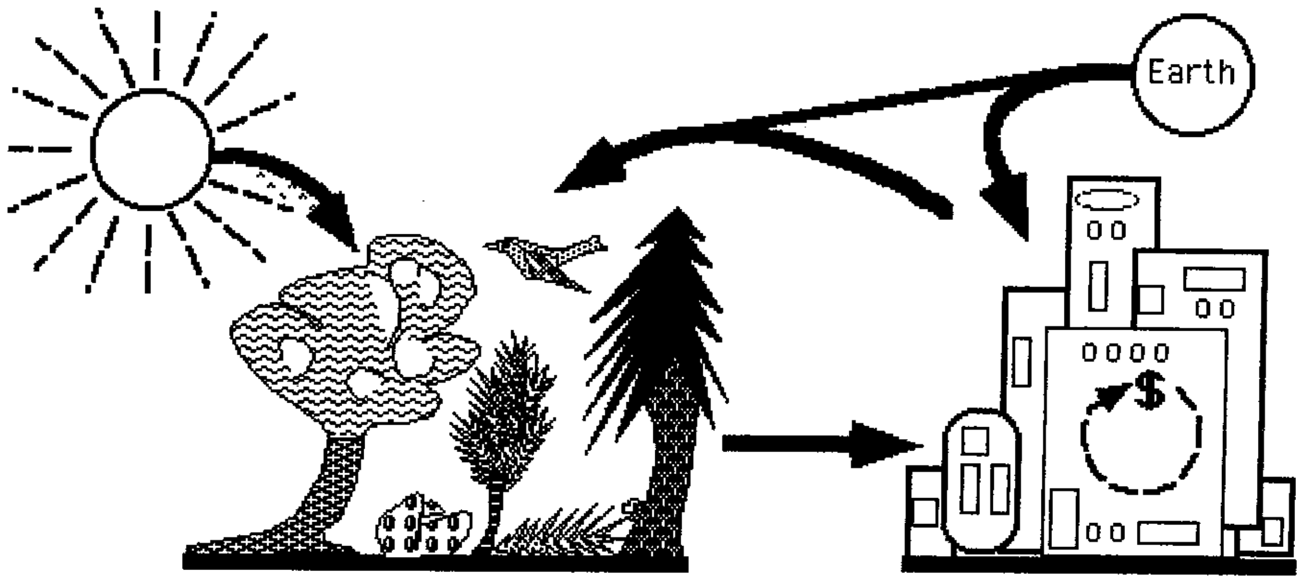
Innovating knowledge and policy for global civilization
University work on long term information and genetic biodiversity
Developing ideas and research for state environmental policy
Environmental theme for the Development Board and the President
Environmental education essentials for all students
Graduate Curricula for environmental professionals
Fit of university to city and county organization and transport
Management policy for plant, grounds, and waters
Environmental part in the ontogeny of human individuals
Sustaining integrity of small scale nature on campus

*Odum, Gayle and Brown (1978) made an emergy evaluation of the University of Florida system at the request of then President Marston, and some of those results are included.

Web Presentation. 1999. for "Greening UF" Conference, Rinker School of Building Construction.

Symbiosis of Knowledge and Environment

Today we are here to help fit the University to the environment in symbiotic relationship to benefit both. See symbiosis Icon (Figure 1):



Icon for Environment and Society
(Center for Environmental Policy)

Figure 1. Environment and the human economy.

The outstanding example of a system being forced into symbiosis is the great experiment of Biosphere 2 at Oracle, Arizona. (New book on this: *Biosphere 2, Research Past and Present,* ed. by B.D.V. Marino and H.T. Odum, Elsevier Press, NY, 356 pp.)

Environment is the whole system of planet earth (Biosphere 1) and its many scales of structure and function. Universities are concerned with them all.

The Greening of the University is part of the Greening of Humanity worldwide--accepting responsibility for serving the combined economy of humans and environment.

Environmental knowledge in the University is in all colleges, and most have environmental initiatives. But is that enough? Classical disciplines divide up the environmental system. University administration is also decentralized in its environmental relationships.

Environment is a new discipline that cuts knowledge differently, combining elements of the classics (Figure 2).

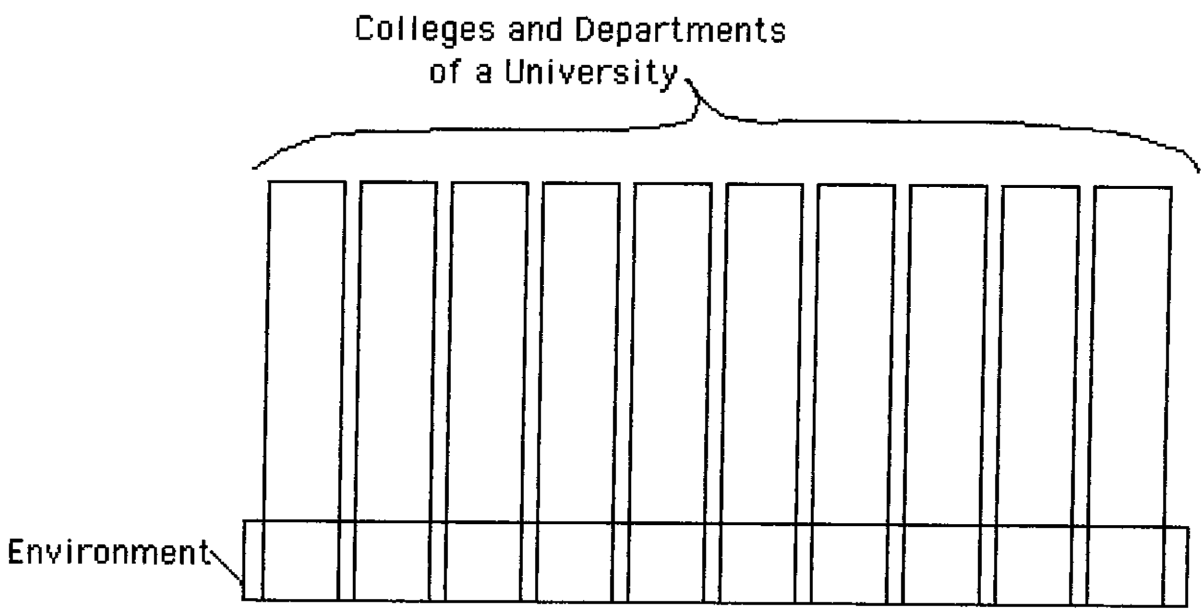
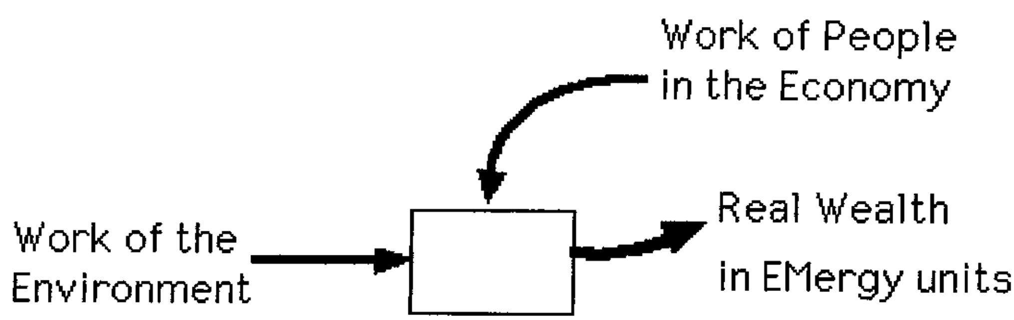


Figure 2. Divisions of knowledge.

Principles of Energy Systems

This presentation begins with some principles and from these derives suggestions for initiatives.

Principle 1:
According to the maximum empower principle, successful systems maximize real wealth, both environmental and human-economic. Emergy (spelled with an "m") is a measure of work of both on a common basis. Emergy is sometimes called Emergy memory. The diagram shows how the two kinds of work have to interact to maximize both. Universities need to do this on many scales (Figure 3).



Emergy is sum of all work expressed as one kind of energy.

Figure 3. Contributions by interacting inputs of different energy quality.

Principle 2:
When there are unused resources available (example sun, nutrients, fuels), empower is maximized by competitive overgrowth of a few short-lived growth specialists. Often regarded as bad, a eutrophic stage is normal and necessary in these conditions. But when available resources are in use, empower is maximized by high diversity of specialists in complex organization. This accounts for the ecological successional pattern first described by F. Clements around 1900 (Figure 4).

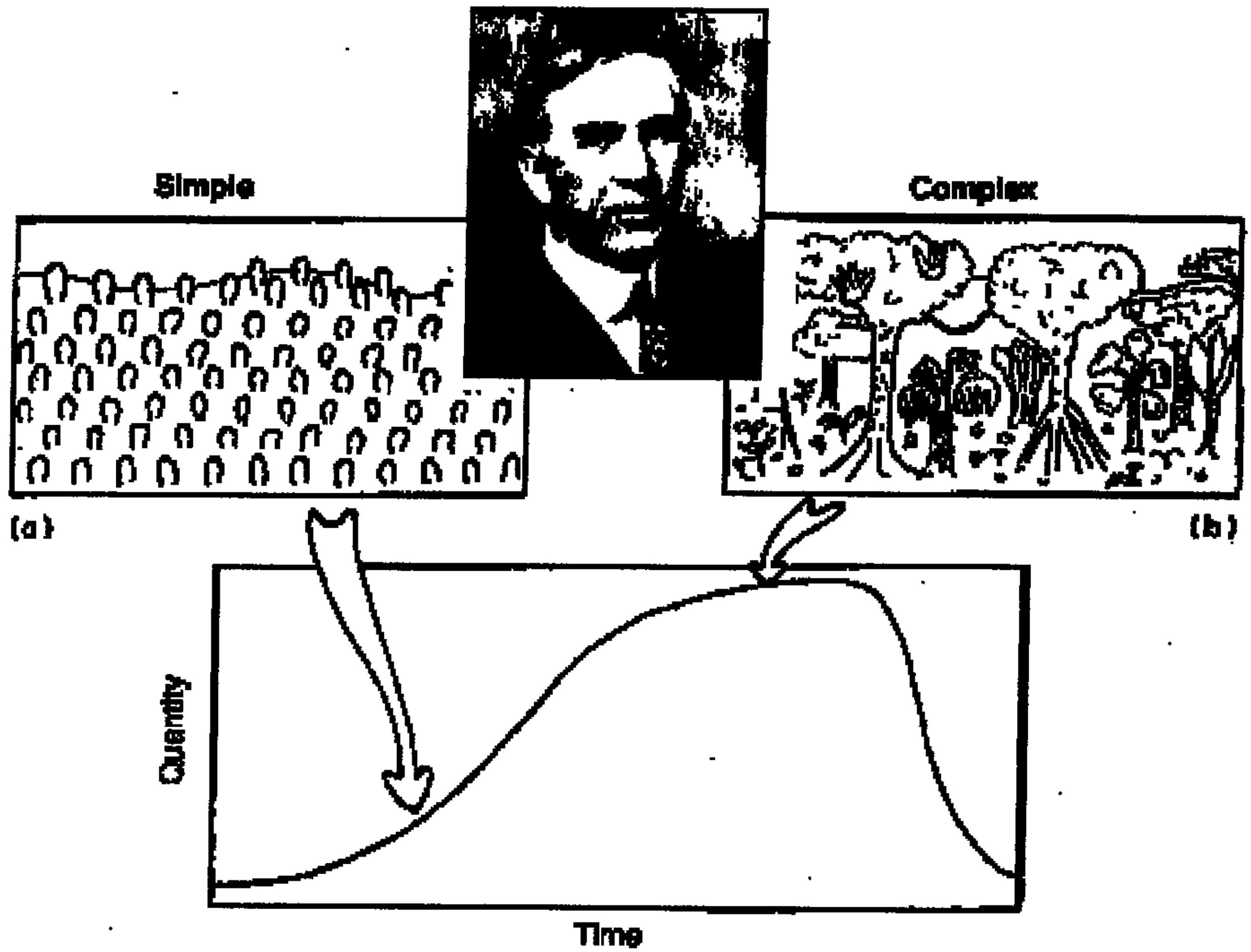


Figure 4. Stages of succession.

Principle 3:
Energy and the materials that accompany energy are organized as a natural hierarchy everywhere in nature and in human affairs. Many units of small scale and concentration combine in transformations that produce fewer units of larger scale and concentration.

Transformity measures the energy quality. Transformity is the emergy per unit energy. Solar transformities range from 1 for sunlight to 10^{32} for the genetic information of life. The relationships of the small-abundant to the large-scarce are quantitatively shown with graphs of Quantity versus transformity (plotted with logarithmic scale in Figure 5):

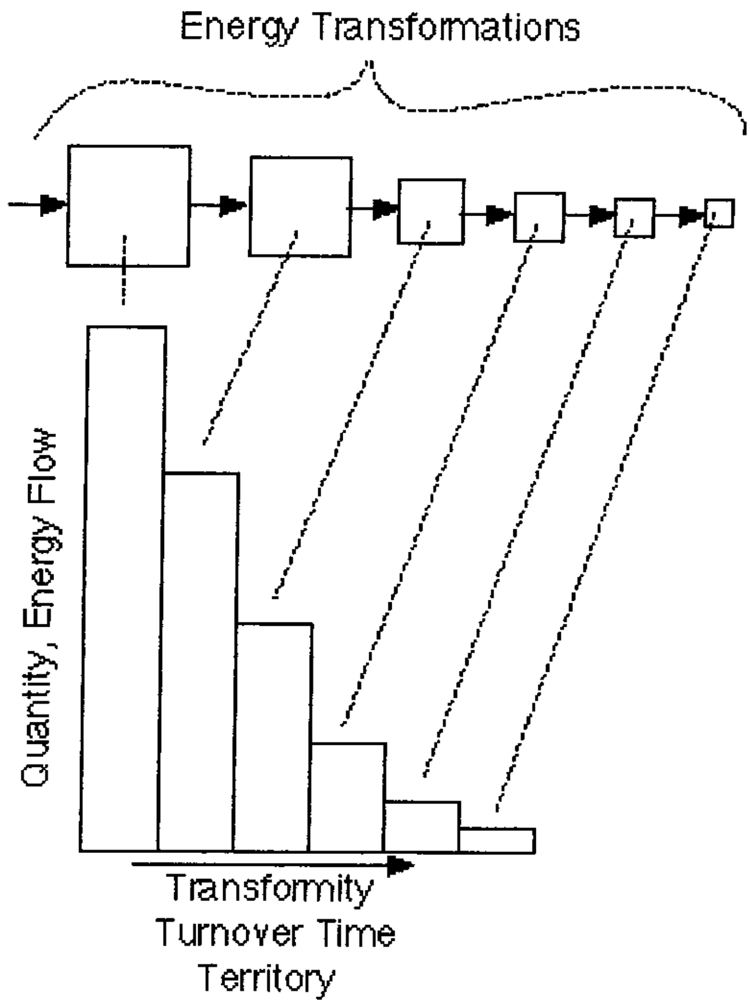
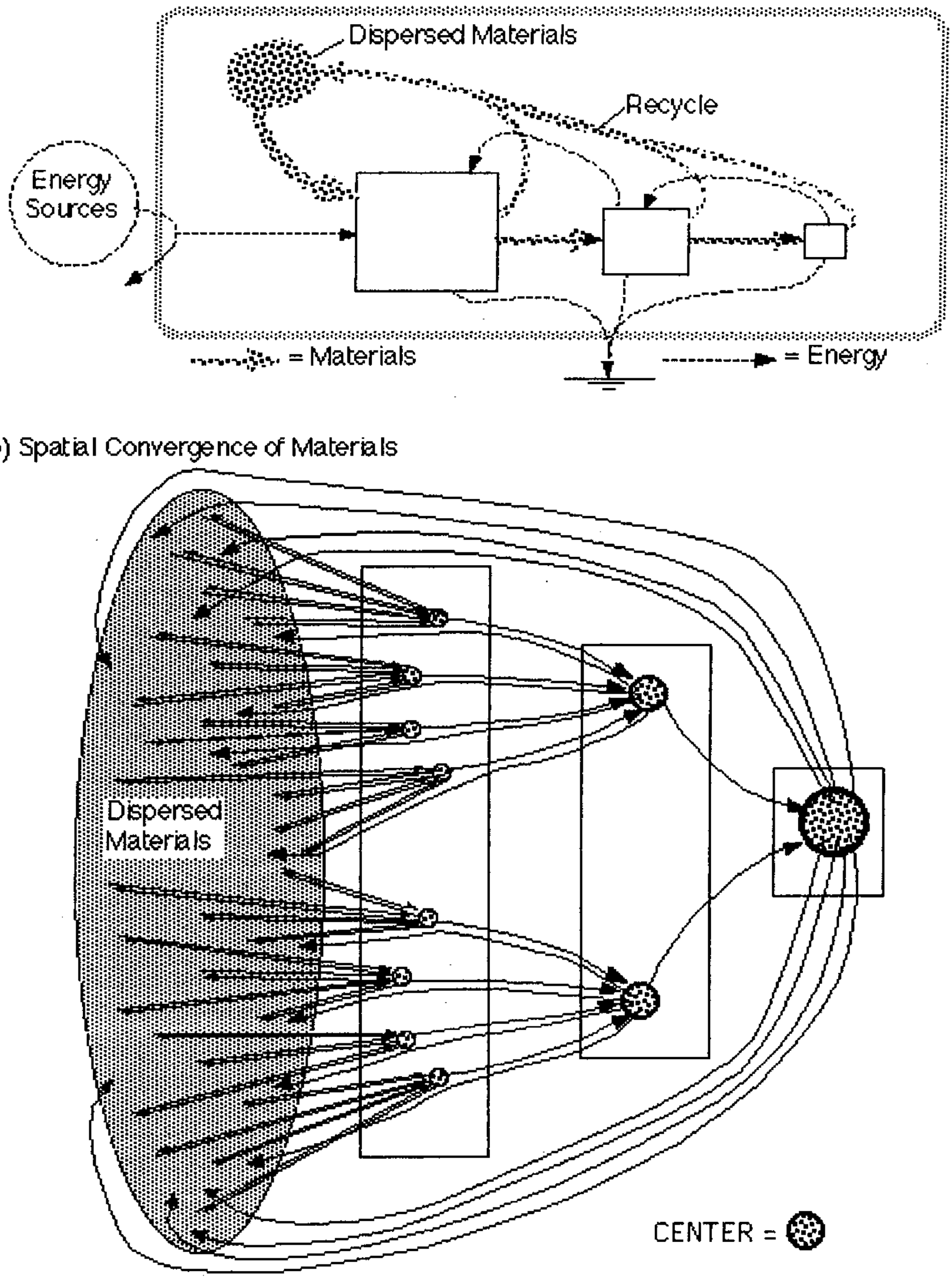


Figure 5. Hierarchy of energy represented by quantity as a function of increasing scale (logarithmic plot).

Principle 4:
Energy and materials self organize in a spatial hierarchy with many small inputs over the landscape, converge and are transformed to smaller centers of high concentration (Figure 6). At each transformation a larger amount of available energy is used up to make an output of higher quality

(a) Materials Combined with Energy Flows

(b) Spatial Convergence of Materials



Spatial Hierarchy of Energy and Material Cycles

Figure 6. Convergence, concentration, and transformation in centers.

and ability to control and amplify. Empower density (empower per unit area) measures position in the spatial hierarchy where transformities are high.

Examples of spatial concentration of emergy: tree trunks, bird colonies. stream deltas, volcanoes, beaches.

High quality energies diverge as they feed their actions back outward from the center. Materials disperse outward in their recycle. Wastes need to diverge, dilute, and be dispersed--not landfilled.

Doxiadis discovered these principles at they apply to city planning. Material concentration increases in centers. Information concentrates in centers. Buses should follow the converging lines increasing flow towards center. As the diagram suggests, good landscape organization has centers converging to larger centers.

In developing housing, infilling is incorrect because it interferes with the appropriate relationship of the different levels of concentration and their interactions.

Spatial maps of empower density, transformity, and other measures of spatial organization and hierarchy are in the most interesting recent dissertations of David Lambert and Sherry Brandt-Williams on Alachua county and the Masters Thesis of Douglas Whitfield on Jacksonville. Highest values were found in Shands Medical Center. (Lambert, J.D. 1999. A Spatial Emergy Model for Alachua County, Florida. Ph.D. Dissertation, City and Regional Planning, Univ. of Florida, Gainesville, 500 pp.; Williams, S.L.B. 1999. Evaluation of Watershed Control of Two Central Florida Lakes; Newnan's Lake and Lake Weir. Ph.D. Dissertation, Environmental Engineering Sciences, Univ. of Florida, Gainesville, 257 pp.; Whitfield, D.F. 1994. Emergy Basis for Urban Land Use Patterns in Jacksonville, Florida. Master's Thesis, Dept. of Landscape Architecture, Univ. of Florida, Gainesville, 224 pp.)

Money circulation and finance also concentrate to the centers. There is a higher ratio of money flow to real wealth in the city centers. Satellite view of night lights shows hierarchies corresponding to the distribution of population (Figure 7).

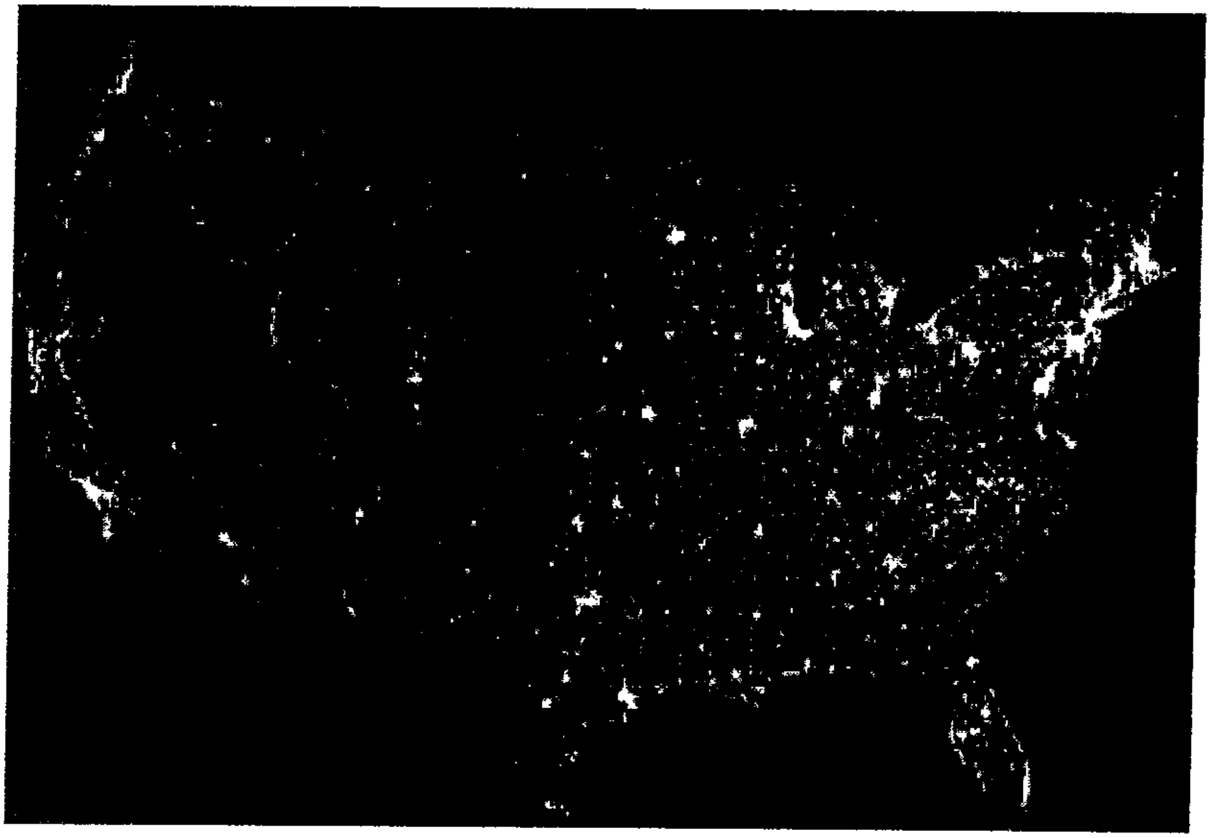


Figure 7. Spatial Hierarchy indicated by urban night lights.

Principle 5:
Money circulates among people, but not to the environmental units of the system. Therefore, money cannot measure environmental contribution to real wealth. Emergy measures both human work and environmental work on a common basis. Emergy can be expressed in economic equivalents for any year by dividing by emergy/money ratio for the economy of that year to obtain emdollars (abbreviated Em$). Economies maximize real wealth by symbiotically maximizing total emdollar production and use.

Principle 6:
Starting as babies, people develop larger and larger scale of operation, territory, and transformity. Their transformities (= Emergy/energy) increase (Figure 8):

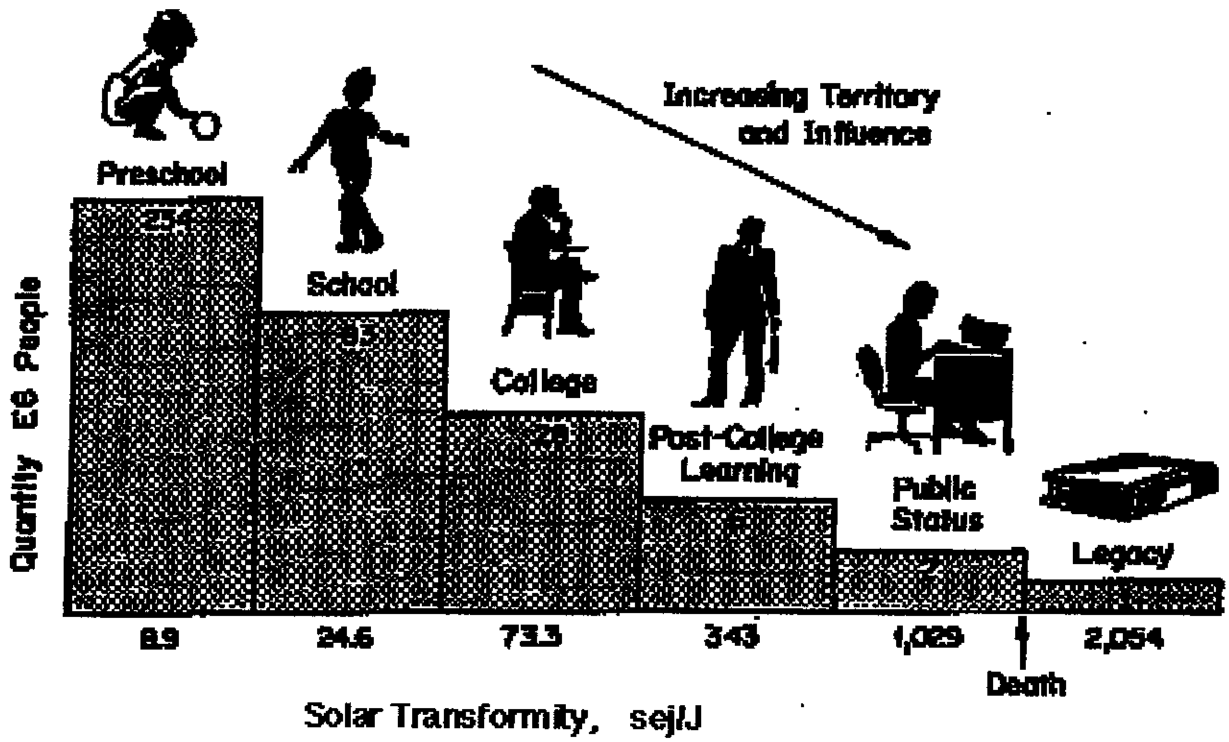


Figure 8. Energy hierarchy of human life.

The useful work that people do is higher transformity than their inputs. They link with larger and larger environmental scale as they mature (Figure 9).

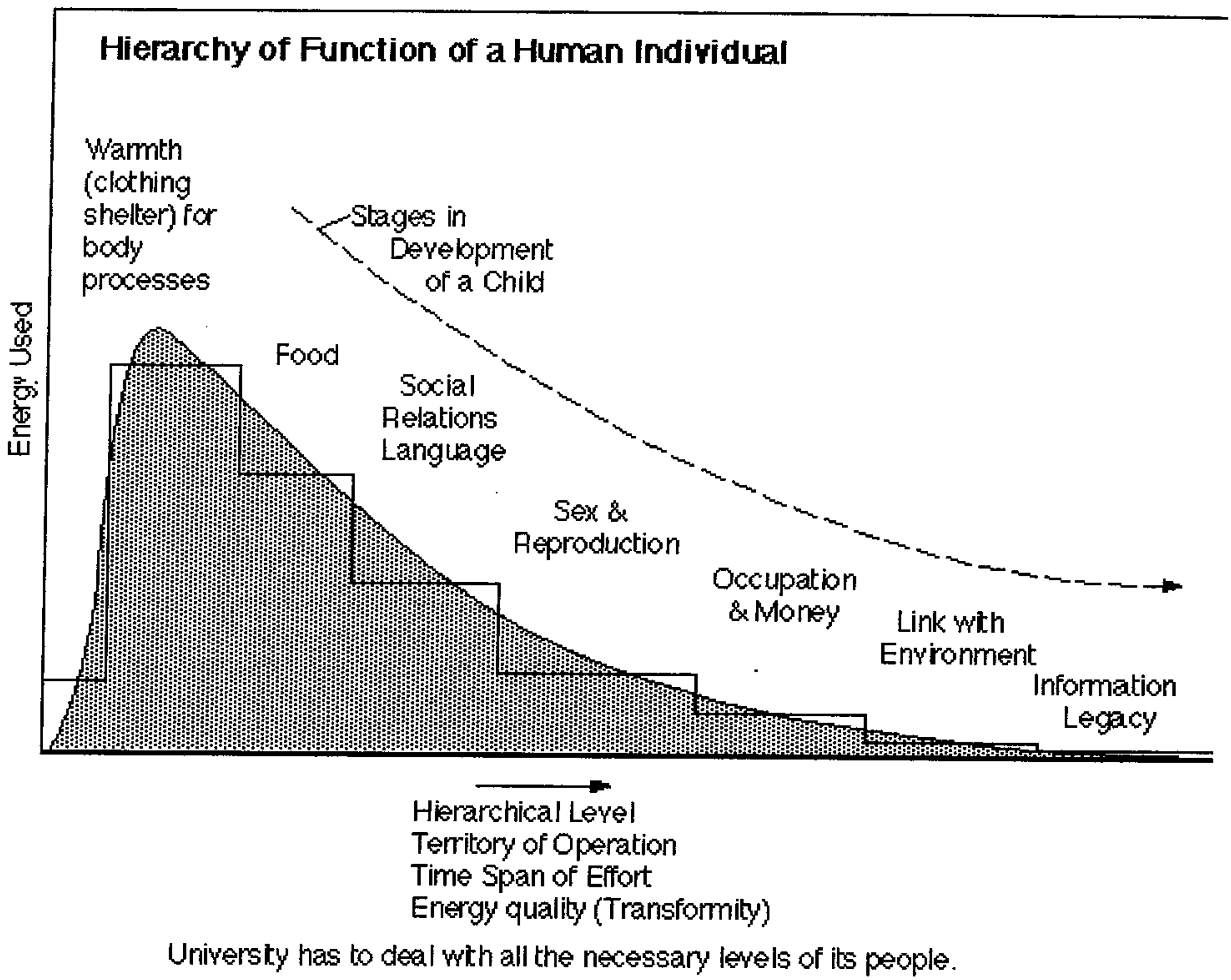


Figure 9. Environmental scales of human ontogeny.

Principle 7:
Because it allows a small energy storage of high quality to have maximum reinforcing effect in controlling lower levels of the system, <u>self organization stores and pulses at each level of scale</u>. The higher the level the less energy is available, but the transformity is higher, and the pulses have greater effect by storing longer and delivering pulse energy in stronger shorter bursts. Since all levels store and pulse there is no sustainable level except that there can be a repeating pattern in the long run. Ecological succession is half of the repeating cycle. Descent and restart is the other half as shown in the pulsing cycle:

Like everything else universities operate in pulses at all scales from their global role down to the biochemistry of their individuals. The most important pulse is on the scale of our civilization, which is at or near the Climax of Stage 2 (Figure 10).

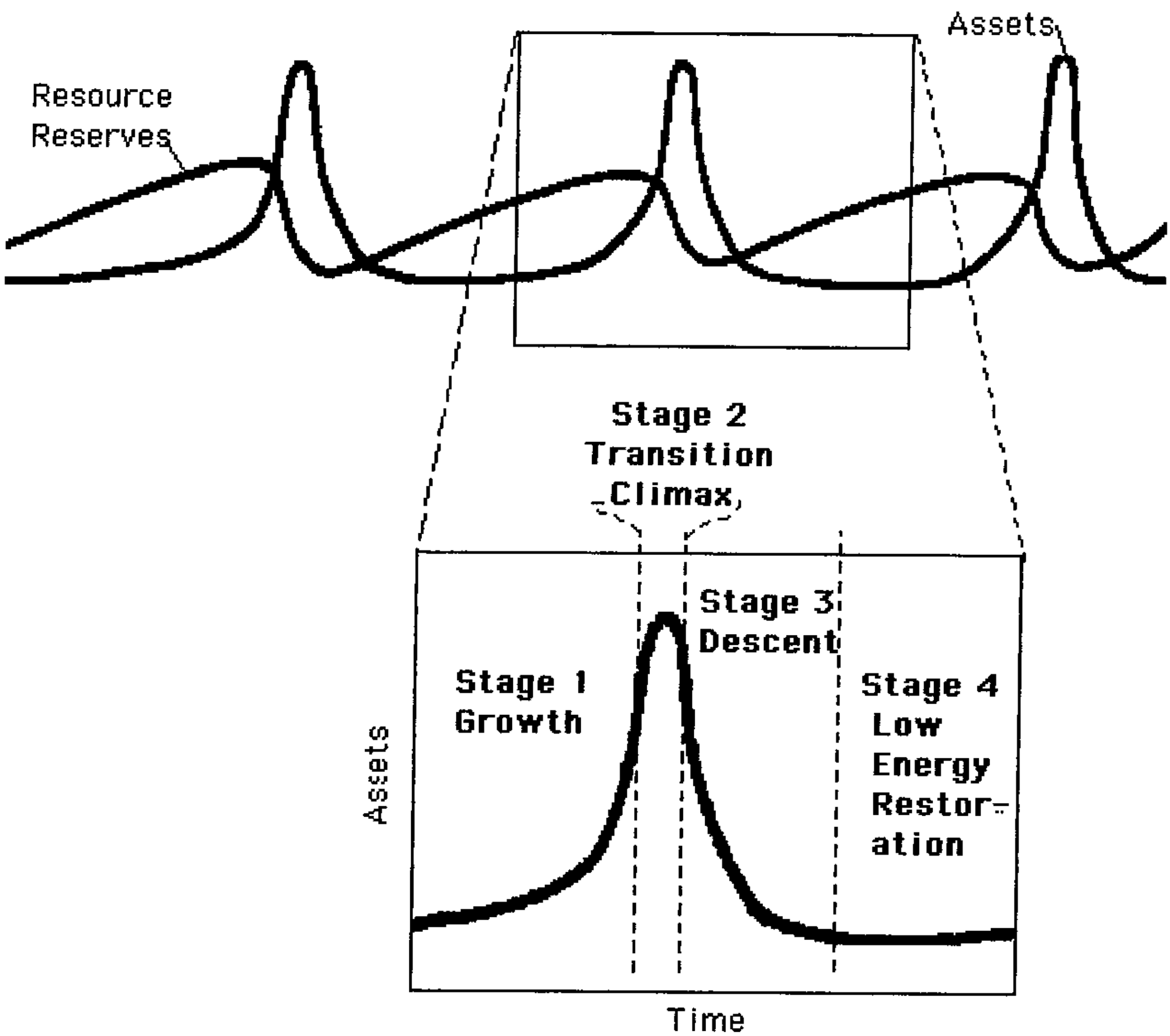
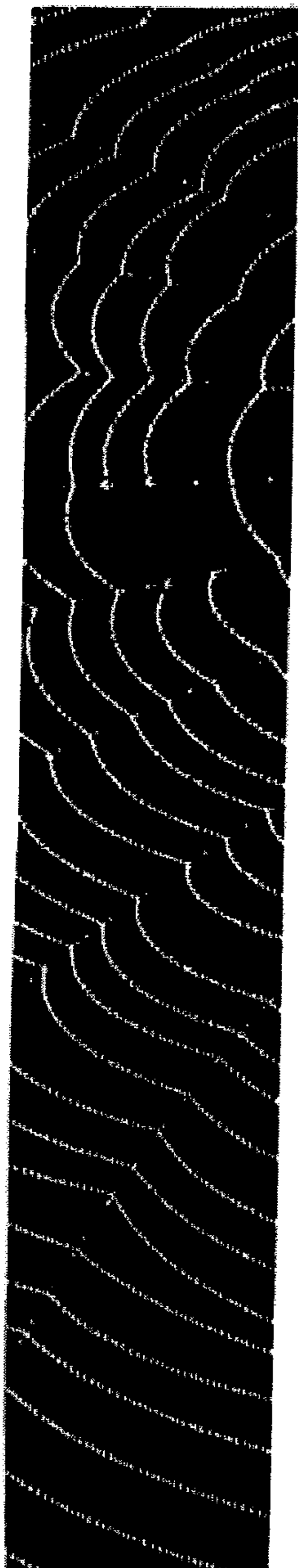


Figure 10. Stages in the cycles of accumulation and pulse.

We have a new book on energy systems principles, models and simulation from Academic Press:



MODELING FOR ALL SCALES

AN INTRODUCTION TO SYSTEM SIMULATION

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All manner of models are used to describe, simulate, extrapolate, and ultimately understand the function of dynamic systems. These sorts of models are usually based on a mathematical foundation that can be difficult to manipulate, especially for students. **MODELING FOR ALL SCALES** uses object-oriented programming to erect and evaluate the efficacy of models of small-, intermediate-, and large-scale systems. Such models allow users to employ intuitively based symbols and a systems ecology approach. The authors, leaders in the systems ecology community, have originated much of the scientific vocabulary of the field. After an introduction to modeling and its benefits, several chapters detailing the more particular elements of successful simulation are followed by another series of chapters, each devoted to models of different sorts of systems. Small-scale models of growth, competition, and evolution give way, successively, to larger and larger scale models such as international trade and the global geobiosphere. Anyone interested in an easy-to-use approach to modeling complex systems authored by perhaps the most original systems ecologists of the century will want this book. To further enhance the user's ability to apply the lessons of this book, a CD-ROM that provides the fundamental tools for modeling at all scales is included.

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San Diego San Francisco New York Boston
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Printed in the United States of America

ISBN 0-12-524170-4
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MODELING FOR ALL SCALES

Greening the Many Scales of University Function

The scales of the university function are shown on a graph of quantity and energy scale (transformity) in Figure 11. Initiatives are needed for each scale.

For the Global Scale

An energy systems diagram shows the university role in information and environment (Figure 12). Items in the diagram increase in transformity from left to right, with highest values for information.

Conservation of information, both genetic and learned, through teaching and archiving, is the first mission of universities. Included are the biodiversity of nature and the long range memory of society, which is the library. Scarce library money should not be diverted to short range needs. The internet appears to be the short range memory of society. As in the analogous processes of the human brain, short range information has to be sifted and selected for preservation, a university function.

Planning for the descent should take priority in universities, not only for itself, but for its role as the long range information storehouse of society. Our Australian colleague, David Scienceman, suggests the word empathy for the process of maximizing empower on the pathway down.

Not all the great quantity of information in our current climax pulse can be sustained in the down cycle. How do we organize and save what is most important? Perhaps this is a priority for long range greening committees.

University presidents often describe the university mission as teaching, research, and service. But a great university emphasizes the Fourth Mission, developing new ideas for leading the world.

Emphasis and promotions should be for:

- Long term concepts and ideas (not short term projects to get money)
- Global sharing of information and ethics (not patents, copyrights, and profits)
- Giving long term security to knowledge emphasizing principles

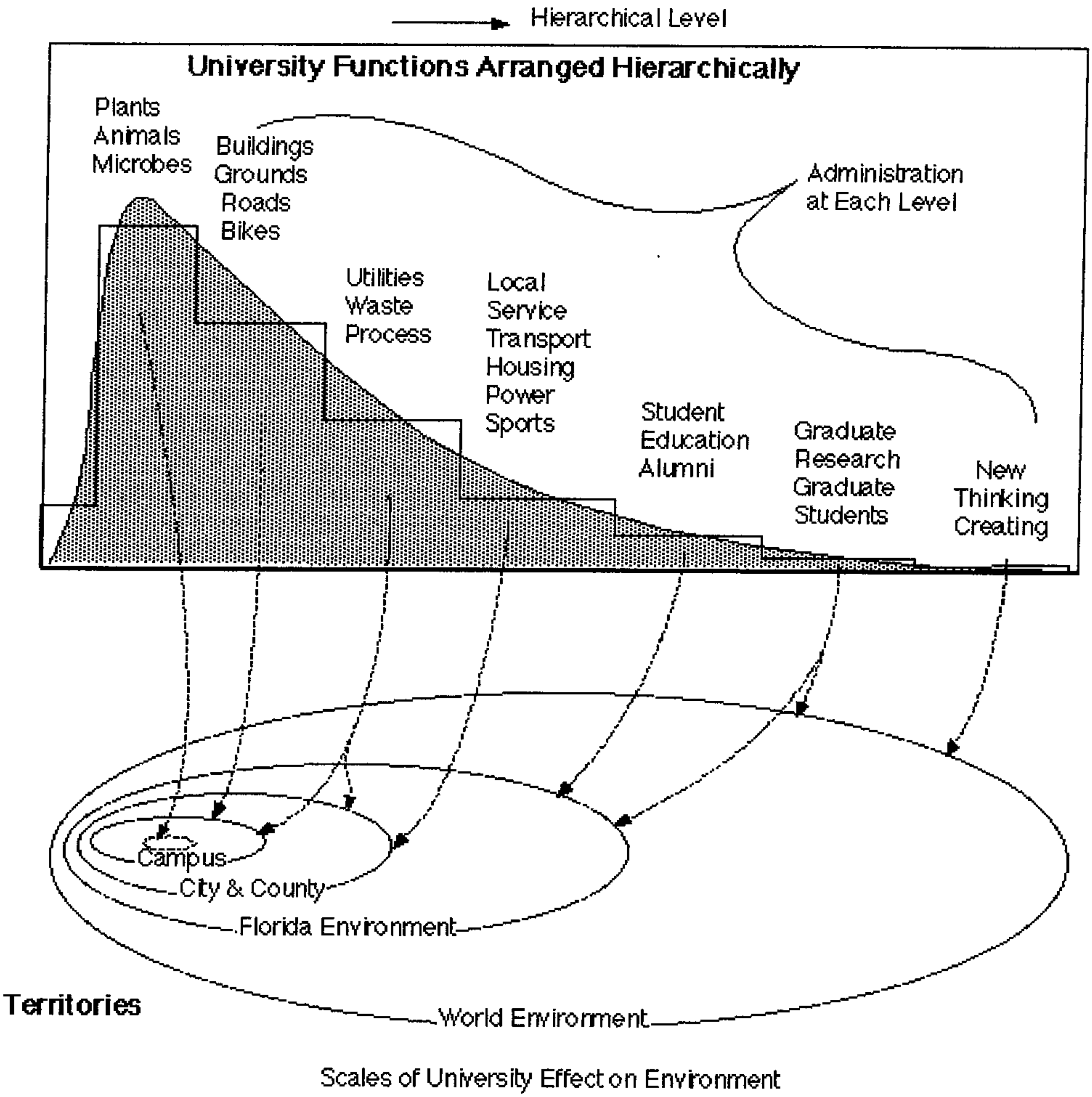


Figure 11. Energy hierarchy of university function.

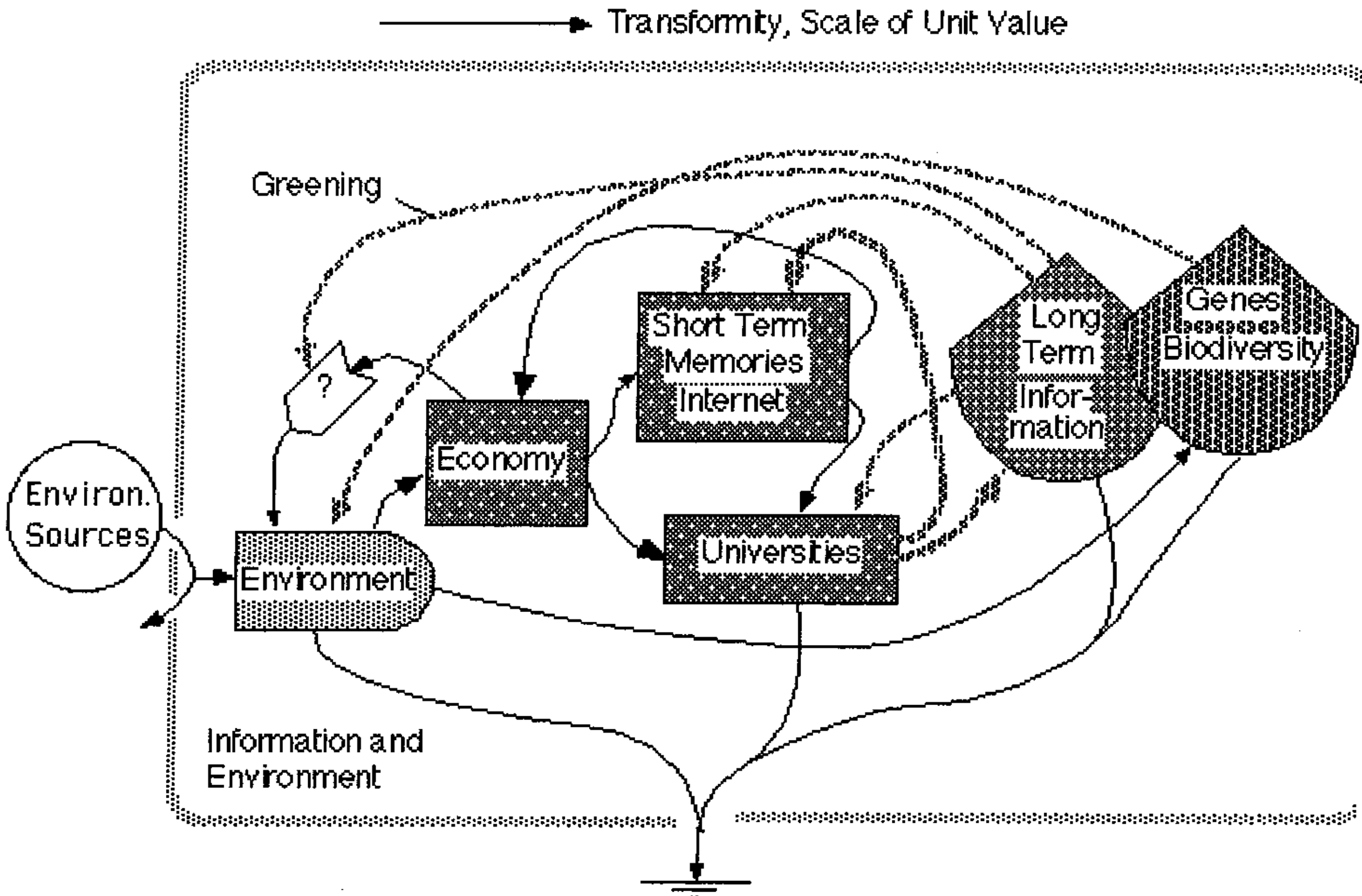


Figure 12. Basis and roles of information in society and environment.

Projects are needed on international organization:

- Fostering peace through shared respect of differences
- Arranging equitable exchange treaties using emergy evaluation
    - (free trade is usually unequal when measured in real wealth emdollars)

Show how to limit the global climate impact from the excess carbon dioxide of civilization without violating the maximum empower principle:

- Developed countries can limit private automobile horsepower
- Poor countries can reforest their lands

For the Scale of a University's Role in Its State

Develop and justify concepts and policies for environmental management

Construct wetlands to filter runoffs from all urban areas and agriculture before waters are routed to ground water

Develop guidelines for conservation easements for water management:

- Retain pond-cypress recharge patterns
- Keep freshwaters on land not into estuaries
- Route paper mill waters to wetlands in the pine lands

Retard sea level rise due to land subsidence by stopping heavy ground water use in coastal areas.

Use water resources to maximize values within counties, not pump across counties to overdevelop some cities

Evaluate environmental alternatives and select to maximize their contribution to real wealth using emergy measures as follows:

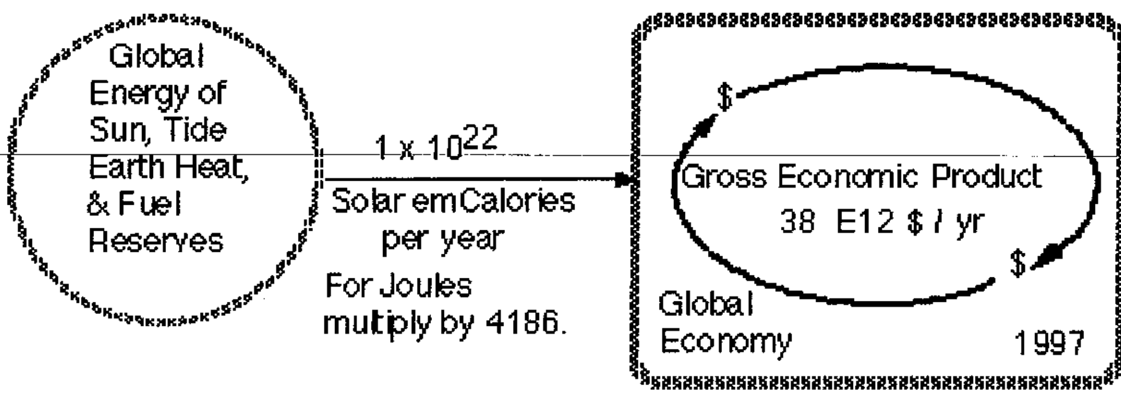
Use Emdollars to Evaluate Nature's Work on the Same Basis as Human Work

1. Multiply the area by nature's annual work for that kind of area in emergy units. (To do this, each type of energy used is multiplied by its emergy/energy ratio. Emergy/energy is called transformity, and tables are available.)

Emergy is the sum of all the energies expressed as one kind of energy, solar energy, that would be required directly and indirectly to generate the work. Its unit is the solar emCalorie (or solar emjoule).

2. The buying power of money depends on the emergy of real wealth. Multiply the emergy by the money/emergy ratio for that year to get the monetary equivalent of nature's work.

Money/emergy ratio has been called Monergy. It is obtained by dividing the gross economic product by the emergy contributed. Example from Brown and Ulgiati (1999) (Figure 13).



$$\frac{38 \times 10^{12}\ \$/yr}{1 \times 10^{22}\ semCal/yr} = 3.8\ em\$ \text{ per } 10^{9}\ semCal$$

Figure 13. Emergy basis for global circulation of money expressed as emdollars (modified from Brown, M.T. and S. Ulgiati, 1999, Emergy evaluation of the biosphere and natural capital, AMBIO 28(6):468-493).

A full treatment of energetics and emergy evaluation is given in my 1996 book: Environmental Accounting, Emergy and Decision Making, John Wiley, NY.

For the University within its Local Region

Maximize the economy by greening with systems concepts
- Help information of the University foster the center of the local economy.

Integrate county, city, and university as one system
- Combine City and County Commissions?
- Include an ex-officio university representative?
- Unify the (county-city) tax system, less tax with distance from center

Plan according to natural hierarchy
- Arrange bike lanes straight, smooth, curbed separately
- Arrange hierarchical bus lines, small buses in feeder inflows
- Foster developments in centers that connect--not infilled

Develop policy for environmental biodiversity
- Retain all biomass on the lands, building soil (not gathered by city)
- Eliminate spraying; use biodiversity method of reducing insect pests
- Initiate incentives for less intense lawns, replaced with complex diversity lawns, shrubs, and trees

For the Scale of the University Itself

First develop a systems understanding of relationships. For example, improve, extend, and update the 1978 systems view of the University of Florida in Figure 14 (Odum, H.T., T. Gayle, M.T. Brown and J. Waldman, 1978, Energy Analysis of the University of Florida. Center for Wetlands, University of Florida, Gainesville, unpublished manuscript).

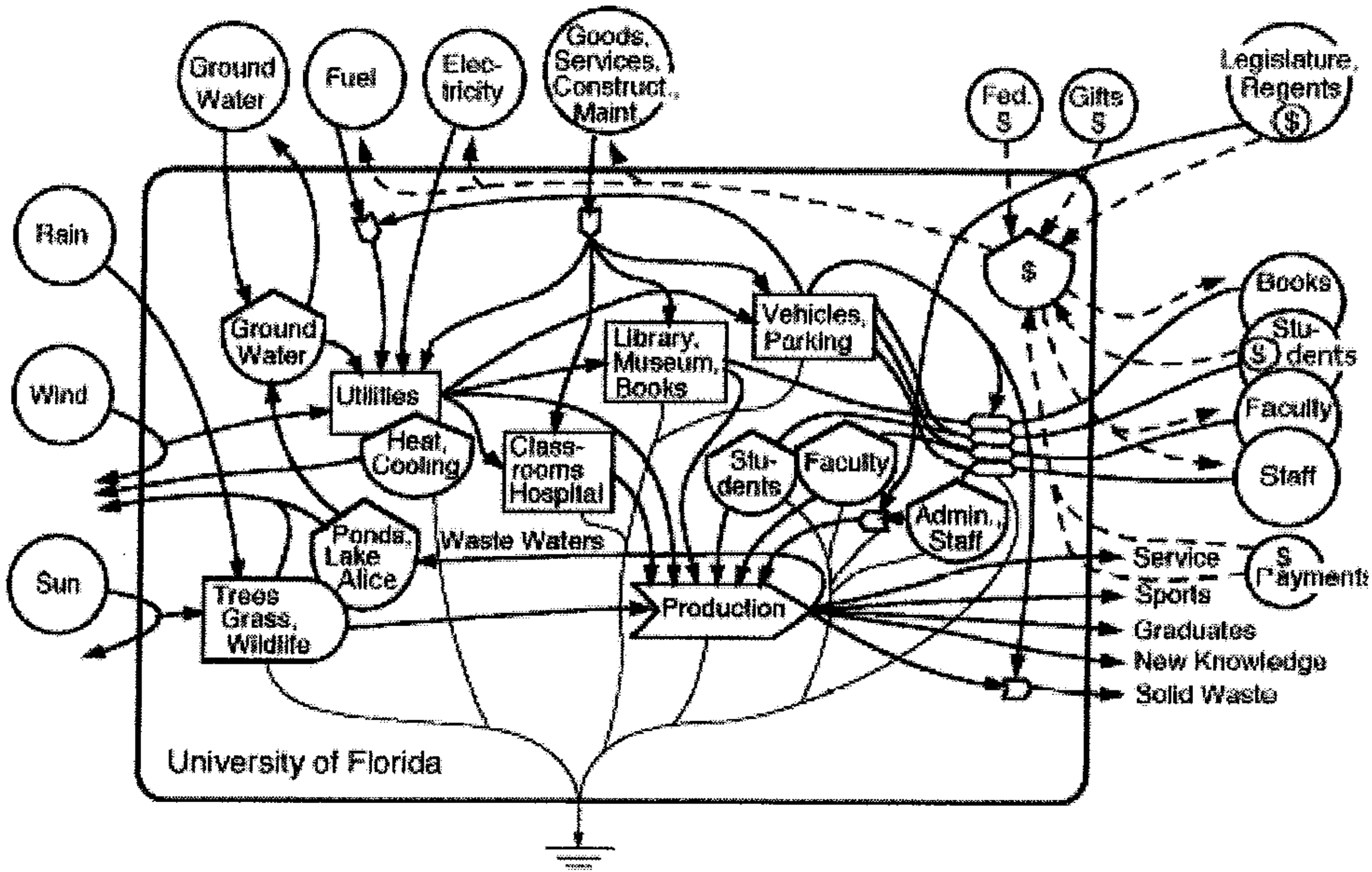


Figure 14. Energy systems diagram of a university.

The university production function is enlarged in Figure 15 to show the necessary inputs and the products: service, sports, graduates, new knowledge and wastes. The most important emergy input may be that of the information in the students from their pre-university education. A proper evaluation of library books has not been made. Possibly, the high emergy required to generate the first copy plus the emergy required for preservation should be divided by the estimated number of copies in existence to get the real wealth value of a library book.

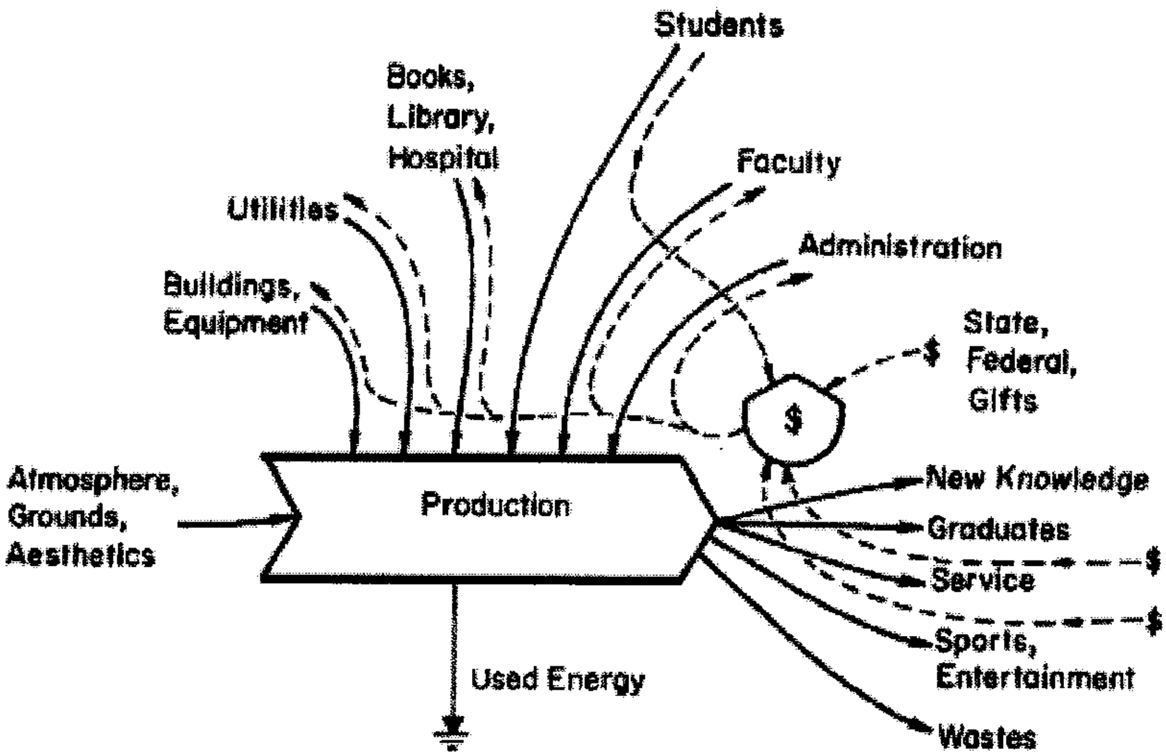


Figure 15. Production function of a university and its relation to money.

The following table summarizes the preliminary evaluation of real wealth involved in the University of Florida in 1978:

Emergy-Emdollar Evaluation of the University of Florida Production in 1978*

Item	Emvalue Million Em$/year#
Local environmental inputs	1
Fuels, water, electric power	101
Plant and administrative services	102
Entering students	973
Student support	585
Library	23
Faculty knowledge used	1449
Faculty service	655
Building and Replacement	63
Total	3,952
Part from paid services	1,075

* Odum, Gayle, Brown, and Waldman (1978)
# Expressed in 1997 Emdollars

Possible Administrative Initiatives

Declare a year of the environment with the environmental theme for fund raising.

Assemble environmental departments and centers in the Environmental College--but retain links to their present colleges. In the present system, environmental science staffs may be decreasing because the colleges give other appointments higher priority.

Seek new law to set up university teaching and research land trust for gift ecosystems (lands that can't be sold by development boards). A land management division should be separate from a development board to receive gifts of special lands for environmental teaching and research that cannot be sold for cash. Seek at least one kind of ecosystem near campus to be become part of this educational resource before they become unavailable in north Florida.

Innovate environmental art and its teaching (both abstract and realistic)

Develop initiatives to increase environmental ethics in early religious teaching--perhaps using philosophy courses

Establish degree in Ecological Engineering composed of the normal core engineering courses, the essentials of environmental science, and the principles for leading environmental policy. People with this degree are needed to guide environmental management. Neither engineering nor biological science backgrounds are adequate alone.

For the Longer Range Future

Plan present initiatives now consistent with the downsizing ahead after the last of growth.

Accelerate mission to consolidate knowledge--the long term memory of civilization

Provide state and national guidelines for making the way down prosperous: reducing population, excess transportation, luxury, and waste.

Adapt the university to sustainable levels for each step down with fewer and smaller cars, shorter commuting, permanent housing at campus, and less funding available for capital expansion.

Restore pre-1950 educational efficiency patterns:

- Saturday morning classes, students remaining on campus on weekends
- High School graduation after 11 grades

For the Small Scale within the University

(illustrated with University of Florida examples)

Vary the water level of Lake Alice outlet stand-pipe 4 feet during each year to provide the normal water level regime that will restore a broad wetland again. This helps bind nutrients and oxidize peripheral muck.

Make a swamp tree island to attract a bird rookery again. Lake Alice was originally set aside because of the nesting waterbird rookery on drowned trees.

Make campus an arboretum; start with 5 plantings of each native species

Fence and label with signs the ecosystem patches that are in walking-distance of classes in ecology and environment. For example, just below the New Engineering Building is a patch of upland forest and a patch of floodplain forest. Allow dead wood to decompose normally in these. The several ponds are excellent for limnology. Let them self organize.

Start a policy to retain more dead limbs for woodpeckers where people underneath are infrequent. Perhaps fence below old trees to avoid liability.

Foster higher diversity lawns, low nutrient, no fertilizer or pesticide; encourage high diversity of insects--few of each.

Allow self organization of the mix of ornamental exotics with natives to maximize diversity. It is not natural to try to hold on to past ecosystems if they don't fit new conditions.

For the Individual Scale

Establish an introductory environment course required of all students with some common core content (defined by committee), but adapted by and for teaching in each college with relevant examples.

Parting Thoughts

By this talk I wanted everyone to see that the human individual, the university, and the environment are each hierarchical organizations operating with many scales. To green the university means to make better symbiotic couplings between these systems. There are opportunities for new initiatives on each scale, illustrated here with a few examples for each. Emergy valuation is available where choices require quantitative perspective.

An elementary on-line course that introduces energy systems concepts is available at Santa Fe community College, Gainesville, FL: Energy and Ecology, 3 hours credit, Elisabeth C. Odum, Instructor. The text is our book: H.T. Odum, E.C. Odum and M.T. Brown, 1998, Environment and Society in Florida, Lewis Publ., Boca Raton, FL. Call Santa Fe Community College at 352-395-7344 or go to web at www.santafe.cc.fl.us.