COMMENTS AND THANKS TO STUDENTS AND ASSOCIATES

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Handout on the Occasion of the Celebration in Chapel Hill, N.C.
"Advances in Understanding Ecological Systems"
August 31-September 2, 1989

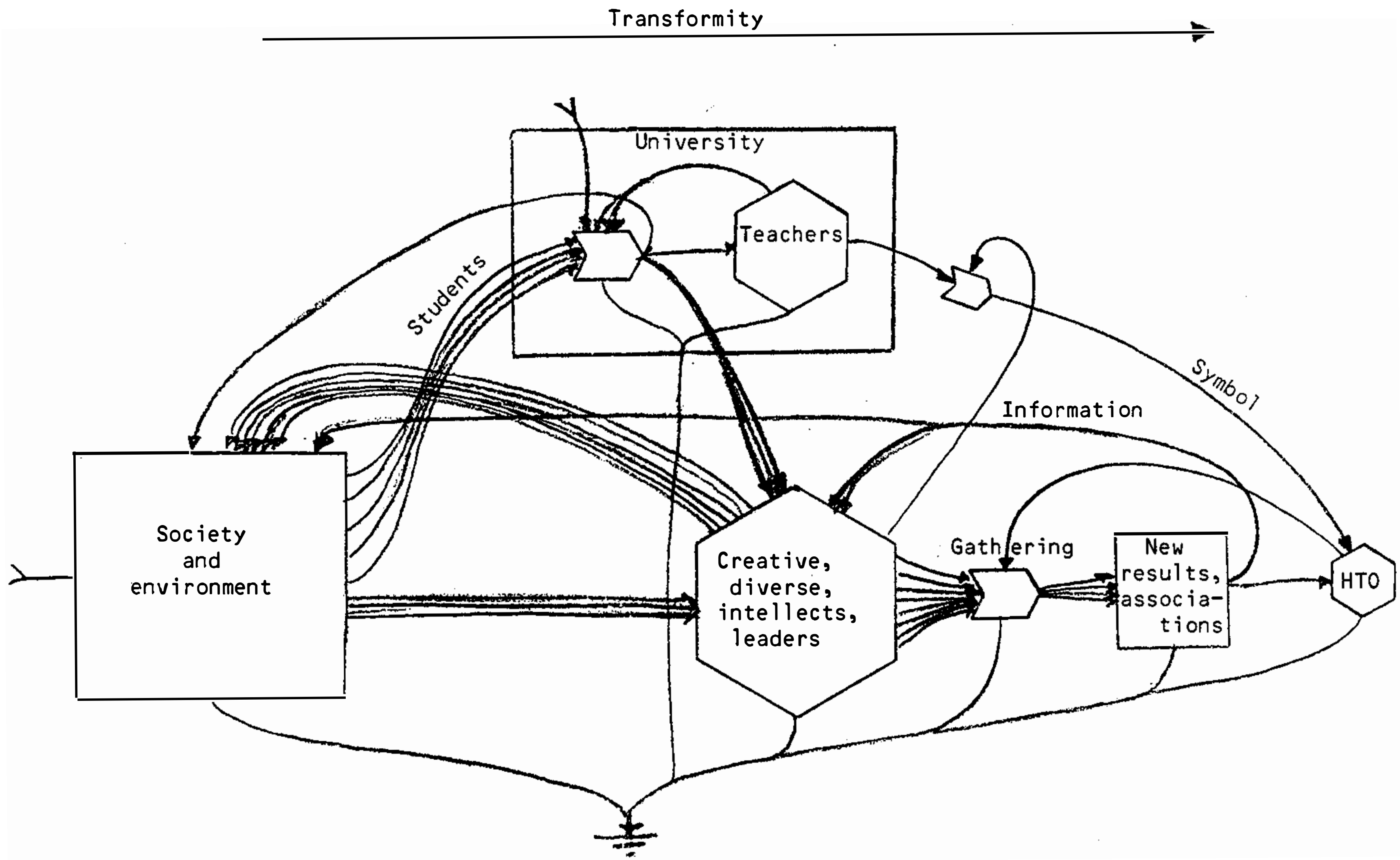
Other handouts for those interested (See corner of the room):
1. Green book for introductory teaching "Environmental Systems and Public Policy"
2. Purple book for teaching microcomputer simulation "Minimodels #4"
3. 3 1/2" or 5 1/4" disks with the minimodels described in books #1 & #2 for IBM-PC, Macintosh, and Apple II
4. Green energy systems symbols template
5. Page corrections for "Systems Ecology"
6. Page corrections for "Energy Basis for Man and Nature, 2nd Ed."

First, I need to acknowledge with all manner of thanks possible the vitalities and missions of those present, of those who could not come, our roots in intellectual grandfathers, many of whom you have never seen; of the intellectual grandchildren, many of whom I have never seen; the courageous key persons in the world who open the door for our new principles, many of whom we never even know about, and thus all those that form the world-wide web of shared ideas that now begin consciously and unconsciously to lead the earth's progress with the principles that have been recognized first in the ecosystem.

It may be customary for one honored to express the surprise and humility to be in such a position. On the one hand surprise is an honest feeling for a once shy child, since one's self-view is always behind the time and one never really thinks of oneself even as a grown-up, much less as a focus of attention of important people. Recognition is quite unexpected when one is used to having concepts forty years developing ridiculed, ignored, and if successful, quietly absorbed into the general knowledge. Its a surprising role for one used to being an outcast intellectual rogue, although also always the loyal opposition.

On the other hand, humility may be out of place for one forced to develop enough arrogance to sting the majority when it is wrong. I have played many roles sometimes with the majority, but more often attempting to shock the scientific establishment into a better view.

But we are not really here for personal honors and feelings. The real purpose of ceremony is to galvanize a group around important purpose. A systems view of this is Figure 1. The subject is the ecosystem and its increasing use as a model for understanding the whole self organizing system of the planet and beyond. I never cease to be amazed by the power of self organization. Like the ecosystem generally, the food chain builds information symbols which, if successful, catalyze feedback to humanity and nature (Figure 1).



Information Production System for
Humanity and Nature

Figure 1. A systems overview of this celebration meeting (Sept. 1, 1989).

To the extent that I understand it, something like this system (Figure 1) is operating here today: an aberrant network teacher is being used as a symbol to unify and catalyze a unique and contrasting set of key individuals as they rise to the time-ripe opportunity to turn the paradigms of humanity around as the new self-organization of humanity within the biosphere.

Each in many different ways replicates the system (1), catalyzes their own group to develop better patterns of environment, sometimes teaching, researching, regulating, planning, building, probing, criticizing. It's a chain reaction of synthesis information now falling on more and more receptive ears as the world reprograms humanity to maximum performance.

Some affect the systems by blending and bending and becoming the symbols of the majority; others by attacking, denouncing, confronting, becoming the nemesis symbols of the opposition.

What are those concepts we bring to organize the planet's information store? Let's review some principles shared by many here:

Look to the next larger scale view for solutions to a problem.

Neither verbal nor quantitative is adequate without connectivity perspectives of network overview.

Structural and functional principles easily seen with ecosystems are the basis of other realms; the concepts quantitatively abstracted with measures of energy, complexity, network designs, and information seem to be easy means to new knowledge in other fields.

The human is the biosphere's programmatic and pragmatic information processor for maximum performance. When neither brawn nor baby production is the primary route to maximize system production, information processing becomes even more the shared main-line function of both sexes, perhaps as it always was.

The percent error is the same for each level of hierarchy.

The level of precision by which systems control their own self organization is the same at each level, abandoning precision of one level in order to achieve the same percent control at the next.

Truth is a state of mind in which there is no contradiction. A person with an idea that has never heard contradictory concepts sees his idea as true because there is no contradiction visible. Scientific truth requires that some data from real world nature, particularly in response to experimental test, elicit answers from nature for matching with quantitative ideas (models).

The less one knows, the easier it is to be dogmatic and sure as to what is true. The things we are taught tend to be dogmatically defended as true, whereas the things we learn from experience and experiments tend to be properly couched in reality. Those with only revealed truth teaching (example, religious or scientific dogma) are the ones with the strongest feeling that they are right--since there is no contradiction in their heads). People with only revealed truth (uncontradicted teachings) are the most zealous and potentially the most dangerous in the sense of taking actions with unexpected results that can be destructive to their surroundings and themselves.

The unification of open system thermodynamics with mathematics and science is continuing more briskly now. On this we had a 20 year head start. With help of some physical scientists such as Richard Pinkerton, we spent 5 years of study on open system thermodynamics including weekly seminars on Prigogine's early books at Port Aransas in 1958-59, when the minimum entropy generation principle was being advocated, in sharp contrast to our development of the Maximum Power Principle. Luna Leopold invited me to Phoenix, Arizona, to argue the differences between maximum power and minimum power (minimum entropy generation) in earth systems and share our interests in passive electrical analogs. It became obvious that classical thermodynamic equations chop up real systems into pieces too much to adequately represent open system thermodynamics principles. We realize that work is a hierarchical transformation in a closed loop system configuration that requires system expression.

Thus, we invented the energy systems language so as to adequately express maximum power reinforcement as well as the first and second laws. I used a version of it on ecologists at the ecological society meeting in Seattle about 1962. Our first published use of the symbols was 1967.

The emerging systems ecology field was riding the crest of new computers as a way to put detailed parts together and thus have the whole emerge. Most systems ecologists still think this way. They thought our energy systems language was only another way of writing equations like Forrester's language and, thus, they generally though they could do it using differential equations. Thus, they missed out on thermodynamics of the ecosystem and, thus, the real importance of hierarchy in putting constraints on mathematics. From the start, the diagramming of systems had some hidden truth in it which we gradually recognized and made rigorous, such as representing hierarchy from left to right with transformity as its measure. I used to wonder why students we taught to diagram seemed to throw symbols all over the paper with pathways every which way instead of in the standard pattern--it was a case of our subconscious recognition that hierarchy of food chains and information should control position on the paper.

We found out later that the language also specified mathematic kinetic relationships of systems rigorously whereas ordinary differential equations do not. For example, there are 16 different models already known that generate logistic mathematics. As one learns from analytics and from simulation what the configurations do with energy constraints equations, the ability to understand and see in advance what systems of medium complexity will do is much increased over what can be done with knowledge of separate equations only. The power of the diagrams to encompass problems and anticipate experimental results, setting out important hypotheses, is still overlooked by the majority. Is it because of different aptitudes in regard to network thinking? Is it training?

Or is it desire to simplify by isolating? Traditional experiments in biology remove all complexity except the mechanisms under study. Good ecology keeps all the complexity, holding it as constant as possible while varying the factors of interest. Simulation models are a way of seeing if the mind's ideas as to causes are consistent with experimental results.

It was always a dilemma as to whether to require our students to take classical thermodynamics, because as a field without any new principles in many years, its proponents had become dogmatic and not open to what was now required which was a rejection of classical definitions of work and recognition of the maximum power principle. Those who took thermo picked up the dogma and shut their minds; those who didn't take it were vulnerable to the dogmatic attacks.

At a Gordon Research Conference in New England about 1984, they had King Hubbard, Georgescu-Roegen and I give the preliminaries and a full discussion followed among thermodynamics people who were mostly on the wrong track in making too much of EXERGY, which is nothing but a new word for the old concept of chemical and mechanical potential energy. However, the transformity concepts were finally getting some respect. I believe many took seriously our statement that for energy analysis purposes Embodied EXERGY (Exergy EMERGY in exergy emjoules) is the correct parameter, not EXERGY itself.

The Gordon conference was quite different from the earlier Stanford conference which was set up during the energy crisis with economists, public policy advocates, and input-output types, at that time all new to energy thinking, to discredit our Emergy analysis (not yet called that). It was organized by TRW with NSF public policy insiders who had billion dollar oil shale contracts pending, that our methods said were not net EMERGY. As you know, our viewpoint was outvoted and the testimony to congress ignored. The result was a several billion dollar fiasco when the realities which our analysis showed came home to roost.

It becomes increasingly clear that most of practical thermodynamics is not rigorous except when a calculation is made within one level of hierarchy. Most of process analysis that is supposed to be rigorous is not because all the inputs of chemical, fuels, etc., are of different transformity. Even now, Alvin Weinberg has endorsed Spreng's new book on net energy, which is ignoring transformity. In rejecting the confusion that is in input-output misuse of emergy evaluation, the Oak Ridge establishment threw the baby out with the bathwater. It is hard for scientists to reject what was taught them in freshman courses before they had learned to think (that work is proportional to energy). What you learn early becomes hard to question without creating an intellectual crisis of rejecting your life's assumptions.

What is something of a miracle is the backing and tolerance of the University of Florida Engineering leadership of our programs in the last two decades. Every once and a while a dean would come to hear an energy-simulation lecture to check for himself. The Institute de La Vie prize helped. Once Tom Bullock in electrical engineering was commissioned (rumor has it) to see if our analog simulations were valid. Fortunately he chose Hank McKellar's dissertation simulations, which turned out to be accurate. We were fortunate to have the backing of Chairman Pyatt of Environmental Engineering Sciences, who asked us to form the Center for Wetlands, and pushed us into getting a hybrid computer, although by the time we had it we were jumping into microcomputers. Dr. Pyatt pushed environmental science AND engineering as symbiotic whole. One thing our program does is pull engineering up to a larger scale of hierarchy to include the design of environment and technology and what to construct as well as how. "Ecological engineering" seems to be a good term for it (see Mitsch's book for example).

Maximum power is defined as a useful energy transformation (to higher transformity) where useful is defined as a network feedback to an amplifier interaction with energy of lower transformity. When Herendeen and others ask for a simple equation definition, they are denying the fact that maximum power is defined as a network design and requires a special language, which is what the energy systems language was invented for, the rigorous representation of open systems thermodynamics relationships that prevail.

Following some discussions in General Systems Society in Scotland this summer, it was good to see a newly emerging set of thermodynamics trained thinkers considering the open thermo of the living biosphere. As I first learned in thinking about weather systems in the second world war, the more energy, the more fluid structure emerges and the more power becomes processes.

In Scotland, discussion centered around comparing the non-living Bernard cell to ecosystems, a good way to get biological and physically trained people together. However, it takes the energy network language to really understand. Figure 2 is The Bernard Cell, the energy diagrams, and the simulation that results with the same minimodel that we use on the ecosystem or the economy.

Those with the thermo background find it natural to speak of the maximum rate of entropy increase as dragging the construction of structure (Prigogine's views changed after he abandoned the minimum entropy principle, indirectly advocating maximum power principle but not under that name). A structure accompanying maximum power use he called dissipative structure. A better way to represent the unified process is not as degradation-making structure but vice-versa. It has to be recognized that transformation to a higher quality (that can and does feed back-multiply) is necessary to maximize entropy production rate. Maximizing environmental energy dispersal and maximizing entropy production differ only in dividing the energy flux by the environmental Kelvin temperature. There is ambiguity in the literature on Power as to whether it means useful (or as taught in some elementary courses as any flow of energy per time). It is probably time to take David Scienceman's nomenclature and redefine maximum power as MAXIMUM EMPOWER principle. In other worlds, self organization develops connectivity designs and mathematics that maximize EMPOWER (where EMPOWER is EMERGY use per time). Empower (and power) are not maximized without feedback amplifier configurations and these do not prevail by reinforcement unless there is an energy transformation.

My first priority interests have always been open system thermodynamics of the ecosystem, general systems theory, and simulation. Because I taught in Biology, Marine Science, and Engineering departments I did not emphasize these fields with students. It seemed better to add these theoretical concepts into the environmental science, more down-to-earth teaching, using the energy language for a bridge. But those taught did not always realize how fundamental and new these concepts were. Not many of our students go to general systems society meetings. Perhaps, this is a failure in our teaching to install the love, power, and primacy of the general systems concepts. For about 10 years the general systems society fell under control of non- quantitative verbal behaviorists, losing the mission that Von Bertalanffy started, seeking the homologies between all systems. But the new leadership in that society is promising.

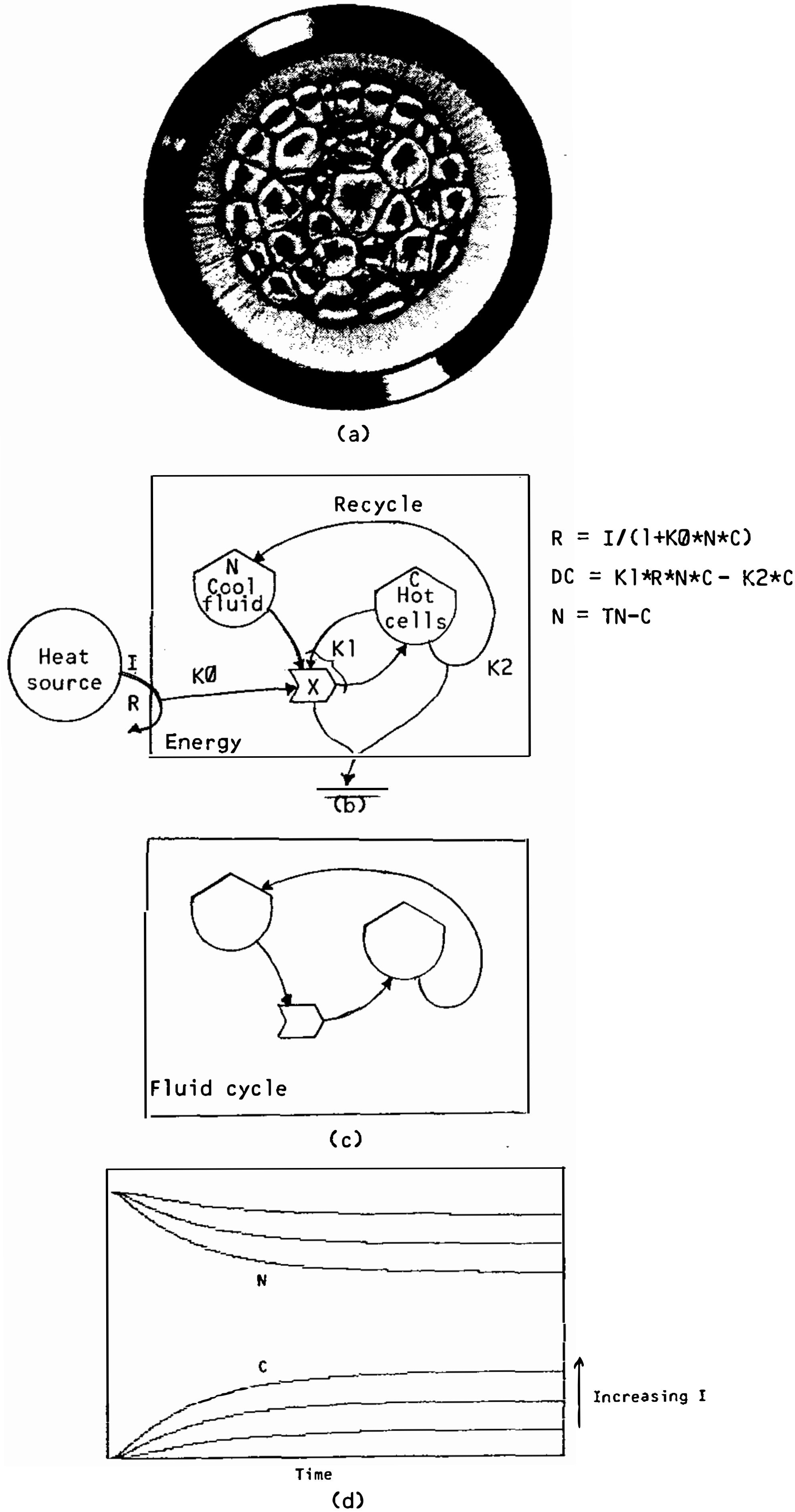


Figure 2. Non-living Bernard Cell microcosm with energy driven material circulation through cells structure maintained away from equilibrium. (a) Sketch from Swenson (1989); (b) energy systems model; (c) material cycle; (d) simulation.