April 2, 2006

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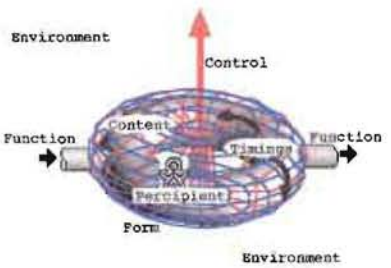
Dear Phil,

Thanks for the letter and for the specific questions. Since I am not out making a public nuisance of myself nowadays, I lose track of what concerns others and how my presentations may be interpreted. I think that we have more or less agreed that "systems theory" and the "general systems movement" failed except insofar as they accumulated a heap of feel-good clichés and easily-tired platitudes collected in a lot of more or less vapid books and worse conference papers. Conceptualizations and theories fared better in some hands than in others, of course, e.g., in G.M. Weinberg's Introduction to General Systems Thinking and in some of von Foerster's stuff, especially his article "Cybernetics of Epistemology," (1974 Proceedings of the 5th Congress of the Deutsche Gesellschaft fur Kybernetik), but remained unsatisfying in most other presentations. The word "system" has come to mean everything, hence nothing, but nowadays tends to mean "something about computers." Meanwhile, "cybernetics" in the Norbert Wiener sense, which developed into control system engineering, serves as an actual working discipline, although you wouldn't know that from any meeting of the systemists associated with the American Society for Cybernetics. Nowadays, "cybernetics" is also equated with computers in popular parlance, but the core of it requires no such thing, merely a feedback loop of any description whatsoever. I depend on a thermostat to keep my house warm in winter and a cruise control on the road, and I need a lot of other relatively stable goings on to stay alive as a biological creature. By my reckoning, computers have no necessary connection with any of those, but classical cybernetics has everything to do with them all. The one thing that must be true of anything which persists — whether it be analog or digital, technical or social, biological or psychological, scientific or artistic, real or imaginary. — is that it must cybernate. And it must do so regardless of whether we can see how it works or whether we can formulate the mathematics to describe it. This fact is, after all, the holy grail sought by general systems, the one ubiquitous characteristic and the one universal principle which has been hiding in plain sight under our noses since forever.

When first I took a course in "general systems" from Weinberg in 1967, I was pleased to find he was someone who had an enlightened appreciation for systemicity in general, and I later tried to follow through with related studies in Russell Ackoff's department (Social Systems Sciences) at Penn, but even after writing a master's thesis called "An Introduction to General Systemology" I remained unsatisfied with my understanding or my formulation of the subject matter, and it took an immersion in topology to help me put it all together in a way that informs me. I have never stopped trying to comprehend systemicity and to formulate it in words and pictures in such a way that the questions I always had about how the world works could receive some tentative answers. Before turning to your particular questions, I offer below a consolidation of some of the materials from my scattered pages you have already seen. This little essay is not an attempt to tell you what you already know but merely to say what my opinions are. You may know better.

Regarding systemicity — one can define the concept of system any old way and most people do, e.g., as "things which seem to belong together" or perhaps as "a set with relations," but for best results when building a theory of systemicity, one might better try a constitutive definition such as mine: At a given echelon of order a *system* is a dynamic, organized, delimited, open, persistent, volutionary, composite whole. It is heterarchical and volutionary, comprised of at least one loop and at least one link, and it manifests the aspects of **function**, **form**, **content**, and **control**, together with **timing** and **scaling** factors, relative to an **environment** and relevant to a **percipient**. (A visual metaphor for systemicity in these terms is shown at right.)



It is less important that anyone agree with my working definition than that they "get it" that a useful definition of "system-in-operation" must precede any competent theory of systems and that the definition must be neither too general nor too particularized but rather a mellow medium, i.e., a solution to the Goldilocks problem that is just about right. Incidentally, I am not one of those who takes "system" to be necessarily an embodied thing or — at the opposite extreme — merely a matter of the opinion of a percipient; rather I take systemicity to be at once "real" and "imaginary" where the reality is that every system entails a cybernation, hence includes at least one complete loop, circuit or volution which is relatively objective, this together with other inclusions which are relatively subjective and dependent upon a percipient, e.g., the shaping, the meaning, the fur, and the feathers. This conception provides for a science of systems as well as a humanities of them because the cybernating loop(s) included in a putative system are subject to investigation by and demonstration to multiple percipients regardless of what individual opinions about boundaries and inclusions and exclusions may be, though even the loopings are non-trivial matters as Weinberg points out at some length in his An Introduction to General Systems Thinking.

As for topology, I find it to be the key to any sensible and productive discourse about systemicity. One of the places where the general systems movement got lost was in the "isomorphies" and the "hierarchies" and the structures of "objects-and-relations" of their excessively morphological worldview. If "connectivity" is really what systemicity is all about, I think we would do well to pay a lot more attention to the discipline of topology which studies connectivities and continuities as its main business rather than to try to force piecemeal structural and formal parts into cobbled-together wholes. My "Construing ..." pages provide lots of details, but the short form is that toroidality — not sphericity — is at once the most competent topological metaphor as well as the most ubiquitous topology of embodiment of matters systemic, and indeed of most matters. The torus is the gross anatomy of every creature having an alimentary canal; it is the dynamic embodiment of the cyclonic storm and the dynamics of every living plant; of the circuits of electricity and of the fields of magnetism; of the "nervous system" and of the "circulatory system." There is even a conjecture that DNA *in vivo* is organized in loops rather than as the twisted linear strands found *in vitro*. With Homer Simpson, we can say after all, "Donuts! Is there anything they can't do?" The visual metaphor of my application of toroidality to systemicity is sketched in the definitional image above, but more tangibly there can be no mistaking my fondness for the exemplary toroidal images of the hurrying hurricane and the living tree as:

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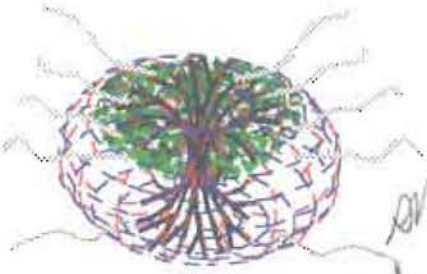
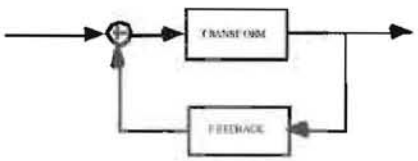


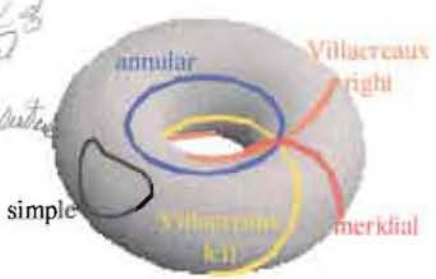
For the purposes of construing systemicity, I extend the canonical topology of the closed torus to the open-torus-with-throughput as:

Obviously, as examples such as the hurricane and the tree show, throughput is not necessarily so channeled as in the image above, but this rationalized image has the advantage of showing by inspection how classical feedback cybernation relates directly to and is entailed by toroidal systemicity, i.e., as shown on page 219 of my "Construing ..." pages, where the abstraction



is "derived" stepwise from the torus-with-throughput. This view also provides a reminder that a system is relatively closed to organization (cybernation) even as it is relatively open to material and energetic throughputs.

Besides physical (3D) embodiments of toroidal topologies, I find helpful a variety of visualizations in terms of surface topology, e.g., as elaborated in Surface Topology (Second Edition, 1991) by Firby and Gardiner. First and foremost for me is the image of multiple connectivity below, i.e., more than one kind of way to trace a complete circuit upon a torus. Indeed, there are four different kinds of circuits upon a (2D) toroidal surface, one of which (Villacreaux) has a left handed and a right handed variant, and none of which can be smoothly transformed into any of the others.



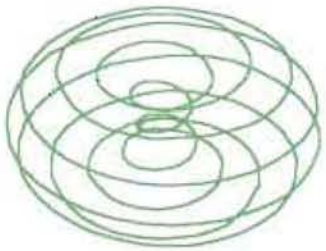
(In contract to this richness, there is only one kind of circuit which can be traces upon the simple connectivity of the sphere.)

Assumption of a metaphorical world of sphericity and simple connectivity is what makes the Western Rational Tradition less than great; but once we have attended to the "heterarchy of values" set forth by Warren McCulloch in the 1940s, we know in an instant that a "hierarchy of psychological needs" such as that of Abraham Maslow has to be bunkum, as does most else that passes for science of the psyche and of sociality. (Only William Powers in his seminal book Behavior: The Control of Perception makes any sense of the topology of a real science of psychonomy, and that only by implication through cybernetics.) I could rant on indefinitely: maybe Biosphere failed because it should have been "bio-tore"; maybe we can't manage things properly because "spheres of influence" are topologically hopeless; etc.; etc.

Visual metaphors of toroidal topology can reconcile many conflicts and resolve many paradoxes and dissolve many problems. One of my favorites (attributable to Arthur M. Young) is the paradox of the relation of the individual to the collective. If one (mistakenly) supposes that individuals are analogous to billiard balls knocking around each other and that the collective is just a bunch of billiard balls, only junk sociology can result. It gets no better if the individual is taken to be a point upon a spherical surface. Things get interesting, however, if the individual is taken to be analogous to a toroidal hole in a toroidal whole, for then — because of multiple connectivity — the individual can be cut entirely separate from the surface in one way (as below) and remain entirely connected to it in every other way. Try that at home on any sphere and watch things fall apart!

Visual metaphors upon (2D) topological surfaces are helpful in their own right, but they are under-dimensioned and cry out for further elaboration. One can take the image previously shown of traces upon a surface and make every trace into a tube as shown below, thus to suggest how dimensionalities can be enhanced as well as how surfaces may order channels and vice versa, etc.

One may also visualize in terms of free-standing 3D multi-cyclical Villacreaux pathways how respiration, etc., go on by going around, i.e., as:



Which brings me full circle to the notion elaborated in my "What's going on with the topology of recursion?" paper that everything must go around to go on, hence must cybernate to persist operationally. While the sphere is the topology of encapsulation and static closure, the torus is the topology of circulation and dynamic volutionary closure, with options for openness to throughput which are themselves toroidal of a different order with tori as relatively closed to circulation (hence cybernetic organization) and relatively open to channels of throughput.

Turning now toward your questions, it should be apparent from the comments above that I tend to mix the visual images of 3D topological figures and 2D topological surfaces in ways which may seem confusing but which can be reconciled as long as one is willing to use all of the images as visual metaphors and not demand that any of them model "reality" perfectly in their every aspect. The bankrupt metaphors of "planes" and "spheres" have never been held to a very high standard in this regard — else they would already be in the waste bin as obsolete. There remains plenty to do, however, first to supplant the failed metaphors with richer ones and then to improve them to be much better models. That is why the "Construing ..." pages contain so many different kinds of examples: to suggest that there are very many topological approaches to improve our grasp of systemicity. To take only one of these, our prevailing either-or mentalities come from severely under-dimensioned worldviews which take a geometric line as their metaphor and therefore can only go one way or the other on it; expanding the metaphor to a geometrical triangle gives us philosophies in which pretty things come in threes; on a geometric plane or a spherical surface, the magic number is four, e.g., as the solution to the map coloring puzzle upon those surfaces or the quadrants of mutual exclusivity; but on the surface of the torus of genus one (one hole) the magic number is seven for the solution to the map coloring puzzle, and more holes (as in a web) increase the numerology without bound ... a different metaphorical and philosophical and technical world to be sure. A clearer appreciation of topological matters can avert or quickly dissolve many a meaningless quarrel over numerologies and theories based explicitly or implicitly thereupon. What would great scientific conventions be without such meaningless bickering?

On the subject of change, the rates-of-rates-of-change curves on p.282 of my "Construing ..." pages are only part of what must be considered, since they are only the croppings of the traces of what is going on. True going-on entails going around and requires for its representation at least an Argand diagram but is better addressed in terms of feedback cybernation of first (Wiener) or higher (von Foerster) orders. (The approach to cybernetics taken by Ashby is valid in its own right but not what I would look to first to appreciate classical "cybernation" as I use the idea.) In matters of exponential "growth" per se, i.e., where the next amount depends upon the existing accumulation, we can refer piecewise to real exponential equations or, with the continuality of goings on, to the complex exponential equations applicable to cybernetic loops dominated by "positive" feedback. Since indefinite growth is not possible at any scale — political and cosmological rhetoric to the contrary notwithstanding — a leveling or collapse must happen, and that effect can also be incorporated into ordinary piecewise equations with sigmoidality or cybernetic formulations with negative feedback. My partiality to matters going-on makes me favor the latter. Whenever I see an exponential or a sigmoidal trace drawn, I ask first whether it is supposed to represent "growth," e.g., in size or amount, or "development," i.e., a change in capability or kind. (The latter of these need not involve an ongoing increase in consumption or other growth, of course, and may rather provide increased efficiency and reduced usages of time and materials, witness such technological changes as the amount of "computing power" per watt and/or per dollar during the last 50 years.) In my reckoning, growth has primarily to do with more stuff but development concerns a transition to different stuff, i.e., a transition from one *system* to another. If the sigmoid under discussion concerns development, my second question has to be whether the development is contingent, programmed, organic, or deliberate. Contingent developments are neither simple nor obvious, and there is much theory missing. For example, I find the "accretion under gravity" theories about the development of the solar system unsatisfying, but clearly something developmental happened through contingencies and it included feedback cybernations. Perhaps most fascinating is the contingent development of eddies, vortices, and cyclonic storms. We know from the engineering texts that circulating patterns in laminar flows will occur at a critical point which can be represented mathematically in

closed formulation with complex variables; but in three spatial dimensions and real time, I have never seen a good rendition of how a current and a crosscurrent interact to constitute a consubstantial circulating entity. It is fun nonetheless to watch a "smoke-devil machine" at a natural history museum in which a steady upward draft of smoke-tinted air in a glass-enclosed chamber interacts with a small bias flow of air from one side of the chamber; most of the time there are only "random" curlings and curlicues visible in the box and then every so often an eddy takes shape and persists for a while, then dissipates. I take this effect to be my central analogy for contingent development of dynamical systems. As for "programmatic development," I take it to be a change in kind which is brought about by a sequence of more or less deterministic steps, as if done by a computer or biotic (genetic?) program, i.e., a Turing machine of whatever physical manifestation. "Organic development" seems to entail both contingent and programmatic aspects, together with plenty of cybernation and perhaps something more, but surely not less. As for deliberate development, you have seen my annotated sigmoidal traces of it in terms of phases from "initiation" through "specification" and "design" and "implementation" to "operation" in the process of going from an idea stage to a realization stage.

During the decades which I spent working on, managing, and teaching "system development" as it applied to computer software and hardware, I focused most of my attention on matters along this sigmoidal trace of the process from idea to realization where deliberate activity is mustered to produce a new result under the sun. As you have observed, however, my approach to "systemology" focuses primarily on systems in operation and what keeps them going-on, i.e., those systems whose life trace is fairly "level" for a duration between development and demise. I have not given up on studying developmental aspects, but I have put them aside in most of my systemological work, partly because I have not yet found a satisfactory fully-dimensioned metaphor or model for developmental processes beyond the linear traces of sigmoids. Pages 273-276 of my "Construing ..." pages were the best I could do with the topology of development a decade ago, and I haven't gone back to that subject matter since then. Maybe you can inspire me to do more so as to complete the story.

If you've made it this far, I guess you can see how I would address your questions:

- My approach to systems in topological images uses characteristics of 2D surfaces and also of 3D figures, without rigor but with some discipline, as indicated above. Surface *topology* is important to me as a metaphor, but not so much *geometry*, since geometry drags topological discourse back toward morphology and its pitfalls. Along the way, every spatial conception tends to be a "relative Flatland" compared to the rich dimensionalities actually to be found in every subject matter.
- Meridial pathways through the center and back around the outside of a torus are very important as examples of mutual (with annular circuits) complementary control in a heterarchy (after von Foerster as suggested on pages 241-243 of my "Construing ..."pages), but my open-torus-with-throughput model is what I use to represent throughput per se, i.e., as a flow around a center of higher order whose closure is beyond the scope of the diagram.
- I take systems to be volutionary toroids under cybernation and non-systems (congeries) to be whatever they happen to be. My epigram that "the eddy is the entity" is exemplified for me by the smoke-devil machine mentioned above and how a system is qualitatively different from its ambient dynamics as regards its organization and entitation. In the smoke-devil example, relatively unorganized dynamics become relatively organized and then relatively disorganized again, and these large qualitative changes play the roles of development and dissipation of fluidic systems generally. The toroid of the organized system is the apparent one; toroids of larger and different kinds are involved at other echelons of order, e.g., the systems which provide the updraft and the biasing air flows for the smoke-devil machine. Certainly, as pages 273-276 of my "Construing ..." pages suggest, developmental change from one (toroidal) system in operation to

another can occur, but as the smoke-devil machine demonstrates, change can as well be from relative (non-toroidal) disorder to relative (toroidal) order and back. There is certainly a lot to do to better conceptualize, grasp, and model the various manners of processes of change, and your interests surely contribute to that.

• I use the phrase "set point" merely to mean the "reference level" for a cybernetic control, e.g., the desired temperature set on a thermostat or the desired speed set for a cruise control. In that sense it represents an attractor, but has little to do with critical points or "tipping points." I guess "set point" is an old-fashioned label, but I do not mean anything fancy by it. I do, however, mean something a little bit fancy (or fanciful) when I say that a "purposeful system" is one which can set its own set points, i.e., as "virtual attractors," but that is a different treatise.

• As mentioned above, Ashby is an important reference for a particular approach to cybernation. You have correctly appraised some of the limitations of his approach, and there are others, but his work on self-adaptive "homeostats" and on theories of control as related to modeling are timeless and valuable and somewhat different than the material which dominates his Intro. When it comes to good old-fashioned classical cybernetics, however, it is control system theory and control systems engineering (sans computers) which matter most as a core discipline. I guess you are familiar or even fluent in all that based on your work with fluid flows and know the drill: stable loops necessarily having poles of their frequency domain formulations in the left half of the Argand plane, etc. (For my part, I was never able to pass my control engineering classes; it was all too complicated for me, that being a reminder that it is the rare feedback loop which is stable enough to go on going on.)

• I do take relative individuality to be an inherent characteristic of systems, and that in itself suggests a kind of "discontinuity" between system individuals and everything else. I believe, however, that continuity and discontinuity are in the mind of the beholder (or of the mathematician), and in any case not absolute. Here, as in examples above, it is important to consider the topology of systemicity and to think of individuals as consubstantially vorticulate rather than as substantially particulate. The visual metaphor I like for this is at left below and augmented with a tree at each center at right below, i.e., a toroid of indefinitely high genus, i.e.- i.e, with lots of holes:

Here, each hole represents a systemic center through and around which cybernation persists. This represents discreteness in terms of toroidal holes rather than in terms of spherical lumps. It is another one of the ways that the visual metaphor of the torus (having one or more holes) transcends that of the sphere (as a degenerate torus having no holes) so as to turn counting inside out, smoothly relates the ordinality of organized circulation with the cardinality of discrete numbering, and shows how the analogue and the digital emerge together in a mutually complementary fashion. Such a metaphor gives us a kind of discontinuous continuity, thus to dissolve many an old morphological paradoxes in a rather delightful way. As for systems as "loops that grow," I tend rather to define systems in operation as "loops which don't grow or shrink very much," i.e., as relatively stable volutionary goings-on.

• My systems-as-toroids are circulations, but they may also have subordinate circulations and they certainly partake of superordinate and collateral ones. We could probably agree on this, and also as regards the role of the "stuff left lying around" (which I would prefer to call the ambient

the whirls of smoke devil

unorganized dynamics) such as the relatively unorganized whiffs and puffs visible in the smoke-devil machine.

• One need not slice and dice the toroidal topology to get at systemic multidimensionality. It is one of the joys of heterarchy that it enables comprehension by "catalysis" (rather than the illusion of understanding by "analysis") in which elaboration of individuals into networks, etc., takes place by making dynamical connections — whether collateral, subordinate or superordinate —so as to constitute higher order toroids (rather than artificial morphological hierarchies of things). In a topological perspective, the old problematiques of what belongs to what, what category embraces what, who's on top, and who's on first just melt away because they can be seen as the artifices which they are, useful in particular situations but not worthy of generalization at the heart of any *principia systemica*. And where it comes to questions of "several trunks," the visual metaphor immediately above says a lot, a way to see the forest and the trees all at once.

Finally (gasp, choke, wheeze), at any given time, we are blessed when we can enjoy some beneficial systems in stable operation and cursed by the persistence of some of the less beneficial ones. There are other systematic considerations, however, in particular that there are things going by which may or may not be able to go on as systemic wholes or are in the throes of change, e.g., of development or of decline. The phenomena going by and the systems in decline won't stay around (though they can make a big mess while they last). The systems in development or in growth can't go on as they are and may not be around very long either, unless they can reach a cybernetically stable operational plateau beyond their exponential changes. That is how come we have to pay attention to the various (exponentially) increasing traces of data which we can measure; they are indications that things related to them are in transition rather than in stable operation and that, since such doings cannot go on indefinitely, something is going to get very different before long. This brings us to your page concerning indications that there will have to be some changes in order that our "life-support system" not become a global undertaker. It reminds me of Limits to Growth – The 30-Year Update (Meadows & Randers, 2004) where the observations and the computerized simulations (made using feedback principles in the spirit of Jay W. Forrester's work) show how the world passed the point of no return into the realm of global unsustainability in the 1990s, with only a very unlikely scenario for gradual moderation and return to viability, and this analysis assumed no wars, no extreme weather, no significant climate changes, no ecosystemic collapses, no resource shortages, no catastrophic contaminations, no pandemics, no serious sabotages, no financial crashes, and so on. As well you know, collapse is by far the most likely result where exponential excesses have got out of all control and can't go on, especially when metastatic growth is accompanied by social myopia and inattention and denial and, as you suggest, suicidal designs. What is always interesting to me is how the dire analyses are surely right that there will be a comeuppance (or comedownance in this case), but how seldom the exact nature of it and the exact timing of it can never be predicted. Examples in recent memory include the collapse of the Soviet Union and the expunging of New Orleans. The prognosis is not good.

Best regards,
Don

P.S. I found the Syllabus (enclosed) which I didn't send last time as promised.

Eddies in the stream … construing the natural philosophy of systemicity

Syllabus

"Respect for the ordinary is the beginning of wisdom."

Adrift in the stream … Where did we go wrong? … Where do we go from here?
"All extant sciences, arts, philosophies, and religions are bankrupt in the present situation."
Problematique: Western Rational Tradition … Modernism
philosophies – sciences – arts – religions
assumptions – sources – consequences
Persistent questions: human roles, spirituality, fragmentation, prediction, meaning, etc.
Putative answers: rationalism, romanticism, theism, scientism, postmodernism, etc.
The "General Systems" rejoinder: holism, hierarchy, homeostasis, relations, isomorphy, ETC.
Doing better systemically in the meso-cosm and the eco-cosm

Seeds in the core
"We reap what we sow … and we find what we seek."
Generally: ultimates – ubiquities – archetypes – representations – reasoning
Individually: perceptions – perspectives – preferences – predispositions – prejudices – paradigms – partialities – purposes

Thin paradigms to rub together … stasis or rheosis … Having swallowed the coin, no change yet!
"Is the Hokey Pokey really what it's all about?"
tools – models – conscience
stirring at rest – orders of change – compellors – cybernation

What counts?
"Two kinds of people in the world: those who divide everything into two kinds and those who don't."
numerologies – dimensions – reductivity and elaboration – dualism and dialectic
invariants – irreducibles – principles – ultimates

Where's it at?
"Donuts! Is there anything they can't do?" [Homer Simpson]
topology – connectivity – complementarity – heterarchy – complexity – cybernation
homeomorphy and homeodynamics

Systems and environments and percipients
"The system is the problem." … "The system is the solution."
A system is an organized, dynamic, persistent, volutionary, composite whole relative to an environment and relevant to a percipient.
characterized as a matter of definition and of aspect … by percipient and environment
function – form – content – control … and timing
membership – partitioning – emergence – persistence – organization – wholeness
cybernation – going on means going around … The eddy is the entity

Who's on top?
"Winning isn't everything; it's the only thing." [Vince Lombardi]
competition – cooperation – collaborations – alternatives – "progress" and "success"
complements – supplements – dimensionalities
mutuality – niches – sufficiencies and necessities
appreciations – comprehensions – enlightenments
holarchy in the topology of being

Who knows? … Who says?
"It's not what we don't know, it's what we know that ain't so." [Will Rogers]
bewilderment – confidence – certainty and uncertainty
sciences – stories – statistics
imaginary ontology – real epistemology
models – controls – theory and practice

Who cares?
"Nothing in human affairs persists unless all parties perceive some benefit in it." [Cicero, and Ziegler]
self – other – relationship – communication – tradition – culture
an individual in the collective

D.H. McNeil January 2006