a Nature Full of Independent Parts !

Why causal models don't make good operating manuals, And what would: Determinism v. Individualism

I. Abstract

A. Much of the difficulty of using causal scientific models for managing natural and social systems is that they are logical. Any self-consistent representational model of an environment, by necessity, actually leaves out all its independent working parts. Not clearly understanding that, and mankind now needing to deliver a major redesign of the world economic system 'at scale and on time' as is said, is exposing a number of very remarkable conceptual errors. While not making these errors worse is important, the even greater value seems to be in how graphically clear they are. It shows how we keep making them, a seemingly natural cause, and how to begin looking for the large parts of the natural world our way of thinking has been hiding from us. Some of our 'wicked' problems can then be seen as errors in defining the problem. That includes a system of representation that hides the independent, individual and locally eventful behavior of nature from our scientific views. That physical environments work by having lots of differently organized systems and individual and local behaviors is then 'lost' when people make sense of their world in the usual self-consistent way. Environments have so many different logics, they can't be logical as a whole. It means our mental models leave out the individual working parts, if we carefully make them self consistent. It calls for a rather new approach to steering our complex systems. Current policy and practice for the use of self-consistent models, along with some of the complex system learning models are discussed. One is a way of attaching strategic questions to normal models for locating the working parts of nature being referred to, and foreseeing their individual changes of form. Then models would no longer automatically 'hide' but instead *'lead you to'* nature's individual working parts and productive questions about them. Some of the philosophical problems of a world made with independent parts are raised.

II. Intro

A. In hindsight many of today's multiple and converging great environmental crises seem like they could have been seen coming a long way off. Indeed they were. That the foresight of some who saw them coming was not useful to others is of a peculiar kind, seeming to stem from the common thought habit of drawing fixed and self-consistent pictures. When viewed in hindsight the patterns of relationships we see are fixed, because the past is finished and will never change except for the information to gradually be erased by indiscriminant decay. While some of the clearly repetitious patterns we see in records of the past have enormous use, as the usefulness of classical science clearly displays, it will actually make those same models far more useful to find how to link the understanding of the creatively changing world of the present and future with them. I need to start with a shower of new perspectives as the scientific conversation on the design of nature has been so very one sided.

B. Nature displays both invariant and fluidly changing systems of organization and relationships between differently organized kinds of things. That people have survived at all indicates that our learning difficulty caused by our tendency to read nature as following fixed sets of rules is not all we do. We have lots of informal relationships where we engage with each other and the complexly organized and changing parts of the world with relative ease. How to distinguish the rigid way of relating to the world from the fluid one may never be simple, but it seems to have been studied with some interest relating to the perceptual problem and persistent learning difficulty called 'functional fixedness' from in Gestalt psychology. When our thinking becomes fixed it inhibits learning and learning transfer. One of the aspects that may reveal it's source in natural causes is that that prevents a mind from holding differently consistent stories at the same time, like a working environment does in great profusion. It may derive from a common natural system source, the highly interesting part of nature we have the very most difficulty understanding, it's complex independent whole systems. A 'whole' is sort of one self-consistent set of relationships, and connecting them seems to require inconsistency.

C. Scientific models do not make good operating manuals for nature because fixed sets of rules leave out the independently organized and working parts. That's part of what Fredrich von Hayek (1974) was referring to in his Nobel Memorial Economics Lecture saying:

> "this failure of the economists to guide policy more successfully is closely connected with their propensity to imitate as closely as possible the procedures of the brilliantly successful physical sciences…"

D. The issue concerns the question of the model fitting the subject, not trying to make the subject fit the model. Hayek was pointing out from a 1974 understanding of complexity that using the deterministic models of the physical sciences for the complex relations of society failed to account for the dislocations that people would experience following them. It's quite interesting that even as he said that Hayek also objected strenuously in the same essay to the argument in The Limits to Growth (Meadows 1973, 2004) that the general principles of economics were overlooking the major societal dislocations that following them were developing too. He and Meadows were saying much the same thing it now seems, but each one's fixation on their own way of drawing the picture failed to connect. In case this is as far as one can read on the first pass, from a natural systems view, the real reason for paying attention to growth curves and look for the individual internal network of mechanisms producing it, is to be able to imagine how they will upset themselves and what the choices may be for what will take over.

III. A Philosophy of Models

A. That scientific models leave out the independently organized and behaving parts of the world is something quite easy to observe but naturally hard to understand. 'Systems' of rules are not much like natural systems at all, having complete, fixed and self-consistent relationships. They are the kind of answers to questions we like, a complete order of relationships with no independent parts, and the unchanging record of nature's complexly changing past is a good place to find them. Perhaps the attraction is that they let us form images of our world that are whole and complete. Some people say we need to accept the faults of models because we do the best with them we can with them. Still, working with nature requires relating to many differently organized and changing self-consistent things. The whole systems of nature are also notoriously difficult to well define, and traditional scientific models don't even direct our attention to them to help us see how they work. Environments are composed of many individual islands of order connected with each other by a sea of 'discarded parts', communities of individualistic partners in larger systems, and not unitary in either design or behavior. Scientific models are made of numbers in fixed relation to each other. There's much of interest in making 'better' models, but simply making them more complex self-consistent representations using statistical, dynamic and multiple 'agent' methods does not correct the flaw of being self-consistent. The models still need a way to refer to the objects of nature in order to connect our thinking and nature's. To do that it would be necessary to find some way to use models to refer to and help us independently explore nature's independently organized systems and inconsistent ways of connecting them, and helping us recognize the inherent individualism of nature's parts. We would need to insert inside our artificial models certain pointers to the physical working parts of nature themselves that we omit from our models by necessity.

B. Leaving out the mystery of the world around us is not simply a matter of lacking a comparable complexity, of course. It's also a failure to identify the eventfulness of the world and things happening that are entirely new along with a failure to acknowledge where they come from. Waves are an example of completely repetitious motion, fairly well represented with equations. A breaking wave is an example of individual eventfulness and the curl and eddies that develop are examples of new individual forms. Truly eventful behavior actually seems to come from the within independent systems themselves, because that's where it can be seen to develop, though it's a part we mysteriously can never quite see. Distinguishing between new and original behavior and secondary reactions is difficult. As with people, the original behaviors of all sorts of systems seem to come from the individual system as a whole, without any place to locate a point of beginning or end. These eventful whole system behaviors seem to be the main source of all real eventfulness, and a primary reason models built with fixed rules for events in open systems are not reliable. Partly that is to watch for the kind of discrepancies that help signal the need to adjust models to follow systems that are moving targets. It's also necessary to sometimes look beyond the model entirely, since it's not the model that we ultimately need to engage with. Our models need to signal us where to expect new behavior to develop and help us explore and describe the emerging local systems driving it.

C. Either problem is inherently not a matter of computational power, or the 'computability' of the problem. They're both problems of the flexibility of the model and how the model helps us engage directly with the organization and events of our world. The incomputability of models is an interesting theoretical question, though, in that there seem to be a number of reasons for models being quite incomputable (Boschetti,2007). Computability is usually discussed in terms of 'chaos' in which small differences can have large mathematical consequences or the inability to define boundary conditions of environments clearly or that models can't properly represent the multiple scales of organization that natural systems have, or Rosen's "Evolution of life is not the construction of a machine"(Rosen 1991). There's also an incomputability of mathematical models that comes directly from our means of doing it, the physical process of calculation. Calculation has an easily perceived 'grain' that comes from its being built from the assemblies of individual parts in computers, the 1's and 0's. Self-consistent sets of equations do not have any grain. The implied continuities of mathematics, therefore, can not be represented with the integer calculations required for digital processing. Mathematical rules imply shades of difference and dynamical derivative rates of change without limit. Perhaps how our mathematical tools necessarily operate then shows that the problem isn't just that how math is built it can't successfully emulate nature. Maybe it also shows that the way nature is built it can't successfully emulate math. If nature "can't do math", that may have different implications, that the mathematical model is itself an 'approximation'. That this is yet another way that our models are unable by design to remain faithful to their subject is another good reason for it to be dangerous to not use them to help show us the discrepancy between what they do and how our environments work.

D. Now that the environmental conflicts between human and natural systems are becoming genuine life and death issues, people really do need to rely on science as a guide. Our tools are proving themselves tragically unreliable though, as the examples below will clearly show. The dramatic kind of mistakes we are making display our major blind spots with great clarity, though, so they might also represent a curious kind of wonderful discovery. They could help us see both the form of our models and the form of nature they are not working for. Environments provide a physical medium that is not limited to one self-consistency. Even the best of self-consistent models can't do that. They don't locate the 'sheep in the meadow' but need to describe them with a statistical profile of occupied or unoccupied squares with tables of properties on a grid. The individual sheep are missing. Where they statistically might be, based on patterns from other times, may help you reliably tell how frequently they should be moved to new pasture to maximize the number of sheep without harming the land. It doesn't relieve the shepherd from needing to watch his flock though. If you're not alert you miss what happens and that can be critical. Discovering how very much of the new eventful behavior in nature comes from the individual emergent systems is a rather wonderful kind of discovery. It includes every kind of organization that begins and ends. It could also a set-back for our faith in science, and give us considerable pause. We really are under extreme time pressure to make big changes, and have them work with high degrees of confidence. A large part of the sluggish response of governments and societies comes from their own kinds of failings, of course, but a large part also seems to come from the fact that scientific models don't actually show the way.

E. Science still has that image of reliability earned from centuries of building on very high confidence physics and engineering theory. That came from using the deterministic model for parts of nature for which it worked, applying the model where it fit. The story is certainly much more complicated, but you could say the error was then that the big money went to applying determinism to one of the subjects to which the deterministic model least applies, money, as Heinrich (1974) essentially says. Not having yet learned why the model does not fit, it is being unwisely accepted as the tool we must now use to redesign both the natural and economic worlds, in a big hurry, stepping into the fray as too many things are going haywire all at once. If we were thinking, this would be a big mistake, but the interesting thing is that we therefore seem not to be thinking, unable to see the questions we need to be asking. Growth was supposed to produce the greatest good for the greatest number, not burgeoning populations and impacts so great as to threaten the sustainability of living on earth. That changed so fast, relative to our thinking, that we're quite caught off guard. It's one of many glaring errors that expose how unprepared we are for being in charge of the planet we have dominated. It's not just our heavy reliance on accelerating the depletion of our natural resources. It's that more and more of our own major interventions to fix our multiplying problems are failing too, and it appears we are not ready with any reliable method of predicting what will work. Indeed, our entire method of creating wealth by increasing our control and manipulation of nature seems to be in disarray. We need to learn to look at the individual working parts, the parts of complex systems that develop into and act as wholes. Our best scientific tools, however, just show us a statistical haze that our unitary sets of rules for them create.

F. Environments accept, and actually rely on, being occupied by a multitude of differently consistent individually organized parts, the systems that are organized and behave as individual wholes, like storms or cultures or technologies or traditions, all with their own separate complete cells of developmental loops for integrating their networks of parts, through which their interactions with each other as wholes are animated through an environment. The environment does not drive them, it houses them. Nature is not unitary, but individualistic. Because our models are nearly all unitary, the working parts of nature and their behaviors are therefore excluded from them. In a way the scientific method is to find all the individualistic behavior and strip it away to form a unitary model, so one of the best places for scientists to find individualistic behavior is in the trash.

G. Scientific models approximate, for short periods, statistical behaviors of measures. Independently organized systems develop by themselves in open environments and out of control. Finding some way to represent their inconsistent behaviors is more the problem. Because the scientific method does not identify these particular individual systems that are an environment's working parts it also can't suggest relevant questions that just directly watching their individual behaviors would raise. That is, by contrast, what an individualistic approach to nature rather than a deterministic one would do, use models to direct your attention to individualistic behavior. The difficult step, though, is the first one. Just noticing that natural systems arise on their own as individual self-consistent networks of relationships, in an otherwise uncontrolled environment, means admitting that the world might work just the way it looks. That we have to puzzle over whether nature is remote controlled or not is another sign of how far our thinking, our functional fixations, have drifted from our real world. It's the difference between watching wisps of curling smoke and trying to think of the global rules you could invent for them, or noticing that the intricate designs of physical dance are unconnected with anything similar and are apparently developing their own organization by themselves.

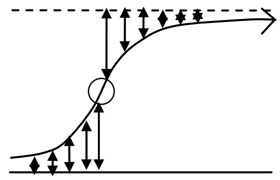
H. Instead of portraying nature as out of control for not following *our* rules, an individualistic view suggests that as far as we treat complex things as following simple rules we are what's out of control, for not being able to identify nature's independent working parts. It would take effort, but what we'd need to do is learn to tag our models with lots of question marks, locating where balances switch and new behavior could be expected to emerge, or maintaining contextual indicators of hidden strain, like the main one we frequently seem to miss, diminishing returns. Not having a habit of using the models to point to the individual physical systems prevents us from observing and coming to understand their individual behavior. The deterministic view of the world considers the 'parts' of nature to be the measurements we make and the equations that connect them, not the things being measured. That means representing a system as if the model has simultaneous information about all parts at once, a 'God's eye view' or 'designer's view' of simultaneous universal knowledge, with nothing having any inside. Individualism considers the working parts of nature to be its self-defining and individually behaving circles of relationships. It takes a natural observer's eye view, seeing the cells of relationships that make up nature's working parts starting from the observer's outside view of them, and then noticing that they have an inside that is hard to see. That's the big difference. Nature's independent cells of relationships have different interior and exterior connections, with the interior ones being particularly mysterious and not readily observed from the outside. They also completely color one's view when looked at from the inside. What community of you're from defines a great deal of the meanings you'll find wherever you go. The catch, then, is that to make a self-consistent 'model' of such a confusion of independent parts requires a model very full of questions, not just answers. It would mean using models as pointers to the rich worlds of events around us, to help us 'go look'. Doing science that way would represent a rather big change in plan, perhaps fitting Einstein's observation that we can only solve the problems caused by our way of thinking with a new one. This is part of a very long history of discovering there is more to this world than we first noticed, and this new perspective is being experimented with in different ways in many places. That it is coming partly through the discovery of very major mistakes, due seemingly to a natural tendency to fixation that has long been with us, means that people have surely been struggling with it for a long time. Lots of things we do as well as falling into the trap are the opposite. We find many useful ways to live with a tendency to rigid thinking while living in a richly complex individualistic world.

I. The particular view of nature presented here may be unique, but there are great many approaches to the natural problem being explored in other fields of study and practice, generally under names like ecology, general systems, complexity, emergence, organization, sustainability and partnerships. I think my own natural systems view may go the furthest in breaking with determinism while finding strong and useful connection. Nature shows it's not necessary to be completely consistent, even necessary to make an environment work. Mixed models would be convenient for lots of things. I just conceptually acknowledge that everything in nature appears to be organized and operating individually, partly because as much as I can not disprove the 'puppet on a string' hypothesis, I also can not find any 'strings' other than individual developmental processes. Still, with many subjects the idea of determinism is tremendously successful. What it is less successful with and seems most important to treat another way are the cellular organizational structures that originate through a process of growth and end in a process of decay. Those are the systems that seem to have definite interiors and 'lives of their own' and where the eventfulness of life comes from. Humbly speaking, world is also just more interesting that way. That not only one doesn't have all the answers, but that the universe is continually making up new questions, seems to be an exciting reason to get up in the morning and find a joy of discovery in the continuing search.

IV. Reading Natural Systems

A. This discussion will attempt to lead to a review of the well established and experimental methods of using science as a working tool for steering natural system change, and some reflections. The practical use of science and how it needs to adapt to the world we're in is the main subject. That broader view still seems to need to be preceded by some review of the form of nature we're dealing with and the great errors we're making. The idea is to look through the 'cracks' in our understandings of the world to begin to see what we've been missing. It's a new purpose for using science.

B. Complex systems are distributed learning processes from which organization develops, and to respond to our own natural blindness to how they work we then… need one . We need a better way to learn, and use science to show us where to look. This 'problematic opportunity' needs to apply to tasks like responding to global warming and our own great errors. There the emerging long term threat of our own energy policy to world food supplies. We also need to learn how to provide aid that does not do great harm at the same time. These are among a number of converging crisis of conflicting interests coming about as mankind collides with its limits to growth. If all you do is acknowledge these contradictions as 'cracks' in our perception to look through, it can become a way of seeing the independent working parts of nature, and how our covering up the 'cracks' in our images without looking to see what you're covering up, is rather dangerous. When you look through the cracks an see a world full of independent parts coming into increasingly intense conflict it becomes clear that further exploration, not just another quick patch are in order. A whole worldwide system of independent parts managed for growth works by each part successfully using only uncontested resources and avoiding conflict with each other. It's because they are successful at avoiding conflict that their uncontested common resources tend to all run out at once. What happens when uncontested resources is that all the independent parts run into each other. It's a dead end with rapidly increasing conflict as a consequence. Their methods of avoidance, like creative adaptation, new technology, greater efficiency and living simply, etc. are what are running out, relative to the whole system's rate of growth.



C. The beginning of the environmental movement about 50 years ago was the beginning of our effort to solve the problem of natural limits. It was a switch in the direction of our thinking and our approach to pollution and resource consumption. It was not a change in direction, but a change in the change of direction. At least in our thinking we switched from imagining accelerating increase to decelerating increase in our use of the earth. As such it provides a fairly good marker in time for the inflection point in our natural whole system growth curve, and the beginning of diminishing returns for our way of exploiting the earth. We started to think about being constrained by both what's left to take and what's left unspoiled. The financial curves may not show it, but the number and difficulty of physical problems with growth began to sharply increase then. Perhaps the graphic represents a 100 year time span, perhaps longer, but the structural information is the same. A growth curve traces the organizational development processes of a complex system. It can be highly informative about the how the internal feedbacks of the distributed organization of the system are progressing. They're not just statistics. The developing complexity of the system is an information structure and the trace measures of it's development are its whole system learning curves. They invariably begin with the system learning going faster and easier and then going through a turning point to proceeding slower and with more difficulty. The emergence of the environmental movement signaled a whole system switch in attention from learning about growth to learning about limits, the switch to diminishing returns on investment. The feedback switch occurs as change in proportion to where you came from (adding %'s to the past) switches to change in proportion to where you're going (subtracting %'s toward the future). Because limits of development for individual systems represent increasingly difficult learning, the system as a whole can 'sense' where they're going and sometimes respond with a cascade of internal changes.

D. The neat trick is that they don't know where they're going till they hit their diminishing returns. A growth system is first in a seemingly infinite environment and begins to develop in proportion to its own size, producing an exponential growth curve. Upon approaching increasing constraints change switches to slowing development and an exponential decay curve, and perhaps stability. While many of our intentions switched, and the 'picture' in our minds of how to treat the earth changed, many of our habits didn't. That's importantly because we still don't quite see were the systems of our environment are or how we are part of them. It's a problem. Following the 70's and the increased recognition of the need to conserve, energy consumption, environmental impacts, and the dwindling of both renewable and non-renewable resources has only continued to accelerate. Everyone seems to act like no one knows why. The popular response has been for everyone to voluntarily 'use less' and to make improved efficiency more profitable. These are directly conflicting choices, but most people see not other options. What the environmental movements seem to be doing is responding to all the positive *cultural* values at once. That means applying 'sustainability' to the growth process from which the impacts are coming, so it isn't making the earth more sustainable.

E. Starting a learning process for seeing the behavior of whole systems, their developmental stages and how our choices influence them, is critical for envisioning real sustainability plans. Real sustainability plans are learning processes for the whole system. One of the great observers of mankind to write lucidly on the subject from a natural systems view is Jane Jacobs (1969, 2000). She does a wonderful job of bringing out the richness of differences that natural systems thrive on, that her main subject exemplifies. Understanding the life of cities is one way to discover how environments connect many kind of completely differently organized things. Without understanding that there's the likelihood is that we'll keep making plans entirely without them… like the ones that have been failing so badly for us. Seeing the working parts is essential for scientists to show people what's happening and for people to be then able to tell scientists what they're missing. It's also essential for political and institutional efforts to coordinate responses so that they have accumulating positive effects rather than uncoordinated negative effects. That includes the economic sustainability problem at it's core, of course, because all of our major catastrophes come directly from how we pursued economic development over the past centuries. Detailed discussion of it needs to be left to another time, though.

F. The practical advantage of using science for a new purpose, to direct our attention to the independent local working parts of an environment, is that that is what our decisions directly interact with, and what non-scientists directly experience and see. The way scientific models have normally been used does not do that, and that confuses people, and makes it hard for them to inform scientists with their first hand knowledge. It's not just a conceptual problem, of course. Learning to recognize individual natural systems often depends on viewing them from the right scale, and aggregating ones data to correspond, and knowing what to look for in their distributed organization. The main problem seems to be that our ways of collecting information tends to include overlapping images of many different systems at once, as if overlapping transparent images of faces and trying to resolve the image of any one person. The simplest principle seems to be that things that grow together act as a whole. That and other tricks help you indentify individual systems. Still, natural systems are confusing because many do in fact physically overlap and do often have unclear boundaries. These things make them hard to see until you discover more of what to look for. What makes them distinct, of course, is their individual developmental circles or relationships, that are what come to stabilize following a period of developmental growth. There are variously reliable signs, but individual systems are usually different enough from one another in unexpected ways that they're also a real surprise. You can know for sure that the environment will contain lots of individual systems, communities, businesses, technologies, along with all the natural system supports they need. You can know for sure that they will respond to any intervention, and that it is likely to be with wholly new systemic behavior. You can also know that there are just too many possibilities to confidently guess what the emergent response will be until you pick up the first hints of it actually happening.

G. If people could better identify the behavioral parts of their environments they would be better able to help outside professionals and aid organizations discover what would actually work to make things better. Most particularly, they would be looking for how the independent parts of their world might independently respond to change. They'd be much more likely to catch some to the major errors that our driving blind naturally causes, just to be looking for what our plans will run into. That concept, the follow-through of planning with asking what our plans will run into, is rarely done. The simple reason is we don't see that they would run into anything. Usefully asking that question requires that you depart from the assumptions of the plan and ask what inconsistent behaviors of the world might develop in response, and hard to do. The last 50 years of concentrated effort in global problem solving has used a well funded, fair minded and sincere scientific approach to the world's problems. It has also left us almost completely stranded with a wave of approaching insolvable problems all around, and our being heavily dependent on quite unsustainable technologies. Some of the most remarkable modeling successes, that the whole world has been told to depend on for life and death decisions, are among those based on the most faulty assumptions.

V. Our Mistakes

A. There are very basic problems with the most celebrated environmental research efforts, ones like the IPCC climate models. There may be some error in the climate analysis portion of the models, but that's the part the physical scientists paid attention to, so the errors are probably small and accounted for. The big error is in the unquestioned economic assumption that was used as a condition of the model. The economic assumption is that after a kind of 'mid-course correction' to fix the carbon problem that growth can continue without effect. There was perhaps no discussion at all of what that might run into in a physical world. We're now actively engaged in rebuilding our whole life-support system to follow a plan based on it. The idea that growth could continue without effect solidified in the 1987 Bruntland Report and the 1992 UN Rio meetings on sustainable development, and in the OECD Forum, 14th May, 2001 (OECD 2001) to continue growth without anything 'bad' happening[1]. The whole unresolved discussion of the 'limits of growth' from the 1960's to the 1980's was neatly sidestepped by the easier task of creatively redefining the term in the implementation strategy, changing 'decoupling' to mean a condition in which the measures of wealth are increasing faster than the measures of the impacts[2]. That 'decoupling' then means allowing endless multiplying business expansion to have endless multiplying physical environmental impacts, is a phrasing of it they avoid considering. It's one of the very best examples of the dysfunction of sticking with fixed models from past experience until they don't work any more. Now we are using it to guide long term life and death decisions. What it specifically did in the scientific models is discussed a bit more below.

B. Because scientists can't represent the unpredictable responses of independent systems, their best way of learning about them would be to use indicators to direct their own attention, and that of local stakeholders, as to where to look. It would then allow the science and policy community to discover what the real issues are. Then the kinds of coordinated changes needed from the people most directly involved would be possible to communicate to them. This learning mechanism does not yet exist as a common approach, though we can probably all think of circumstances where it has occurred by accident and worked well. That it conflicts with the established model of natural science inhibits it. The orientation would change from thinking scientific models are for telling people what to do, to partnerships between stakeholders and aid organizations in identifying the locally interacting systems and how they can be accommodated. This is not just for the undeveloped countries, which have been so disserved by mistaken ideas of how to provide development aid. It's as much or more for the developed world which is faced with a rather abrupt change in the kind and direction of economic change, our sudden collision with our limits and the explosion of conflicts emerging from it. Hopefully the mistakes we're in the middle of making with the earth will be a signal, and the communities of thinkers that one hopes are behind the growing dissatisfaction with our fate in all corners of the world can find acceptance for doing it right a new dawn in our relationship with the earth.

C. The classic problem these days is rapidly erupting resource disputes, typically different users of a common resource seem to suddenly run into each other, and cross each other's lines of conflict as the uncontested portion of their shared resource runs out. You could say these are classic cases of a 'tragedy of the commons', but the present ones seem to be appearing by surprise and with increasing frequency and severity. A classic case is Darfur, where drought forced the migration of communities of farmers whose then displaced herder communities from another ethnic group who then retaliated in mass (Morton 2008). It appears the Aid communities then greatly compounded the problem by sustaining population growth for the communities no longer able to support themselves and whose social systems and livelihoods were disrupted. That this is a clear means of unintentionally helping people and producing growing populations of refugees who can never find a place to settle is not a pleasing observation, of course. Observing it in a way that lets you see that dealing with whole systems as a whole is the solution is what is prevented by avoiding the unpleasing part. In that kind of situation there seems no possible kind of political solution without whole system understanding. People just don't ask the kind of questions needed to see these things coming, or explore far enough to understand what then happens. So no means of organizing around a truly systemic solution is possible, and all the separate attempts to solve the problem end up working at cross purposes and make things worse.

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[1] "The term decoupling refers to breaking the link between "environmental bads" and "economic goods." Decoupling environmental pressures from economic growth is one of the main objectives of the OECD Environmental Strategy for the First Decade of the 21st Century, adopted by OECD Environment Ministers in 2001" (OECD 2002).(1st sentence)

[2] "Decoupling occurs when the growth rate of an environmental pressure is less than that of its economic driving force (e.g. GDP) over a given period."(OECD 2002)(2nd sentence)

D. Another of this kind, though quite different, also concerns Africa, and how their Atlantic fishing villages was being destabilized by the European fishing fleet exhausting the local fish stocks (Lafraniere 2008). African fishermen are increasingly unable to find fish due to overfishing by the European fishing fleet, which in looking for fish is following the rules to restrict their catch in European waters, that did not protect the African waters. The story in the NY Times was about the irony that African fishermen abandoning their homes and migrating to Europe where their skills could get them jobs since their skills were no longer of use to them in their own communities. This is another clear example of resource conflict causing whole system destabilization. Sometimes different kinds of competitors for the same resource can collaborate by protecting each other's particular uses, say if the two fleets were actually after different catches and the European fleet only inadvertently took the local catch too. That takes a lot of insight and negotiation, and neither science nor the political and aid organizations are really prepared to identify and coordinate solutions to common potentially foreseeable problems. Only seeing these things in hind sight usually means the damage is already done when we get the first hint. All individual systems sharing an open environment rely on their being able to function independently, and their ability to actively avoid crossing the lines of conflict with each other. When differently organized individual systems run into conflict it forces either highly complicated coordination or lasting harms, and at the limits of automatic growth that's perfectly unavoidable.

E.

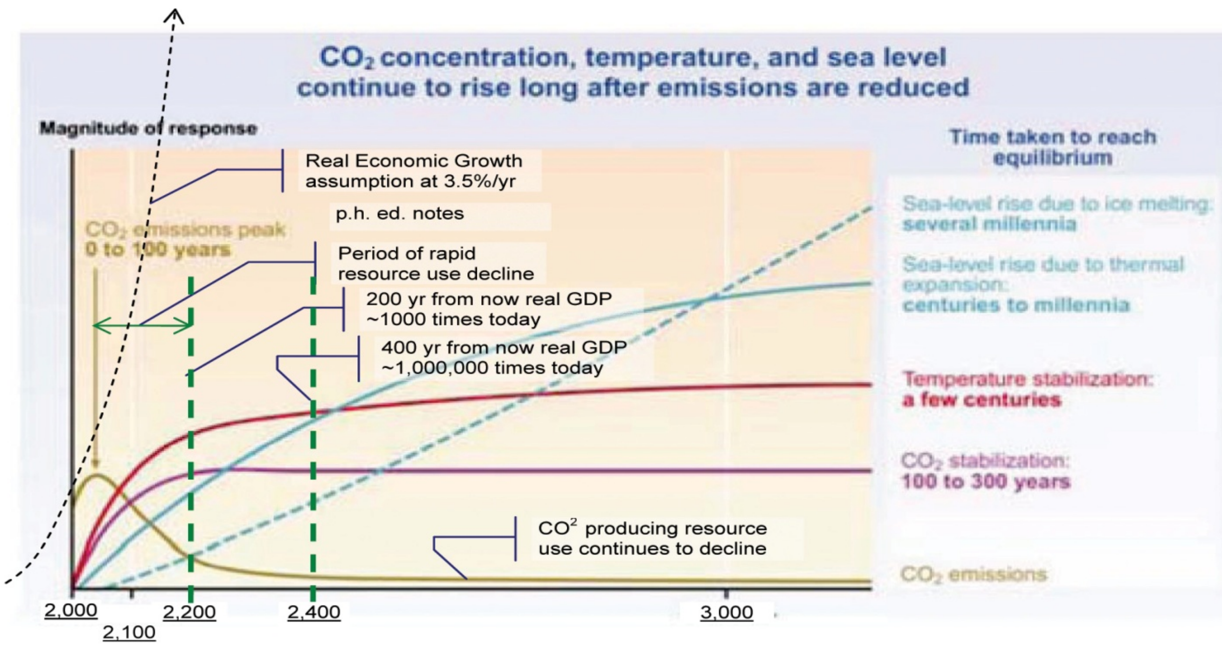

Figure 1 - Inertia Of The Coupled Atmosphere - Ocean - Land System; IPCC climate model

F. The above mentioned dilemma of the of the OECD economic assumptions underlying the IPCC climate models is clearly shown in the above republished curve from the 2001 OECD economic model that continues to be used with minor adjustment as the basis of the current IPCC climate models (CEM 2006). Added to the original image are the notes in black and the real economic growth curve. This view of the future uses the standard 3.5% real growth rate assumptions. That means that as the economies invent new kinds of things of value the old things continue to have comparable prices at the inflation adjusted rate, so in the future an apple is still an apple. Growth over the period of the long range plan represents the economies of the world growing by a **multiplier** of a billion times a billion, in real terms. It would mean ending wealth production that has environmental effects and having all the new wealth coming from the 'decoupling' of wealth and having vanishing environmental impacts. It's always a trick to make large numbers meaningful, but worth the humor in this case. That multiplier comes from the expected doubling of the size of the world economy every 20 years, five times a century, for 12 centuries a factor of 1.2×10^{18}. If you think of that as our projected 'earnings' for using the earth, the average rental value of the entire land surface of the earth would become an unprecedented 714 present day world economies per square foot[3].

G. A scientist writing such a report, and seeing the problem, might add a footnote. It might say that growth without resources may be unrealistic and so the real side effects need to be considered. That the question didn't become part of the IPCC reports is surely for a combination of reasons, but one is surely that they didn't ask it, probably because it was part of the self-consistency of the problem they had accepted and so didn't raise attention. The more direct reason seems to be that the people paying for the study had asked the science and engineering community to solve a problem, asking them to do what they see as there are uniquely skilled in. That's an operational interpretation of the functional fixation of social relationships that are as much a part of the dilemma as cognitive ones, that in self-consistent relationships it's no one's jobs to look beyond the problem.

H. In this case the critical missing piece of information seems to be that natural system limits of growth present themselves as ever steeper learning curves, with a threshold of rapidly increasing conflict. That we are actually confronting the limits of the earth in many directions of development at once it would appear, and in the middle of making major changes to how we live based on this limitless model for complicating our use of the earth, is quite extraordinary. How learning transfer is inhibited by our unwitting fixations on established rigid thinking is part of the story too. This error has been somewhat widely circulated among knowledgeable scientists, many of whom were directly involved in the writing of the IPCC reports. Acknowledging the problem is apparently not consistent with their own world-view though it's hard to see why. If you could see why a new perspective didn't connect with a new one, maybe you could correct that. One of the dilemmas is that when new perspectives are suggested to people with functionally fixations on others, even when asked they are unable to articulate what seems wrong with them, as if it would be thought to be rude or embarrassing to display misunderstanding, so better to stay mum. Inevitably the message is that working within the group assumptions is what's of most importance. From a larger view, of course, it's clear that competent people wouldn't make such enormous errors unless they simply don't see them.

I. The real problem with how the whole world economy runs into resource limits is with the way systems distribute stresses and opportunities, so limits are approached by every part of the system are once. All the independent parts of an automatic growth system experience this by running out of freedom and into conflict with others all at about the same time. Finding any sort of uncontested resources becoming available in a) smaller amounts in b) harder to reach places, is the key. Those kinds of 'diminishing returns' from systemically increasing complexity and more scattered opportunity are only the first indication of the end of some direction of development. Diminishing returns are typically an exponential increase in difficulty and that in itself produces radical scale changes in the nature of the problem. Our usual experience with the natural phenomenon of resource limits is much the same as cleaning your plate after a meal. With a full plate you can take successively bigger bites, but seeing the end coming you tend to take moderate bites and enjoying the meal rather than wolfing it down. Some will go to the trouble of using a piece of bread to sweep their plate and some will go the one step further of licking it. After going through whatever sequence of increasingly complicated techniques of enjoying their last bite, no one just keeps licking harder and harder. On resource consumption that we approach sensibly we just move on, having previously arranged some place to move on to.

J. If you have a rule that requires increasing returns a normal response to diminishing returns may not be possible. It gets especially complicated if the resource concerned is used by many others. Then when the user who have been successfully avoiding conflict by using uncontested resources all run into each other. Then the only to increase resource use is by complex cooperation or in conflict, both of which increase the complexity of the task enormously, and do also both always result in disappointment for any promises previously made for freely increasing returns. That people don't see these limits coming is the thing that marks our economic approach to natural limits so clearly. Having models that would alert you to the early signs of diminishing returns and the approach of lines of conflict would help isn't all that's needed of course. You also need to read them as signals to change your model. It appears that generalized diminishing returns, complexity and unexpected general levels of conflict would be an effective long range indicator of overshooting ones comfortable limits of growth. That would be the kind of thing a scientist could notice and pass on to local communities to ask them what is likely to happen as a consequence. Given a little time and attention people can back away from natural lines of conflict and work with each other's needs, regaining their independence and out of trouble. They need to see it coming though

[3] Projected 1.2 quintillion (10^18) economy multiplier at the standard rate of doubling every 20 years, distributed over a total earth land surface of 150 million (10^6) km^2 = 1.6 quadrillion (10^15) sf. gives a future average land value of 714 present world economies per square foot, it the end of the 1200 year projection of the future earth impacts of growth used by the IPCC for calculating the remediation needed.

K. Diminishing returns are a kind of information from the environment of inconsistent relationships with other kinds of things, from outside one's own problem definition, and outside your expectations. They seem to be the source of information that conflict avoidance may use in the community systems sharing common resources throughout nature that successfully avoid conflict. One can, of course, respond to a direction of effort getting harder by applying increasing effort. Sometimes a source of new difficulty can indeed be a learning 'hump' to get over. That's an important question to answer, though. If a learning curve is just going to get ever steeper it necessarily becomes a waste of time and pursuing it a measure of nothing more than lost opportunity. For many of our diminishing resources our increasing investments are just building our increasing dependency on designs with no future, and dramatically shortening their remaining capacities too, a double disaster. Diminishing returns, as well as multiplying ones are measures of the future. It's the difference between reserving your surpluses for something more useful than becoming ever more dependent on accelerating the depletion of a direction of effort that is closing out. Reading diminishing returns does not 'control' what you do, it signals you to 'go look' at what's happening and steers you to better opportunities. The signals of systemic events developing or subsiding are these learning curves, exponential growth and decay associated with change in the behavior of complex communities with internal networks of communicating behaviors.

L. One of the other reasons we don't look ahead is the natural planning horizon we've always used. We just push problems off a little and hope they go away, or at least don't come back any sooner than usual. Hunger is like that, so is breathing. It's also how we make work decisions and choose what to buy. We do what economists call 'satisficing'. The problem we're running into with making the earth sustainable is that just pushing our problems a little further up an exponential slope of complications has them come back sooner and much more complicated. We clearly have not defined the problem right if that's as successful as we are being, and need to learn how to think things through and is quite different from just thinking how to push them away. Thinking things through with natural systems, in the shortest form, is thinking 'over the hump' not just up the hill. It means 'looking around' beyond your immediate 'problem' to how a solution creates a problem for the things around it.

M. Both modern societies and earlier civilizations have failed to read diminishing returns and the lines of conflict in their relations with each other and with their environments. It's a very attractive theory as the trap is so easy to understand, and it's very clear that modern civilization is deeply caught by it. It's only a guess that our tendency to become fixated on growth and then trapped in conflict at the end of increasing investment in diminishing returns is a primary cause of our conflict with nature in general. Perhaps there is a partial modern consensus forming among systems thinkers that diminishing returns is central to the cause of many of the great collapses of historic advanced civilizations. The marvelous systems archeology work of JA Tainter on the subject (Tainter 1987) and the independent confirmation from Yaneer Bar-Yam of the New England Complex Systems Institute (MacKenzie 2008) both implicate diminishing returns as central to the problem. That was also the conclusion I reached by a different analytical means of proof (Henshaw 1979) somewhat earlier. The view also appears to be supported by recent NASA archeology studies of the Mayan collapse, noting a succession of innovative agricultural techniques that appeared to fit the description of 'sustainable development', but applied to sustaining population growth and depleting soils as the relatively sudden end of the central Mayan culture approached(Sever 2008). One of the main objects in this writing is to point to some of the detailed environmental mechanisms of the trap, and how the signals fail to be read that make it fatal.

VI. The string of major new cases in point

A. One of the most amazing cases of 'blind sight' and the 'next bigger crisis' on the public horizon appears to be the global food shortage and price war. Increasing energy demand is taking increasing amounts of former food producing land and both the quantity and price of food are cutting out the low income communities around the world. It hit with such suddenness because of the price war that was touched off, when two rigidly increasing demands conflicted over a physically limited supply, and the market used the usual mechanism for deciding who would get cut out. Just taking money from some place to buy food for the poor will only worsen the price war, bringing the governments in to add their rigid demands to the already overstretched market. How we got here was by not asking what the reaction would be.

B. Not even the evident error in targeting the development of renewable energy, trying to understand where these problems come from is certainly a subject still not 'fit to print' in the major media, or journals, or even for discussion in the sustainability science or activist communities. We simply can't avoid the logic, nor the consequence though. You can't have two crops at the same time on one piece of land.

C. 'Renewable resources' has been one of the major policy ideas for the environmental community seemingly from the start. It was part of 'living simply' and going 'back to the land' in the 60's and became institutionalized in the 70's. I certainly felt very much part of it, but then learned how to think things through. What we apparently adopted was not a practical scheme of reducing our impacts on the earth. It seems we adopted a 'word' laden with cultural values, the idea of 'renewable resources'. The sad truth is that using land to produce energy is an entirely new land use, which permanently substitutes for other land uses in continually growing amounts. What are being replaced are fuels that came with little impact from holes in the ground, and being replaced, or augmented, but high environmental impact uses. What we did, saying 'we' because I was very much a part of it, was to mistake a niche opportunity for new energy sources as a new limitless supply. We gave it a nice sounding name and barreled ahead saying it would solve the problem of endlessly multiplying energy use.

D. That says a whole lot about how we think. We saw an interesting modest opportunity, gave it a name, and used it as an unlimited opportunity. I think that describes functional fixation, the error of working with fixed self-consistent models unaware of the world they're about to crash into. It's only a start, but thinking through to the next cycle of environmental response would really help steer clear of that.

E.

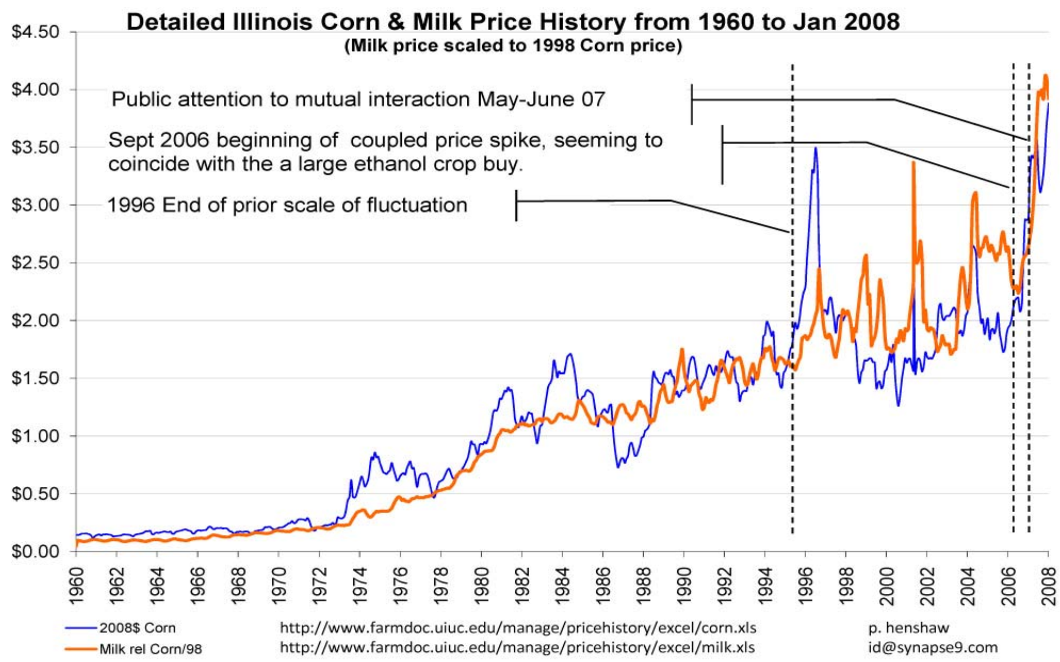

Figure 2 - Illinois Corn & Milk price history, monthly from Jan 1960 to Jan 2008

F. It's not a small error. After 10 years of well funded government and environmental movement sponsored intensive research and advocacy to move ahead on expanded ethanol production before the complete illogic of the plan was noticed because of the price war it touched off. In September 2006 the 50% increase in the amount of corn acreage intended for ethanol production in the US, seemingly leading parallel movement in the whole energy investment sector, set off a local and then global price war in agricultural commodities and just over a year later the more dire consequence of food riots all over the world. It notably caused corn and milk prices to simultaneously jump 50% in real terms. In a 'war' there are always 'winners'. In the near term perhaps, the price war seemed to be waged between mothers feeding their young children and cheese lovers who ganged up to foil the plans of vehicle users on the planes of Illinois last year. It's a classic case, though, and very visible in the long term price fluctuation curves above (Henshaw 2008a). Milk won that battle you could say, since the ethanol refiners ended with considerable excess capacity the next spring, but the world lost inexpensive food. Lester Brown provides a good clear discussion of the whole event too (Brown 2008).

G. Curves like these are open to interpretation based on the particular events and systems being displayed by them, of course. In terms of understanding the evidence here the main thing to notice seems to be that the price levels for milk and corn basically did not follow each other's movements until the fall of 2006. For ten years before there had been a marked increase in price instability. That may have to do with long term strained supply of some other real reason in the environment. The question is less what happened, though, than how the problem was being mistakenly defined and without exploring how the other players in the environment might react.

H. The research done by the many national research programs involved did not even ask if the technology for ethanol would reduce the release of carbon into the atmosphere, seemingly the recent immediate purpose of the plan. A year after the price war erupted, in January 2008 a environmental accounting study by researchers from Woods Hole and associated institutes, did an carbon budget for ethanol (Searchinger et. all. 2008). Their assumption is that the land taken from food would be replaced, by converting available arable land elsewhere, with the available supply coming importantly from burning Amazon forests. It's interesting that this group didn't see the food crisis coming from the long lag response of expanding food producing land. These are very complicated things, and take vigorously questioning ones own assumptions. Though I was writing in a widely exploratory way about the major error of using renewable resources to provide growing energy supply, I missed the food crisis that it would set off too. I framed the use of renewable energy sources as representing an unbounded growth of converting eco-cultures to mono-cultures, and how people could measure their equivalent land use as part of their project energy budgets. I did pick up on the price spike very shortly after hearing about it, and I still think that we'll look back at it as the beginning of the 'big crunch'.

I. It's not exactly that nothing in the lexicon of planning, environmental design, or the natural sciences suggests that when you make intervention proposals that you not look for what the effects will be. Maybe you'll have to look harder for how we made these huge errors than just reading an artful analysis, into your own perhaps matching stupendous blunders to find the same pattern. We all do it. We just tend not ask the unexpected questions because we see no reason to. There are no unexpected effects that will arise within our own self-consistent ways of thinking, and looking outside our own problem definitions is full of contradiction, lots of sloppy precision and playful stubbornness.

J. The independent responses of environmental systems will develop from everything that an intervention touches. Because they're independently organized you have to go look for them. The habits of scientists and planners do not include a world is full of independently behaving systems, with complex interconnections, that may individually make explosive delayed responses. That seems why we don't ask how they'll respond, they're not in the picture. It's a systemic source of surprise, and our society's practice of growing without limit makes it a multiplying systemic source of surprise.

K. There are better and worse ways to respond to surprise too, of course. Just because you learn good ways to look for them does not eliminate them. How to respond to the failure of ideas it then the key, and being open to that is obviously a requirement. The original biofuels plan, to buy corn on the market to make ethanol, was a valid niche opportunity. It was a simple idea that was not adapted to it's changing uses. The real mistake was not looking at the environment of renewable resources and finding that they were already over used, and not noticing that the implied plan was to burden them at continually growing rates. When you discover you don't have a problem right like that the first thing to do is 'look around', dropping all your preconceptions, stripping away the cultural distractions built into your assumptions, to bring them back in only once you can see where they would truly fit. You prefer not to drop your own values, but questioning them too, since the key dilemma is our habit of not noticing how 'good' applied in unrecognized circumstances becomes 'harm'. Working ever harder on the wrong problem, denying obvious mistaken purposes, is all too common too, and hidden in popular thinking quite often. It takes some daring to see beyond your own assumption, and most people are not aware how much that is really required to enjoy and protect one's own freedoms.

VII. Problem Solving Approaches

A. Traditional Scientific Problem Solving

1. The traditional scientific model
    - *a) global view, controlled variables*
    - *b) choices as bending the curve rather than changing the processes underlying it.*
2. 2001 EPA - EPA Science Advisory Board
    - *a) Improved Science-Based Environmental Stakeholder Processes*
    - *b) Research model - proving things*
    - *c) EPA – alternate recommendations*
        - (a) Stakeholder Supporting process
3. 2000 Systems Ecology
    - *a) International Institute for Applied Systems Analysis, C.S. Holling and the IIASA model*

B. Traditional Collaboration Strategies

1. Facilitating Group Process
    - *a) 'buy-in' 'boundary crossing individuals'*
    - *b) Culturing effective creative group process.*
        - *(1) from people in conflict*
            - (a) willingness to engage in personal discovery with those you're in conflict with
        - *(2) from people creating sustainability*
            - (a) foresight to engage with stakeholders of your world to discover opportunities and limits <u>before</u> you get into conflict
            - (b) if you don't see it coming you get caught off guard.

2. US National Academy of Science Rountable

C. Adaptive systems science methods

1. Computer models
   a) *Agent based 'game' models*
   b) *Complexity theory study of natural systems*
2. Complex systems learning/design processes
   a) *Henshaw (2008b) – 4D Sustainabiliy*
      (1) *Evolving the problem through a Cycle of discovering how it fits*
      (2) *Repeated pauses in the work to explore the environment of how it is defined*
         (a) The network of relations inside the problem
         (b) The network of relations outside the problem
         (c) The connections to big ideas and links to networks far away
         (d) Adding up the total balance of effects and devising compensations for excesses
   b) *Midgley(2007) – Adaptive boundary strategy*
      (1) *Islands of tractability from recognizing different kinds of boundaries & Death of the 'super model'*
      (2) *Exploring other people's methods and issues to inform a collaborative process*
      (3) *Quantification, analysis and 'triangulation' of qualitative and quantitative information sources*
      (4) *Systemic intervention with Pluralistic approach to theory & methods w/ systemic boundary identification for connecting problems, methods and capabilities*

VIII. The basic problems of knowledge

A. Dilemmas

1. Representation or referral
   a) *Images or pointers*
2. Creative models only show their world
   a) *Even if Agent Based Models eventually achieve the 'holy grail' of naturalistic behavior that arises from it's own environment, it won't tell us about natural behavior in our environment.*
3. Reading beyond your data
   a) *Looking for continuities in the data where they are not supposed to be, but there to find. You have to look for them though, and since what's being hidden in treating data as noise hiding a self-consistent model.   you look for continuities in individual changes not overlapping ones.*
4. planning horizon
   a) *Satisficing, the immediate task*
   b) *Thinking things through; beginning to end; around the bend, down the lane and to the next turn; the whole event; over the hump, not just up the slope; beyond the crest or trough of the next wave*
   c) *0- - - 1 ↗ 2 ↗ 3 → 4 ↘ 5 ↘ 6- - -*

B. Whole systems as the 'atoms' of nature

1. Identifying local processes of change,
   a) *Local in space, local in time*
   b) *Boundaries of connections, or perception*
2. Whole system 'nucleus' as a network cell of self-referential relations
   a) *The thing that grows*
   b) *History of development.*
      (1) *immaturity, stabilization, decline & decay*
   c) *Relation between interior & exterior*
      (a) Internal consistency, external environment as a free medium of exchange
3. Mechanism of change
   a) *Discovered opportunity by 'randomly' exploring the neighborhood of what works*
   b) *Reading Limits as diminishing returns and lines of conflict as thresholds of complexity*
4. Balance of nature
   a) *Individual learning to be resourceful with what's free as a balance of creativity*
   b) *Pressures between growth systems as a balance of conflict*
   c) *The natural instability of pure conflict and the natural stability of learning in various examples of environments*

IX. Discussion

1. The opportunity & the tragedy, a chance to rediscover the meaning of freedom

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