# Life's Hidden Resources for Learning

## Conversations with a radical idea

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### I. Abstract

One of the great mysteries of life is that science can't find anything mysterious about it. This exploration approaches the question of '*what is life*' from looking at the blinders that science and other kinds of formal representational thinking have built into them that serve to hide the life. Science teaches us to 'make sense' of things, using self-consistent models with no independent parts. Emergence seems to come from indescribably complex real things diverging from any model. Perhaps we could then use our models in reverse, to help us see the emergence of life in things around us by contrast, but we're taught to not do that. We're taught to look at the independent parts of things only through the fixed definitions with which the models are built. That gives us confusing 'functional fixations' to block learning about changing things, and results in large mistakes. Any exploration begins with some accumulation of small steps, after stumbling around a bit to find a productive direction. Hopefully this essay will offer some productive stumbling around, and some more places for an accumulation of small steps toward a new way of thinking about life. Some new scientific methods for exploring a living world are mentioned.

Key Words: life, observation, individualism, models, representation, determinism, functional fixedness, referencing, learning,

### II. Introduction

The main thing wrong with how people see Darwin's theory of evolution as a competition for survival is that the organisms and communities we actually see in nature don't behave that way. They're not mostly engaged in competition at all. The organisms that survive as the fittest in life, and that we directly see populating the earth, are mostly engaged in resourceful exploration when we see them. They prosper and survive by resourcefully using what they find free and uncontested in their local environments while successfully avoiding conflict. I'm not suggesting that in not being combative that organisms are 'unassertive' at all, but just 'smart' in doing it. What you seem to see in ecologies is each individual following their own path of exploratory learning. What the modern theory of evolution does is replace the behavior of the individuals with fixed definitions of statistical tendencies. The theory can't represent things on an individual level, and portrays the individual organisms as if they were following the theory rather than their own interactions. The question then would be how to develop an advanced model of how individuals behave as individuals, to better explain what we directly observe.

One can find lots of examples of organisms engaged in both mortal conflict, and resourceful learning, but to tell which survival strategy is prevalent you need a kind of whole system measure of some critical difference. Once I point it out, I think, anyone with a love for and wonder in the rich beauty and complete integration of natural systems will, well hopefully, remark how completely obvious it is. It's a kind of evidence that has been hidden in sight for centuries, seemingly by the obvious blind spot in the way we've been asking for an explanation, looking for how to represent living things with definitions. When trying to "make sense" that way we represent differently organized and behaving individual things with the same fixed rules, and our personal attachments to them. When we use them to represent the world we become functionally unable to see the independent life all around us. It's a deep blind spot and central to our mistakes in trying to develop the earth as a good place to live. All kinds of complex systems, not just organisms, behave individually and independently. We see it all the time, but keep being totally surprised that they react on their own.

The view here is more developed, but not at all unlike the one economist Friedrich von Hayek used to introduce his Nobel lecture "The Pretence of Knowledge". (Hayek 1974):

> "*It seems to me that this failure of 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 – an attempt which in our field may lead to outright error. …[a] scientistic attitude which… is decidedly unscientific in the true sense of the word, …*"

Looking carefully, it appears that because describing some things in nature as following global rules has been quite successful it prevents us from wondering if other things might be resourcefully learning on their own. So we act as if what we can't make rules for is meaningless. The physics model is not capable of representing an environment at all, though, let alone various differently organized individual complex systems that change as they develop in their local environments. How could its laws describe everything then, if all individual things are left out? How could it not identify that gap in what its method can describe?

Maybe complex systems in open environments are exploring and learning as they go much like organisms appear to be, with all their behavior being 'emergent' as a consequence. It's clearly things not following any prior rule, the meaningful emergent behavior, new relationships and developments, that are the main subject of human interest. The substitution of simple rules for these things that develop along their own independent paths not only hides the wonderful, but is also leads us into serious conflict. We get into steering with fixed rules in a changing world, naturally run into conflict and are naturally made unaware of how it happens. If you think local learning processes taking their own paths of change are following ***our*** own fixed rules and images, you're functionally blind to their life.

A current example of how ignoring the life in things causes us to get in trouble is offered by how the world environmental movement spent 30 years promoting bio-ethanol and other renewable resources only to belatedly discover that using them to substitute for oil requires converting ever growing amounts of food to the new use of providing fuel. Now this new and rapidly growing demand for food resources seems to have been the trigger for a worldwide food price war and panic for many millions in low income communities and societies (Brown 2008). It's perhaps not the whole story, since other things contributed to making the whole food market prone to shocks, but the 2006 & 2007 ethanol corn buys came along as major food market shocks at just the wrong time. We're going to find that the other plans to convert growing amounts of land for generating energy will run into much the same problem, but maybe not till those proposed unlimited takings hit a flash point too.

This is the antithesis of being resourceful in using what's free and staying out of trouble. This is walking blindly into trouble with other living things. It's something people do over and over, grabbing great niche opportunities and treating them like unlimited resources, completely failing to 'see the life' that the footprint of our choices is going to step on. What makes this mistake by the environmental movement particularly useful, though, is that it represents the exact same conceptual error that the promotion of 'renewable resources' was designed to correct. It is therefore clearly a cognitive error and not a matter of holding the wrong moral values. Because we fail to see the resourceful learning other things are involved in and our actions will intrude on, we can't ask how they'll react to what we do. We then can't see the lines of conflict with them in the world around us, by default.

I'm not at all sure I can convey the whole picture I have of nature, that individual learning is a developmental process you can directly observe in all kinds natural systems. I hope to outline a fairly convincing view of a particular cognitive deficit that might well hide that kind of reality from us, if it were to actually exist. The blind spot is this: As much as we think about our world in a self-consistent way, we will not be able to see the independent behavior of its parts. Like a single equation, self-consistent thinking can have no independent parts, and describes all behavior as dependent instead of independent. Nature, though, is a medium that thrives on the wastes of one thing being used as resources for others, indicating their mutually inconsistent organization. Consequently there can be no way to make just one sense of an environment. At least some of the cognitive dissonances we find around us are the direct evidence of this, and widows onto nature's differently organized parts. If as part of making sense of them we replace the dissonance with our own self-consistent images and treat them as representing our world, as we usually do, the life they represent becomes hidden.

Discussing this, of course, also gives me the somewhat tenuous task of 'making sense' of things one seemingly can't make sense of. You can't prove a negative, but you can see gaps and then instead of covering them up with answers, go look and find interesting things in them, and leave some open questions behind. That's making sense by knowing where to explore and being open to learning, not by adopting definitions. It means listening for when to treat settled things as open questions. Still, why would one continually look for the things that would upset the sense we're trying to make of them? Perhaps exploring those dissonances becomes reliably productive in ways we'd otherwise never imagine. One way to find and explore them is to locate and trace individual learning paths in complex systems, closely watching what's happening as locally conserved change goes through development and decay.

If the systems of nature are each adaptively learning, and our usual way of making sense can't represent that, we'd be physically living in the middle of something we don't see happening at all. A separation between the world of physical processes and our world of cultural ideas seems very possible. What's most apparent is that people each have rather different ways of thinking from each other. It appears that for all of us the first assumption is that everyone else thinks the way we do and lives in a world built like the one we imagine. It's good to be reminded that people don't think of the world alike at all, but given the common misimpression that we do, and absent a common reference, it raises a serious question on how we could tell if anyone's mental models are connected.

For this core problem with 'making sense', the blind spot seems more one of 'formal' thinking. It takes a fair amount of effort to make a self-consistent model or explanation from all the inconsistent observations we collect. It also tends to strip away the life. If nature is actually composed of lots of individual things engaged in individual learning, our process of "making sense" of them could indeed physically cause us to loose their individuality and separate ways of learning. If the tools of knowledge can't represent emergence, perhaps the trick is to train them to explore it instead, treating the physical world as its own representation. Informal thinking and spontaneous behavior works very well without artificial representations at all, developing understanding as a matter of 'second nature'. With it people learn to take part in very complexly changing relationships and environments, responding expertly without much formal thought to their many kinds of signals and situations. Perhaps that talent for the complex 'in-physico' world could be trained for exploring the 'in-physico' models of larger natural systems too.

## *III. When tradition rules*

Learning to understand natural systems as being different from our formal ideas of them would certainly take getting used to. Oddly it means considering if natural systems could have individual designs just like what one naively sees in daily life, and that nature works them with every particular of the events involved, just at it appears. That is definitely a break with some of our dominant beliefs and traditions that the particulars of events are just random 'noise'. It's also a central tenet of science that everything is following universal rules, and we can find them. That no rule quite explains any individual instance, and no experiment ever quite fits any theory about it, never seemed to be an interesting question. The apparent excuse that because some rules are useful, everything must follow rules we just don't happen to know yet, seems to have been quite satisfying to most people. How nature does not follow rules but explores paths of development, seemingly the main part of behavior we couldn't find deterministic rules for, really does matter though! Now as human designed systems are colliding with the earth's in very unexpected ways it seems we really need to understand the roots of that, and find out why *everything* somewhat misbehaves.

For a very easy analogy that may help, we often talk about something being a 'bubble'. Usually that's concretely referring to accumulating expectations that collapse when the reality does something unexpected. Purely physical system collapses of all kinds develop on their own too, not depending on mistaken human expectations. Perceptual bubbles can form and collapse completely bye themselves of course. Bubbles of failed expectation can also happen simply because learning always lags information anyway. It's also possible to have bubbles in our minds being tied to ones in the world but accumulating by quite different mechanisms. Physical systems and mental systems have quite different ways of developing, and the linkage is problematic. One type of 'bubble' common to both, though, comes from how natural systems commonly develop by blowing up, accumulating multiplying change that can be naturally prone to 'burst'. It's a common feature of mental and physical systems; bursts of laughter or insight, bursts of energy or change. Having locally accumulating change accelerate and trigger a burst of abrupt dramatic change as a consequence is a very natural kind of emergence of new form in both mental and physical processes.

That scientists have not been interested in why every experiment misbehaves a little leaves us more open to discovering the general flaws in our models only when nature misbehaves a lot. We still don't see quite how our fixation on wealth as creating multiplying surplus, for example, keeps pushing the whole world toward deficit, for example. It's too big a contradiction that multiplying 'good' could be bad somehow, upsetting the thought process. Hopefully that can be overcome as we get used to the cognitive dissonance of the increasingly obvious effects of just trying to ignore it.

On thinking it through, for example, the real culprit in the food crisis seems not to be specifically bio-fuels and ethanol. Perhaps it did trigger the price war, but the 2006 & 2007 purchases of corn for ethanol were of a scale the markets had previously absorbed by stimulating the excess food production capacity of the system as a whole. Large natural systems have networks of 'buffers', where every part has reserve capacity to facilitate adjustments of the connected parts throughout. Why the reaction to ethanol intruding on the world food supply was so sharp is the leading question. It appears other things were at root in draining the food system of all its reserve capacities and ability to absorb shocks. What looks like the underlying cause is a major relentless global trend that no one has paid much attention to in this connection. I think the main culprit is global 'urbanization' (the everywhere sprawl) that is relentlessly reducing the quantity and quality of land available for food production while also continually pumping up the demand, from both total population and it's per capita spending and resource use. These have been and are expected to be quite relentless, and if we're now hitting the firm limits of the earth, so will the price. We should treat population, compounding demand growth and loss of productive land at the same time like real threats to an endangered species, us.

Nature's method of achieving rapid demand reduction at the limits of supply is reducing customers. It's raising the price of food out of reach of many millions of people, and destabilizing small economies[1] . The limits of growth have been discussed for some time (Meadows 2004). The 'green revolution' multiplied populations and land use, yes, but what it didn't do is fulfill the promise of multiplying green revolutions.

One of the rules that apply to things that learn as they go is that they'll change when they run into other things. When individual growth systems in an environment expand each one takes opportunities to expand that avoid conflict with each other. That, interestingly, leads them to all run out of uncontested resources and into conflict with each other at about the same time, coordinated by how they minimize conflict. They avoid conflict until there is no more room to maneuver, and that happens for all at once. Our currentgrowth of resource conflicts is direct evidence of users becoming unable to avoid conflict, and the presence of resource limits that our collective creativity is not able to change.

The simultaneous global price increases in all commodities at once also signals an approach of physical resource limits. It presents itself as a sudden increase in the difficulty of finding added supplies of most everything, increasing the steepness of all our learning curves. Each resource is priced in terms of and is exchangeable for each other, through the 'liquidity' of markets, so there is effectively no real limit to any resource until they all hit limits at once, and we see it in the learning curves as we exhaust both the materials and our imaginations. Other than for the speculative spikes an inflationary spirals touched off by them, the coincidence of price rises for all resources at once implies that the price rises are due to a natural need to limit demand due to the whole physical system being unable to respond by increasing supply. Just buying food and other limited resources for people who can't afford them will then push prices higher. Promoting productivity growth will also increase resource demand and push prices higher. Printing money to protect special interests with deficits will push up prices too. All relieve the pressure on the system by shrinking the circle of people who can afford the real stuff. That would put even more of the world's less productive people in jeopardy. That progression, of course, puts the world's more productive people in jeopardy too. Only slow cures seem available, and that presents us with another profound and confusing moral dilemma for our time.

I grew up in a small north eastern US dairy farm region, and most of those farms are now abandoned. The high productivity farming methods elsewhere have a monopoly on food production and squeezed out much of the whole infrastructure for modestly productive food production in the developed world. The problem is not just farming methods ruining good land and expanding cities that multiply the demand for food products. We've also been paving over the old farms, turning them into suburbs or scatter site housing and golf courses. Some of those farms in the north east and elsewhere might possibly be returned to productivity, but the local traditions and businesses have all changed so some entirely new way of using the more segmented pieces of arable land will need to be invented to return them to use. Those are slow solutions. What the evidence of same learning curve signals for everything suggests is that everyone looking for solutions is finding only slow solutions.

Some parts of the world, the motion of planets for example, do seem to follow simple permanent rules quite closely. Even if they seem like they might never need to be watched to see, the better rule for natural systems is to never quite trust that. You might have a habit of collecting original observations of a high enough quality to pick out the individuality in the behavior of things. Then you could compare your observations to your rules. The alternative is just waiting for the train wreck, trusting your rules as long as you can and then only starting to make new original observations when shocked by things departing from your expectations

[1] The World Bank now believes that some 33 countries are in danger of being destabilized by food price inflation http://www.telegraph.co.uk/earth/main.jhtml?xml=/earth/2008/04/22/scifood122.xml 4/22/08

entirely. Being rather surprised by change is going to happen sometimes anyway, but if you're in touch with the individuality of the other things using the environment you're in, adapting to their surprises is far easier.

Another side of traditions and traditional ways of thinking is that we invest them with an enormous variety of emotional and cultural meanings. That means they develop with very diverse interconnections, like any complex natural system. They also cross connect our complex thinking and value systems with the development of our physical networks and habits. Those relatively unseen ties built by making physical choices for cultural reasons, makes both harder to change. Perhaps people just don't want front yard vegetable gardens, for example, altering the cultural symbolism of homes, not to mention resale values. These complex connections between nature and our traditions tend to represent hidden layers of 'infrastructure' that interfere with rearranging things that are already built. For the past 50 years the most profitable development in the US, because of the cultural symbolism, was to build lifestyles consuming more and more energy and put them in houses further and further apart. That went along with the whole cultural evolution of society. Both are now built in as a permanent feature of our physical settlement pattern for the continent. That's a major barrier to change.

One of the good observers of how economic development operates as a natural complex process is Jane Jacobs (1969, 2000). The city is really a key to nearly everything that humans do well. Multiplying city expansion to the point of threatening the world food supply is not one of the shining examples, perhaps. Still, cities are like mankind's fresh water ponds, where we intensely thrive. We've let a conflict develop between how mankind thrives and our physical place though.

## *IV. The natural balance*

I recently discovered what I hope is the key to revealing a whole new side to Darwinian evolution in reading the writings of one of the earliest ecologists, and one of my ancestors, Stephen A. Forbes (1887). He did his work when the first questions of ecology were being raised, and was the first ecologist to describe the unusual densely thriving and stable communities of fresh water ponds. His original paper is both quite readable and technically thorough. What I found interesting is the way he discussed one of the unsettled questions of that time as he summed up his conclusions, the puzzle of ecosystem stability. To clarify the quote, he refers to predator species also as "the dependent species". See if you can pick up the leap of faith that remains inadequately explained to this day:

> *I will bring this paper to a close, already too long postponed, by endeavoring to show how this beneficent order is maintained in the midst of a conflict seemingly so lawless.*
>
> *It is a self-evident proposition that a species cannot maintain itself continuously, year after year, unless its birth-rate at least equals its death-rate. If it is preyed upon by another species, it must produce regularly an excess of individuals for destruction, or else it must certainly dwindle and disappear. On the other hand, the dependent species evidently must not appropriate, on an average, any more than the surplus and excess of individuals upon which it preys, for if it does so, it will regularly diminish its own food supply, and thus indirectly, but surely, exterminate itself. The interests of both parties will therefore be best served by an adjustment of their respective rates of multiplication, such that the species devoured shall furnish an excess of numbers to supply the wants of the devourer, and that the latter shall confine its appropriations to the excess thus furnished.*
>
> *We thus see that there is really a close community of interest between these two seemingly deadly foes.*

To me his saying that "*the dependent species evidently must not appropriate … more … and thus indirectly, but surely, exterminate itself*" describes why individual learning would be useful. It describes the possibility that dominant competitors might not finish the job of using their advantage in a way that is responsive to their immediate circumstance. If that kind of sophisticated responsiveness is conceivable for the predator, it could also be available to the prey. Prey could avoid the hunting grounds of the 'big fish' during their hunting hour, for example, and for the ones that are good at learning about where the dangers are to preferentially survive. The same general kind of local learning could allow individuals of either predator or prey to avoid over extending their self-interests of any kind, or even for developing other resourceful behavior, if their normal behavior is a learning process to begin with. What they would need is a) a source of information about the approach of limits and b) to prefer directions of exploration that avoid them. It wouldn't require advanced 'intelligence' per se, just exploration combined with avoidance. Since all resources are potentially collapsible, individual learning by both predator and prey seem needed for stability because unequal advantages would otherwise only be stable in rare circumstances.

The real difference in Forbes' view that I think I picked up, what I think raises the question in a new way, is considering the stability of the relationship between predator and prey as depending on their behaviors as individuals rather than as populations. His work preceded the later codification of ecology, during which the question of how the individuals do it was, in my impression, lost. When mathematical ecology solidified on using statistical pressures between whole populations to explain relative population balances in the 1920's (McIntosh 1985), all individual behavior was lumped together with simple statistical rules on the model of physics. The reason why you would need to understand how individuals succeed in their individual circumstances disappeared. Competitive pressure is actually an abstract theoretical construct, the hypothetical sum of individual behaviors, not a real one. If individuals with advantages did not learn from their local environments, and always pursued advantages to their limits, they would exhaust their own resources as a rule and food chain relations would be profoundly unstable as a rule. Well, when you look around, they're not.

This is an apparent proof that resourceful individual learning is the more dominant behavior of stable natural systems. I think if you look for it you confirm it easily. If this interpretation were to hold up, one of the many wonderful implications that follow is that humanity's tendency to stumble into conflict with its environment is not inherent in nature, but a matter of learning. If organisms and various other kinds of systems with little or no brains at all can develop complex stable competitive systems in which the individual parts learn to get along, perhaps we are just missing the signals.

### *V. Reductionism*

As I've progressed with understanding our larger problem of misunderstanding nature, I found a curious error. It's partly that to make self-consistent models or explanations nature's independent parts need to be replaced with definitions. Self-consistent explanations can't have independent parts. Replacing the complex independent things we observe with definitions so they can fit into consistent explanations procedurally strips away all their independence and individual learning behavior.

The particular over-simplification of complex things that assures being surprised by events around us is not conceptualizing that an environment with independently behaving parts could independently respond. Then you can't ask how it will. In traditional science the models we use are all self-consistent, and have no independently behaving parts[2]. They only reference separately organized systems by name or a substitute rule. That excludes all their individual behavior, and precludes asking how it might react. If life is composed of individual learning systems, environments are then inconsistent with any self-consistent representation of them. The one exception seems to be if models retain adequate places for questions. Otherwise representing the world with regular models serves to 'hide the life' and our own real nature, providing a very good reason why we miss the signals about crossing the lines of conflict with other life and our own stability. It's a possible natural cause for why we keep failing to see the life around us that the footprints of our fixations keep stepping on.

I think there's a match between that explanation and many of the particular errors being made, like the error by the environmental movement of promoting the niche opportunity of ethanol as an unbounded resource until it collided with global impacts on food. It was entirely inadvertent that it ran into the lives of poor people all over the world by triggering a price war. Even if other things contributed, it's clear that the models that the environmentalists were following don't turn their attention to the life they would be stepping on. The question was missing from the model. That makes it a cognitive problem rather than a values problem.

Having models that 'hide the life' is a kind of 'functional fixation', similar to those studied in Gestalt psychology, an inability to hold more than one thought at a time (Davidson 2005). As discussed above 'making sense' of things by constructing a self-consistent model or explanation removes any information about original behaviors in the same domain, unless the model also asks questions. Leaving open questions is a way to hold more than one thought at a time, a place mark for further exploration. I learned this principle when studying how the natural paths of air currents develop, every one differently. I could try to have a new rule for each individual one, but what turned out to be more practical was finding some better questions to ask. Environments are full of things like that, and watching with good questions lets you see what's really happening.

Relieving all of one's 'reductionist' fixations at once may also not be practical too, of course. Even making modest changes in old habits of thinking would surely take time and effort. Still, there may

[2] Agent Based Models are intended to build virtual independent behavior in a computer, If they were ever to develop truly original behavior though, we'd still need to study it with the same methods we have yet to develop for studying original behavior in physical systems.

be a fairly simple way to define one potential starting direction, at least. One half of the reductive step is adopting a self-consistent model to represent a complex inconsistent world. That hides all the independent behavior of its parts from view. The other half, though, is then turning off your own stream of original observations and questions, your own play with the sensory inputs used to build your model in the first place. If after you adopt your simple model, though, you could keep both your model and observations going side by side, and get the opposite effect. Then a self-consistent model could become a sensitive detector of differences, and a way to highlight the life around you. It would mean not ending the creative thought process when we first 'make sense' of things. It would mean continuing it. The downside, of course, is that in our cultural traditions that sort of 'thinking forward' after making sense of things is sort of 'thinking backward', as if looking to upset everyone's fixations…!

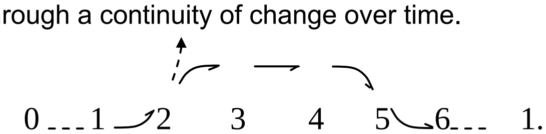
Suggesting that people could actually use this kind of technique to develop the proverbial 'whole new way of thinking' a great many observers have thought needed is just a little preposterous on the face of it. There are so very many reasons why it can't make much of any kind of headway in a human world so self-possessed as ours. People almost seem to not acknowledge the presence of a physical world as a possible subject of attention at all. The subject of physical processes around us is not really part of our conversation. So… take it as a thought experiment, a curious idea to play with as the furniture we're sitting in slides off the decks of the Titanic, or something like that. Life isn't fair! We'd have to overcome so much. To learn to live in a world full of individually behaving systems we'd have to overcome our fear of everything being out of control.

Nature may yet provide us solutions though. Natural systems frequently avoid running into conflict with their own runaway fixations, responding to the approach of unsolvable problems by effectively redefining their problem, and changing form. It actually appears to be a rather common kind of crisis management in natural systems, and often in circumstances not at all unlike ours. As individual learning processes, natural systems generally begin with learning how to multiply themselves, and develop by a process of runaway exponential growth. They may not try to strangle a whole planet, of course, but they all need to overcome that same learning crisis and change their whole way of changing as they run into limits. Natural growth systems that stabilize seem to do it by switching the way they use their surpluses, so at 'the signal' they change from expanding by successively bigger steps to completing their designs by successively smaller ones. It's a complete change in their whole way of changing, a change of purpose not a change of performance that lots of kinds of uncontrolled systems do by following some kind of internal trigger in response to environmental signals. Their whole widely distributed organizations switch from a set of insolvable problem definitions to a set of solvable ones at the same time, with grace and ease, replacing immature growth with maturation.

## *VI. Individualism*

Turning representational models that naturally hide the life and the steps it takes, into tools for seeing it isn't practical if it just means having to question everything all the time. What's sort of missing still is a general image or theory or idea of nature's individualism to replace the general image, theory and idea of its determinism. There's not room to digress far into how some of the preceding questions and problems suggest it. The first step may be to wonder if the appearance that everything in the universe takes place individually has anything to do with how things actually happen. That everything appears to happen separately and individually has been treated as the illusion by much of science, disguising the workings of abstract rules.

There may be various other starting points. The one I've found most useful is how the developmental processes of events display a continuous conservation of change, *temporarily*. Taking that apart, in the mathematics of continuity, exposes a series of questions about beginnings and endings of continuity that includes the formation and dissolution of regular processes in the middle. That's my model of the individual, as an event of organization and disorganization that develops through a continuity of change over time.




Continuity is measurable and subject to mathematical analysis. The developmental trends necessary to link beginning and end with continuity appear to correspond to discoverable complex physical processes of irreversible change, system development. My theory of the individual, then, is that looking for how individuals develop seems to work. It works for forecasting by letting you ask what any particular kind of developmental process will run into to, and how that will change it. It helps to narrow that question down a little by having the approach of the different kinds of turning points in any developmental continuity, 1 to 6, suggest a different set of questions and choices (fig 1.). What kind of choices exist as a development process approaches the instabilities at each turning point, where they 'switch gears', is something you tend not to see unless you're looking for them coming, and don't exist to be seen in hindsight.

When you just slip blindly through these whole changes in relationships, everything can change around you unexpectedly. Severe consequences may develop unseen and become firmly established before you see t, leaving you little or no way to respond. For example, humanity did not notice that nature's signal of things running out is making them harder to find and more expensive, or that exponentials make explosive turns. When you see whole system learning curves getting explosively steeper it shows why limits are insurmountable.

One of the main differences between our hitting 'peak oil' and 'peak food' as cost/learning curves this decade is that we paid relatively little attention to 'peak food' approaching. Now we are caught more off guard by it partly by being distracted by all the attention given over the years to fuel limits. As our long habit of using resources to multiply resource uses now switches from creating showers of wealth to torrents of problems, it's the ones we're distracted from that catch us off guard. The ones we pay attention to are the ones for which we develop options. Malthus' observation about food still seems to apply, with a few more of the details filled in. Our choices have worked to make the upward limits of supply less flexible than the upward limits of growing demand, and nature will find her own way to cut demand if we don't find one we like better.

## *VII. Thinking Things Through*

There would be no method of predicting all the unexpected responses of the individual systems around you, but one unusually effective one is to always ask what will be the end of any particular direction of activity. You learn to either think things through when possible, or at least to keep alert to what's happening. Everything runs into something, and every direction of progress finds its point of diminishing returns. Being sensitive to diminishing returns is usually a very effective signal for otherwise remote and invisible behaviors scattered in an environment with a potential for erupting with conflict. When we don't think things through and ignore the diminishing returns signaling the approaching walls of complication they lead to, the temptation is to think you're solving your problems by just pushing them out of the way for the moment. It makes "barrel ahead" until you're thrown off track your long term planning model.

The more curious thing about reductionism, though, is that that's not always the rule. The place where people do seem to have a high level awareness of life and approaching lines of conflict is with complex relationships we handle very well, but don't "make sense" of. That would include things like personal relationships, story telling, cooking and music, among others. They're things that become 'second nature' to us with the right kind of attention to detail, rather than by making a 'theory'. Still, in solving the real environmental crises of the world, apparently caused by misapplied science, the scientific models of change are completely essential. Since fixed models of rules have no individual parts, they don't show what is actually happening. The question is then how to change them into models for showing us the life around us, even though by definition independent parts can't be included in a self-consistent model.

I think I should only very briefly mention a couple hopeful directions for that. I'll avoid the theory for how to tag deterministic models with open system questions, and focus on one old and two new methods of complex system learning. One example of a whole new type of science is a network science application called 'product space' in which maps of commercial trade relationships display links between different supply chains (Hidalgo 2007). It's a map of everything bought and sold by business and how they're connected. There are sure to be many ways to study the whole network of commerce, but one interesting thing is that the product communities displayed correspond to knowledge communities of each society and their economic cultures. What seems the most interesting is the early finding that this also exposes their natural learning paths.

The way development aid was once designed it promoted the businesses that would make the most money. In a developing economy that might only target businesses that devalued the learning path of the local industries and institutions, and so disrupted the indigenous societies. Having scientific tools to help planners see what organically fits the natural learning paths of the local cultures, to bring them along with change rather than disrupt and discard them, seems extremely important when considering the radical development strategies being proposed all over the world. In addition, disrupted societies seem to have chronic unsustainable population growth.

What's so new about this strategy is that it uses an analytical exploration of the actual structure of living natural complex systems themselves, and not theory. It's certainly subject to misunderstanding, but instead of representing systems with an abstract theory, it builds models of natural systems directly from the behavior of the complex systems themselves. It's an observation tool for watching the life in things.

Another direction of new science is filling the gaps in science through collaborating with non-scientists. Different knowledge communities have different kinds of knowledge and combining them is needed to get the whole picture. That is what takes place in the partnerships between scientists and non-scientist decision makers in relation to environmental conflicts. The scientists see the environment from the outside and the non-scientist decision makers see it from the inside, and combining those two perspectives has tremendous potential. The solution first presents itself as a problem that neither can solve by themselves. When scientists learn how to show non-scientists what in their local environments their models refer to, non-scientists who see the same systems from the inside and in greater complexity can then come to understand the dynamics. They can then also tell the scientists what individual developmental behaviors their models are missing. That lets both better understand it as a whole and what in the circumstance can actually work. That's at least one simplified statement of what goes on in partnerships between communities of interest that need each other, but have cognitively dissonant perspectives NAS 2008). They often can't solve the problem they face without using the alternative kind of knowledge the other is proficient in.

Real learning from different points of view does take additional time. That, then, raises the 'old' method of solving excessively complex problems, slowing down. It may sound contradictory, but that we've been caught off guard with environmental conflict erupting all over means that to respond as well as we can means we need to really think things through and not just throw patches on things and run on. Where possible we'd use the available decelerators of problem creation as much or more than the available accelerators of deep problem solving. We need to try to not make our next set of mistakes even worse than the last, as clearly seems to be happening.. We seem to need a new and unfamiliar kind of problem solving and have conditions racing ahead of us much faster than we can respond. Economic slowing may not be a disadvantage.

Among perhaps a great many others, two advanced complex systems design and learning methods are also worth mentioning. One is my own 4D sustainable design method for finding how choices can connect with the living system in which they are immersed. It's a complex system learning methodology intended for use in planning and design practices. It relies on the basic strategy of exploratory learning: start with a question, make repeated searches to find things to inform it, see how they combine, and leave the loose ends for other searches to connect with. That's used as a problem solving cycle of breaking away from assumed problems to 'look around' to see how it works with its environment, then looking for long-shot connections and following through with adding up the 'total balance' of effects (Henshaw 2008). Another model application for using advanced complex systems learning in problem solving is the practice of Gerald Migley (Migley 2007). His approach is to study the boundaries of the way the starting problem expresses itself and the boundaries of resources and ideas of communities of people involved with it. As that leads to a more complete understanding of the environment of a problem, an intervention that would be manageable, have multiple positive effects and cross the boundaries, is then identified and set in motion. The one essentially starts with the assumed solution, and the other with the assumed problem, and then both work through what they're connected to.

Many sustainability design and science programs still emphasize only solving the assumed problem instead of "questioning the problem on a path to a solution". Many of the tricky solutions we hear about don't account for the learning process to get there at all, and even if they worked temporarily would often leave the world in a bigger crisis when they run out. Collaborative learning to 'find the real problem' is often treated as a nuisance to be avoided. That kind of "barreling ahead" with a problem definition that ignores the learning of the living things in which it operates often runs into trouble for causes made quite invisible by it. Still, lots of organizations have major programs for finding a true sustainability science. It's so new it can't really be surveyed. Some that attend to the learning process itself are the EPA, AAAS and the National Academies of Science and the programs they reference. (EPA 2000)(AAAS 2008)(NAS 2008).

So, what is life? Well, if you're any good at it you can't avoid needing an awareness of the life all around you and being immersed in its learning!

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