Notes on Observing Natural Complex System Events

17 June 06   Philip F. Henshaw

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As you read on you may reasonably say what I have to tell about is all just a little too much. I propose, among other things, we add something like a new dimension to our understanding of the world. People are missing a huge piece of what's happening around us, and making major mistakes because of it. I think the beginnings of a cure can be found by learning to read curves of change perpendicular to the page on which they're drawn. It will let us clearly see some major errors, add a fresh and fruitful new direction to science, and provide a remarkably flexible and useful new way of understanding many of the personal issues and experiences that most concern people individually. The reason I chose to organize my views of complex natural systems around curve interpretation is because it strongly anchors a completely outward searching view of complexity and creative processes in reliable and plentiful data.

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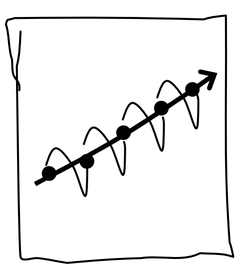

Complex natural systems, weather, communities and culture, organisms, plasmas and other things that exhibit changes of state, are well understood to have many kinds of very real organization that greatly affect us. They've been quite difficult for people to think and talk about, however. We can see complex organizational change, and measure it, we just don't understand it. One reason is a bad habit that cripples our imaginations, thinking of change as progressing the way our records present it to us, as sequential strings of markers, linking one dot to the next with a curve or a story. The dots on the page, or separate facts we accumulate as a sequence, are indeed most likely connected, but by events that are not on the page or in the line of the story we connect them with. The alternative is to read the connection between the dots as perpendicular to the page, the way the thing measured actually connects within it's web of relationships. This short collection of hints and observations is intended to convey some good starting points for learning how to let the information we have become more meaningful.

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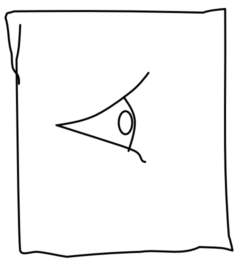

One of our problems in understanding complex natural systems is realizing how extensively we're involved with them.   Our view of the organization of nature and our role in it has been expanding, but remains mostly impoverished.   It actually appears to be the case that it is changes in complex physical systems and their rapidly evolving organizational structures, that generate *all* the animation of life and nature, every blink and echo.   We tend not to see it because we tend to see only the things we can make sense of.   What we see also never includes our own ways of seeing, like a camera trying to take a picture of its own lens, it's just never in the picture. Up till now, complex organizational change has just not been in the picture.   What we've tended to find useful are the rules about what can be expected, but that's not how nature does it herself.   These notes are about learning how to draw meaningful pictures of what was previously incomprehensible.

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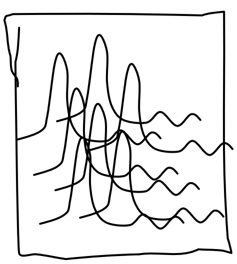

One of the objects of learning how to read graphs for hints on what really connects the dots is seeing that system events may be complex, but are also organized in and discretely recognizable as, separate complete and composed events in time.   System events come and go as wholes.   Nature is a very busy place, on many levels, but complex systems still retain their individuality.   There actually appears to be nothing that happens without an explosion of evolving natural system change somewhere directly behind it. Since most information is information about complex systems events, there are many recognizable shapes of change that can become open doors to new insight into what's really happening.

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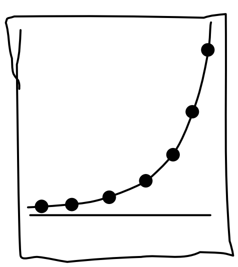

I've had other ways of describing this proposed departure from earlier ways of interpreting recorded data, but reading data perpendicular to the page, for the loops of connection between the dots, seems to explain it well enough, and to be a little less mysterious than some others.   What turns up rather abruptly as you begin to scan time-lines this way are the many occurrences of exponential curve shapes.   It's possible for clearly patterned shapes to happen in data by accident, but unusual.   The family of exponential shapes in records of change very largely represent rapid evolution in some single complex natural system, actively altering the context in which we live and work.

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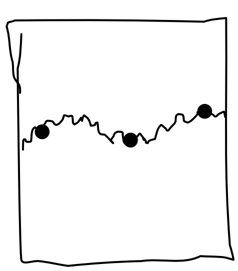

The sea has waves, large and small, and no one wave makes much of any difference.   If you watch waves, and look around a little, you notice there are ripples on the waves and that waves are ripples on the swells.   This pattern of multiple levels of continuous variation is called fluctuation, and seems to be part of the surface pattern of all natural systems.   What fluctuation does to data is mess it up.   If presented with a string of numbers recording the occasional height of the water surface it will seem very erratic.   The data would not clearly reflect any of the scales of variation, perhaps except the tides, the 24 hour waves.   There are also other reasons why graphs of change over time look erratic, but most often it's not 'noise' since none of the variation is random, but just poorly described fluctuation.   Fluctuation is the active response of natural system self-correction mechanisms called 'homeostasis', the endless sequence of correction and correction that gives anything with an appearance of permanency it's structure. Mostly scientists and laymen call it 'noise' because someone one day decided the measurable uncertainty one would have in predicting the next point in a list was the best way to describe what the physical behavior was itself doing, i.e. behaving randomly. It's sort of a nonsense shorthand way of speaking in common use. I'm certainly not suggesting that any good scientist would really defend the practice, or if interested in some subject they wouldn't look closer. I'm just saying that it's how the tools they accept and use are constructed and it strongly influences how one reads the shapes of curves.

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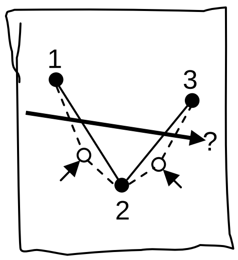

When you're given three dots and asked to draw the connection between them, the usual thing is to assume the dots represent a trend with noise, and that the safe first approximation is a straight line threading a path through the middle. With natural systems the more likely case is that the data points are not inaccurate measures but only poor representations of fluctuation. In the simple case the more accurate way to connect the dots (thinking about what connects them off the page) is by using the natural systems conjecture that the curve passes through the points of measure following a path with a smooth shape, i.e. having continuity. All evolving organizational change has continuity, usually turning up as smooth shape in changing direction. Of course, there are also other kinds of things a series of numbers might represent. You have to look at the subject with all the means at your disposal to see which is more likely. A series of measures might well represent overlapping information about several independent things happening at once, or information from complex roving things like weather or people. You have to treat your sparse records of it accordingly. Usually it's only the data that appears to jump around randomly. The things being measured most generally are complex continuous flows.

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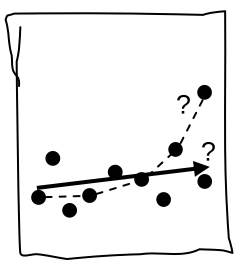
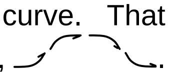


Complex fluctuations can take on lots of shapes, but two things they almost never do. They generally don't have beginnings or ends and generally don't get anywhere. They just keep lapping back and forth. That's what they're for. By compensating for any change in their underlying system they keep stable things from going anywhere. Look at the figure by reading only the dots, and then considering the likelihood of the alternate guesses as to the connections. Does the outlier tie into a regular trend of something happening, mostly lost in the poorly represented fluctuations? Or is it just a problem point to be excluded from the analysis? To begin reading the active systems behind the data what first draws attention to emergent new system behavior rising up out of the background is exponential growth or collapse, and their mirror twins, exponential climax and decay. They're remarkably common. They are actually found a minimum of four times in any flowing shape having a beginning and end, your typical smooth bump on any curve. That constitutes the minimal structural progression of a whole system event, . The four exponential curve shapes come from the four natural system mechanisms for changing direction, and each occur once at the four bends in the minimal description of any non-trivial event. It's a condition of having change and continuity at the same time. Now, you may be thinking, he's absolutely right about this beginning to sound like just a little too much! There are actually some very careful distinctions being made in the above statements, with some of the terms being given meanings slightly adjusted to fit the reality of natural systems. Hopefully you allow that I might be fairly careful with my concepts, and tolerate someone speaking to you without fully conveying the meaning of the words they use. I'd fully expect you to not be quite able to agree or disagree, but only poke at my statements a little and perhaps say 'so what'. I hope at least some fuzzy outline of a critical method shows through, along with some questions about important physical realities that probably can never be well defined mathematically. Some of it will be clearer as people begin to learn to read curves through their context.

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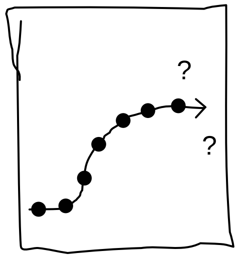

What growth is for is giving birth to something more lasting, though that doesn't always occur. What always occurs is that growth gives up its own unbalanced structure in the attempt. Growth is a form of creative organizational instability that may give up part of its structure to turn into other things, and becomes it's own undoing if not. It's a run-away process of organizational change that in nature is often, but not always, caught and changed into something long lasting. Growth itself is always relatively short lived. There are several ways to express that, other than as a beautiful matter of fact. Some ways of saying it touch a lot of hot emotional buttons etc., and others are completely dry and absent any felt meaning at all. That balance needs to be struck with most every attempt to communicate ideas about natural systems, first because the natural systems that are interesting to us are also intimately part of our lives, and matter a lot. Engaging personal values is also one of the few handles for making this difficult subject comprehendable. For both reasons it's hard to speak about them without drawing on feelings. It's a most curious dilemma, a basic physical science that can't be studied or shared without choosing what feelings to use to convey it. It sort of pushes you to sort out what your true feelings are. It's probably easier among friends to treat the need to use feeling in conveying ideas about what's really happening as theater.

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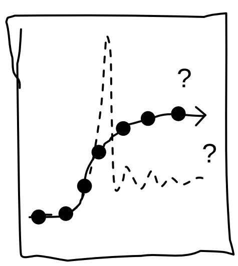

In case it wasn't immediately obvious, what connected the first and last ideas in the previous paragraph is the statement that all growth is its own undoing. It's just amazing that seemingly the only thing in the entire world can agree on, the global concensus, is that it's good for humanity to have endless growth. That is the most profound misconception remotely imaginable for any form of sentient being. Could I emphasize that a little more? It really does amount to a concrete plan for mankind to commit collective suicide by wildly overdoing its own success. We have to change some things. Because nature provides lots of examples, there are lots of choices of how. Why people seem so afraid they'll be bored to death without growth is some kind of secret. We seem to fear making a stable home on earth for not having ever more rapidly increasing stimulus perhaps. I'm quite convinced it's actually mistaken and there's lots to do on earth. If we climax, we climax at our peak rate of creative change after all, and there wouldn't be any obvious reason not to maintain it. It's not returning to our starting rate of creative change after all. It may not be an all together trivial issue, but compared to the alternative… Still everyone has a right to their own opinion of course, and can hold to the world wide concensus and be completely and tragically wrong.

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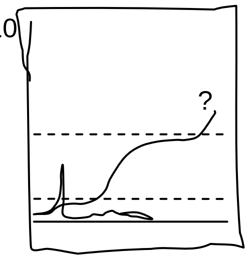

One thing that makes the limits of economic growth not benign is that continually multplying the speed and complexity of change necessarily results in profound confusion if nothing else. Confusion slows responses and causes uncorrectable mistakes. Both are fatal for responding to a continuous multiplication of our speed of changing the earth. The economic system we know is amazingly responsive to shortages of any kind anywhere. Consider the alternate histories represented in the graph though. The combination of human creativity and effective institutions have 'stabalized' a work of explosively accelerating change as a homeostatic system, but that necessarily overshoots. It would also be quite capable of growing in stages, solidifying gains at each plateau as demonstrated by many natural systems, that is, except for the financial drivers that require absolute uninterrupted exponential growth. Growth in stages would probably get a whole lot further than incessant acceleration.

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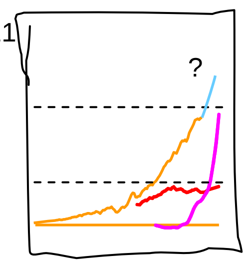

The figure shows the recorded trends up to 2005, of US GDP from 1875, wages from 1947 and the accumulative US trade deficit from 1960. Wages have been stagnant for over 30 years as the financial economy has grown robustly. The trade deficit, reflecting a net transfer of productive assets out of the US, has been growing at super exponential rates since 1980. Learning to read curves perpendicular to the page helps you see when the complex systems on which our life support rely are flying apart. These three structural measures of the system would normally have fluctuating relationships, but have been diverging exponentially for about 30 years. What will bring them back in line, as all three must, are probably upcoming events for which we have no imagination, though there may be some choices. The economists have ruled all this out, of course, but I think a financial collapse is possible if this represents a shift toward speculative investment and the spending of assets to maintain consumption growth as productive growth lags. There are also a variety of ways an economy can dig itself a deep hole based on industries built for short term profits that turn out to be unsustainable. Global warming proves that clearly. If you efficiently stabalize a system allowed to develop unbounded increasing stress, some small fluctuation will eventually produce a consuming cascade of destructive effects. It's possible that a great slow motion growth collapse has already started. There's a growing list of complex long range problems to which we have no ready response. As long range decision making is confused and delayed, there's a similar growing list of critical mistakes being made to go with it. The attempt to disable government response capabilities, as interference, is one of them. Yes, there is more than one reason for mentioning these as curious system phenomena that can be read from graphs if you think about the loops connecting things perpendicuaIar to the page, and the classic timeless transitions of growth and change.

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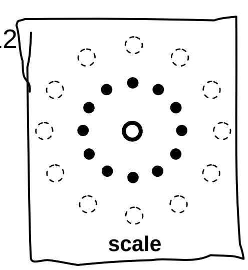

One of the special reasons that allowed us to make our fundamental error in understanding the meaning of economic growth is that in our minds, the world is an image. There's a deep structural difference between images and things that directly effects the awareness you can develop about their limits. Images have no limits. They're infinitely pliable. Images are not 'built' out of anything. They have no scale. It's a snap, for example, to project a detailed image of G^{o} Washington on an electron, in your imagination. Images are projections of mental rules, like a mathematical curve. With a mathematical curve you create the appearance of absolute continuity in an infinite domaine by having a rule for telling you what the points would be, *whereever you ask to know*. That's quite different from the points actually being 'there' in any physical sense. It only means that as you zoom in on the detail of your imaginary structure, your paintbrush just needs to stay one step ahead of your display resolution… It's both a powerful and insidious feature of imagination, thoroughly misrepresenting everything. When you zoom in on anything real you find structure within structure as far as you can see, and require a *different model of description* at every natural scale. That's probably the main reason we've misjudged the effect of our continuously changing scales on earth. It's also a great way to tell the difference between the shapes of things that are real and imaginary. Try zooming in on the text of this paragraph. As a .pdf the shape of the text could be infinitely adjustable except the programmer fixed a zoom limit, as a .jpg it turns into squares with no detail, on a page it turns into dirty whiskers of ground up old trees. In our imagination of growth there's no change on the earth, never any need for a new model of description, leaving us all but completely unconscious of the very real changes our new scales of behavior would require in a practical operating manual for the planet.

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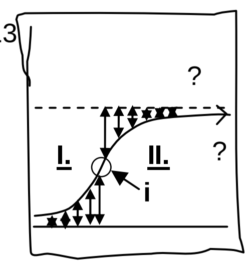

There are various kinds of other evidence one might look for to try to find out whether the above is speculative or actually happening. One is a shift from change in proportion to the origin of the curve (the past) to change responding to the limits (the future). All natural system event histories begin with proportionally increasing change and then follow with proportionally decreasing change. In nature when a growth system is headed for success there's usually a relatively quick switch between the two, at a kind of neutral point. The inflection point between positive and negative exponent increases marks a change in the whole way the system is changing. It occurs at a time when nothing appears to be changing at all, the inflection point in the curve. It's a shift from the system responing to the past to one responding to the future. You can see it in the math of a typical 'S' curve, in that the curve in the first half (**I.**) is roughly increasing in proportion to the height of the curve above its origin and then in the second half (**II.**) changes to proportionally increasing in relation to the decreasing distance below the destination ahead. This is what regular proportional change by percents means generally wherever you find it in any measure of anything. It tags either growth or decay, indicating the measure's connection to one of the normal periods of some complex system's progressive organizational developments. For example, increasing our energy consumption in constant proportion to past consumption relates to the past, resulting in a positive sign exponential increase (**I.**). Changing energy consumption in proportion to improved efficiency of using limited resources is responding to the future, and a negative sign exponential increase (**II.**). We started making just that kind of shift in the 70's because of supply, with pressure to conserve now increasing rapidly because of climate change. In the scope of our approximately 600 year long exponential growth period, 35 years is not long for a major change in direction. The 5-10 year estimate for responding effectively to global warming, which seems may be accurate, is extremely short in my estimate.

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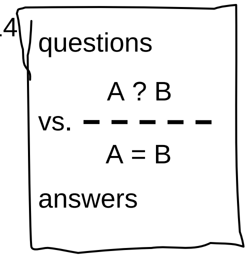

There seem to be three major reasons natural systems are particularly mysterious to people, two having to do with how they're built, and one with how we think. After many centuries of puzzlement the invention of science finally gave us a good handle on the parts of nature that act as if they follow rules, giving us some satisfaction along with our prosperity. Once we know the rules we can invent all sorts of new effects and make promices about them we can keep. That's extremely useful. That's also partly why science has not had much success with, or paid much attention to, the parts of nature in the business of making the structures from which we derive our rules. They're more of a challenge. I've found a few reliable generalities about them that seem useful, adapting from others through my own experience. Various other people have been making progress too. One group under the general heading of 'complexity' have begun to find out how even swarms of simple rules can develop emergent behavioral structures in computers. In a connected development a variety of management, government & networking researchers have made some good headway with understanding elements of the human creative process. Still, research into the nature of complex systems has been very rocky, with numerous failed efforts in many directions. It's just much easier to convey things that follow rules even if there's something quite missing. It's like looking under the street light for the keys you lost in the dark alley. Rules won't be where you find what you're actually looking for in life, but they're an easy place to look.

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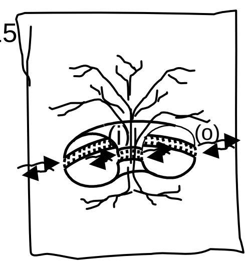

The other two main problems for understanding natural systems are that 1) they work as wholes, using vast networks of independent push and pull connections, with all the pull connections made invisible because they exist only as opportunities for exchange through open resource pools (markets), and extensively interpenetrate without interference, and 2) because they're built from the inside and we look at them from the outside. President Lincoln had a curious phrase, "a tree is best measured when it is down". It's about ignoring the insides of things. They are indeed strangely invisible to us in large part, but negating them negates life and leaves our imaginations about what surrounds us without meaning. The authoritative view for rational descriptions of nature, modern science, includes a rule that says nothing in nature has any insides, a direct correlary of the theory of (outside) determinism. It does interestingly indicate how seductive proof by lack of evidence can be, and how tenuous our grasp of nature's structures really are, but it's also quite misleading. What evidence of growth indicates, perpendicular to the page, is the elaboration of loops, independent interior continuities. Every growth system represents what ammounts to the evolution of a new internal universe of relationships. I've been watching them with better than usual tools for a long time, but I don't yet have a good idea of how they manage to act as wholes. It's clear that they commonly do somehow, and without there being any agent or player to follow rules involved in them whatever. The symbolic diagram of torroidal connections surrounding a tree is an adaptation from Don McNeil's notion of systems as torroidal topologies. I added the split through the middle of the donut, with which he's not entirely comfortable, but I think makes the cartoon a much better model for raising good questions.

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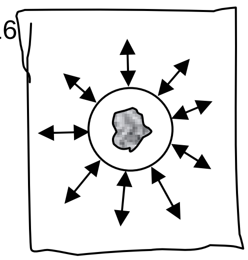

The idea of the model starts with a circle around a plan view cut through a tree trunk, indicating that there are many kinds of feedback links in many directions between inside and out. It becomes a donut when those connections loop around perpendicular to the page, representing their travel through other environments and systems and their return flow by pathways different than their outward flow. Introducing the cut through the donut indicates that return links typically pass through mediums of exchange where the user of another system's abandoned effects, picks them up at their leisure, i.e. providing free and time-independent exchange. These resource pools and other things amount to open markets. Mediums of exchange serve to link completely independent parts into larger orders.

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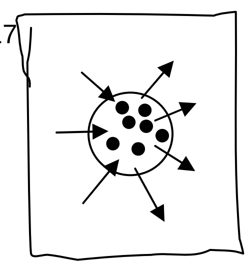

A good example of how mediums exchange work is the connection between people's ideas by speech and writing. You say things, it turns into vibrations in the air or marks on paper, and then someone else chooses whether to pay attention and then invents what those seeds of communication are going to mean to them. The fact that it's the listener who actually determines the meaning of whatever is said is a curious and important fact that is often ignored. Nature's functional plan is quite messy and unreliable, but works just marvelously when it does, and is forgotten fairly quickly when it doesn't. In the case of the tree as a symbol of a general model of systems, it's leaves communicate with it's roots by two paths, inside and out, both connected through open mediums of exchange. Connecting with the outside environment the leaves, in part, send water vapor and oxygen into the air, and soak up CO_2. The roots soak up water and nutrients and provide structure. On the inside the fluid circulation in the tubes of the xylem and phloem allowa the living cells to excrete what they are done with and absorb what they need. This means of connecting things by sending 'messages in a bottle', between parts that have no control whatever in where their messages go or how they're used, turns out to work very well for, and be a good sign of, systems that take care of themselves. Having consciousness neither seems to be a guarantee of, nor a necessity for, that fundamental behavior of autonomy. A good exercise is to list the kinds of open market connections that complete the structure of larger systems and all the many kinds of contributions to them that are essential to making them work. I had a greatgrandfather who was apparently the first ecologist to notice and write about this structure in the organization of the ecology of fresh water ponds. When you begin looking for them, you find them all over the place. It's also a good test of whether you tend to find things *only* because you're looking for them or whether they're actually there. It's not clearly a system link unless you can find the whole loop that connects it.

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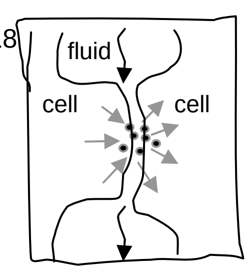

Of special interest is the unbounded openness of even the most localized mediums of open exchange. This is indicated in the toroid and tree diagram by the lateral arrows indicating the exchange mediums have complete openness to other kinds of connections in addition to direct paths of exchange. The diagram in the present paragraph shows a rough image of a synapse junction between neurons. There seems to be some special reason why things sometimes get closer and closer without quite connecting. Some kinds of seeds or elements of thought are exchanged, but the linkage is kept open to things floating into and out of the connection path. Other examples are the structures of pistol and stamen in flowers, a separation in close proximity that facilitates direct fertilization and allows cross fertilization. Sexual contact provides the same kind of open closeness. The intimate relations between people we find so tantalizingly close but that also require strict independence at the same time may provide another example.

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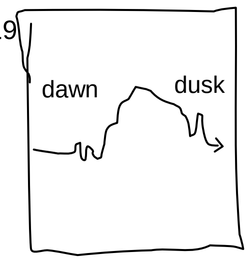

Where this line of thinking came from was a whole array of hints and complaints that I kept collecting many years ago, and then crystallized with two year study of the micro-climates of homes that I did after grad school in architecture in the 70's. I tried construction but got bored and saw that designing buildings to interact with natural climate was a new direction. I got more or less lost in the fascinating details and didn't produce much of any real use, except, of course, this fascination with how things evolve. The weather inside buildings evolves in unique ways throughout any day. One of the fascinating patterns in the thermal curves of a day is a simultaneous wiggle in many places at once that occurs morning and night. What I finally traced it to was the fairly regular whole system reversal in the direction of air currents, indoors and out, at the dusk and dawn shifts between warming and cooling. To change direction air currents have to renegotiate how to bypass each other, resulting in a period of unstable flows giving most points an exposure to currents from many places.

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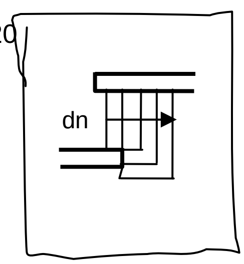

The very first growth system I remember noticing was an almost trivial event in the design culture at my school of architecture. There was a kind of quirky geometry of stair steps I don't quite remember, something sort of like the sketch. I can't be sure, but I think no one ever discussed it, but it was tried out by a scattering of people apparently to see if it did anything, making the rounds in hopping fashion from a person or two in one studio to the next, crossing over to the landscape school too, and then seemed to disappear without a trace. I just wandered around looking at what other people were doing occasionally and noticed it, and that it never seemed to be mentioned in discussion & reviews. It was just a little wrinkle that came and went. I thought that was really neat to watch, and began watching for other things of the kind. Of course, they're *all* over the place. You can follow them using the simple half serious rule for new patterns, once is an accident, twice an experiment and three times a habit. Basically, if you see something you've never seen before three times it has probably established a niche for itself in some manner. You don't really need carefully defined measures and data and sophisticated mathematical tools to tell the difference between strings of meaningless dots from the meaningful ones. The most fruitful source for learning about natural systems for anyone will be the things you understand from being completely immersed in them. Then when you notice a pattern in one thing that indicates an emerging event you have a chance of being able to mentally trace what it's connections are and how they are facilitating the positive feedback loops that any complex system begins with. Anyone might have their first success watching systems when watching the behavior of their own kids, or crops, their business successes or failures, the moods of their personal friends and enemies, how ideas percolate in the lab, thinking about the last great or horrid party they threw, etc. Where you see multiplying change (that little quickening take-off sequence) try to mentally document everything connected with it. Politics and social conflict is chocked full of natural system events, mostly all out of control, like war feavers and the like. Follow the shape of the flow, and note the inflection points where the progression changes patterns. It's a place where, in complete privacy, and with your own genius, you can develop your own set of reference points in the real world for understanding what anyone else is talking about. There's little point in learning this stuff from heresay.

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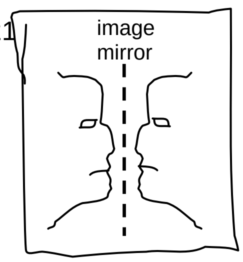

The problem with enemies is that both sides look at each other and see horrible things, always having some kind of validity or no one would care, but the images get disconnected. Neither sees in themselves what the other sees for two reasons. One is because what you look like from the outside is mostly invisible to you from the inside, and the other is that what an outside observer imagines inside the other person is always almost entirely made up. It's a complex system phenomenon coming from the fact that our own *inside* views of other people develop without the benefit of seeing either their inside world or what they see in us from the outside. It's a multiple disconnect that often turns into a frenzy of mutual self-deception with horrible consequences. Finding anything that isn't a lie in the relationship and the perceptions on either side is all but impossible. There are a couple outs, of course. When asked what the motivations of the 'enemy' are, the safe and truthful answer is "I don't really know", which could actually open the door to those around who have constructive alternate views that might help. You can also watch their natural system growth and decay patterns to get an actual sneak peek at their real insides, that even they perhaps can't see. When we first went into Iraq, when neither the US nor the population we were trying to liberate knew anything about the reaction that would develop, there were these scattered solo gunmen who would jump out and take shots at the invading army. We thought they were silly and mowed them down and laughed. Then we found them successively more numerous and determined, changing from rag tag irregulars, following a clear growth pattern, becoming a seriously dangerous enemy. In those first days there might have been an opportunity to read the systemic response as part of the organic local community's spontaneous, if irrational, defense mechanism. We might have said, "Ah ha! There's something bigger here, people with broad community support making a natural mistake about us by reacting defensively to our invasion". If we'd said "take me to your leader, you're the people we've come to liberate", and maintained a careful discipline of not intruding except where really necessary, I think things might have turned out very differently. Sure it was undoubtedly a mistake to invade in the first place, but why compound a mistake by not paying attention to what's happening all around you. Sure, this could be exactly the kind of easy hindsight that is sometimes unhelpful, but then maybe not. The whole mess certainly does appear to have all the earmarks of an auto-immune disease continuing to eat away at proud and strong human cultures.

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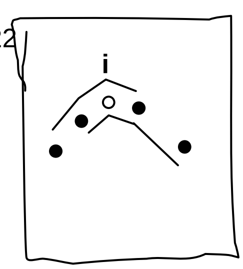
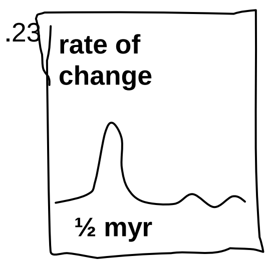


So, there are lots of ways and good uses for reading system dynamics without math. There's also some good math for it and new questions which may be fruitful and lead to greatly improved pattern recognition techniques[1]. It's actually a huge field with which I am only slightly familiar but I have confidence that my small mathematical contribution, when applied by people with more skill than I have, will be productive. The mathematical problem is that since equations do such a bad job of representing the creative dynamics of real complex systems, can we invent something better. A simple device potentially allows data curves to take on the differentiable structures of continuous functions. That would allow creating tools as versatile as equations, but derived directly from natural behaviors for use in exposing and applying the undefined system's actual structures. The primary use I've found is for precisely locating the implied inflection (turning) points in data curves, and it can certainly be improved for that purpose and perhaps other things. The technique generates simple rules for inserting missing points something like a continuously evolving spline curve redefined at every point. The rule that seemed to work best is simply to adjust the location of the center point in a five point series to equalize the 3rd differences (the implied accelerations of change) approaching from both sides. Those who remember a little calculus should recognize the similarity to how the instantaneous slope at a point is defined as the common value found when approaching from both sides. Data rules like this can define the shape of a curve at any point, producing continuities that can be manipulated in various ways.



An application using this and other methods to rigorously reconstruct non-linear dynamics in the fossil record and discuss how they might fill the notable information gaps in the record at the points where species first appear, is in publication review[2]. What seems well demonstrated by the math is that a very erratic looking data set that had been 'proven' to represent a special kind of noise called a random walk, actually represents the opposite, a smooth flow with fluctuation. Validly simplifying the shape to make the data curve meaningfully differentiable clearly exposes a single non-linear event (like the figure) as the principal transition between two distinct forms of a common plankton generally considered to be a transition between two species. Until there are a number of contrasting and supporting studies the difficult issues are that 1) what a species is remains somewhat undefined, and 2) that there are only speculative ideas as to what kind of mechanism would produce feedback loops in genetic variation. It is still generally assumed, but not demonstrated, that only random changes with respect to the success of organisms take place.

A few other studies in various states of completion, some of my older approaches to the subject, and other content can be found on my web site[3]. I didn't quite know where this train of thought would lead yesterday, but it started from being asked to make a little useful summary. It turned out better than I thought, but not perfect. A series of conversations over the past year or so, and some wild free thinking about it from all sorts of viewpoints, started to become more productive recently and I thought I'd see if I had a point of view that would let me write coherently about it. It's been difficult for a long time. Actually, I guess, I started consciously trying to insert pieces of other people's thinking around the time I joined a community group with that intent in mind about a year and a half ago. It didn't really start to develop as a new way of talking about it, though, until I got back in touch with Stan Salthe, another alumnus of one of the various failed systems theory movements of the past, SGSR. We had met and shared a room at a conference 20 years ago. Recently my conversations have been broadening and more productive in various new ways and it seemed it might be the right time to take the suggestion to try to write about it again.

[1] 2000. Features of Derivative Continuity in Shape. Chapter 6 Pp.101-120 in M. A. Rodrigues ed., Invariants for Pattern Recognition and Classification, World Scientific Pub, http://www.synapse9.com/fdcs-ph99-1.pdf

[2] 2006. Transient systems in the punctuated phyletic succession linking G. pleisotumida and G. tumida; http://www.synapse9.com/GTRevisHB-2005fin.pdf

[3] 1995-2006 The physics of happening, http://www.synapse9.com/drwork.htm