For related discussion: Reading Nature's Signals

INTERPRETING "BIG DATA" EXPOSING EARTH SYSTEMS TO GUIDE THE SDG'S

A NEW "NATURAL SYSTEMS" APPROACH TO

POLICY, AIMS, STRATEGIES, NARATIVES, INDICATORS & SIGNALS, BASIS IN PHYSICS & EXAMPLES

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An example to start with

Regular proportional change is usually a direct sign of a developing system. Figure 1 shows the recorded history of US "National Product"[a] with its historical 3.2%/yr constant growth rate, and numerous disturbances that didn't change the growth constant.

Think of having just come across the remarkable shape of this curve, not knowning more than it might indicate a growing system. You'd want know about it, if you needed adapt to how it's changing your environment by ever bigger steps.

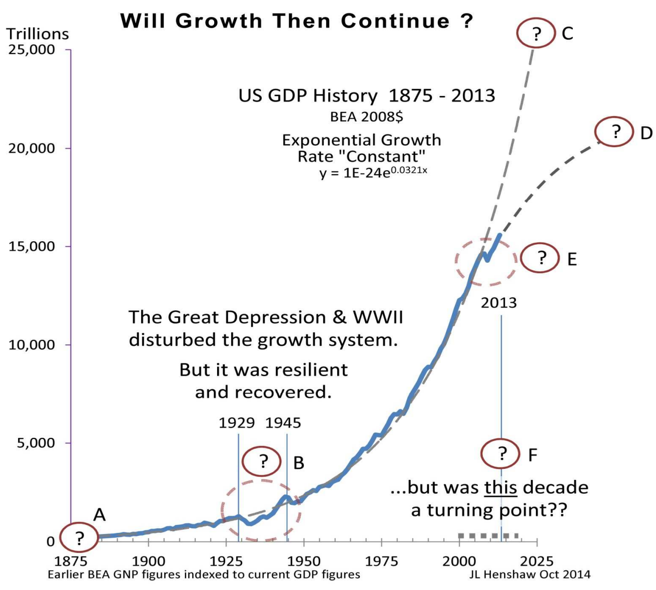

Figure 1. The growth history of US GDP

You might first wonder why the growth rate is so constant, the curve returning to its original path after every prior disturbance. Nothing in human history is that constant. It indicates something in the system was not being disturbed, and retained a continuity that stabilized the growth rate. These are the kinds of questions a "natural systems" approach would raise and explore.

a) GDP is total end user spending, adjusted for inflation, largely personal consumption and real investment

Natural Questions to Ask

A. What was the start-up event for this stage of the whole system's emergence ?
B. Why did the great 1929 to 1945 disturbance not alter the system's "growth constant"?
C. Could the system remain resilient and keep growing as before?
D. Could the system be about to smoothly level off and remain vibrant?
E. Was the recent financial disruption important?
F. Might this decade have been different than others?

*(possible answers in grey below)

a. Industrial revolution b. System resilience c. Natural complications are a limit sometime, d. Many natural systems remain vibrant at their peaks but it's not generally known how, e. Probably just a bump,… unless a symptom of constraint for the whole system, f. Rising resource costs, ecological distress, national debts, societal inequities, unemployed youth, indecisive public decisionmaking and other delays in responding to shocks, give a broad appearance of declining resilience.

I. MEASURES REFLECTING THE WELL BEING OF WHOLE SYSTEMS

A New Approach

The term "big data" is generally understood as referring to the collecting of private information about people to help big business control their consumer decision making. It can also change the world much more positively and dramatically, letting us record observations of the flows of economic, environmental and cultural change to get sufficiently rich images to let us recognize those flows as made of many separate innovation events. That realization itself quickly leads to a far better understanding of the constantly changing organization of our world.

Just closely observing nature's way of building well organized systems of separate parts would give people a much clearer idea of what changes in new and old features of our world we're talking about. Ways of watching them emerge exposes nature's way of creating and changing separate systems of independent parts that work smoothly as one, her "big data of life" approach you might call it. Just seeing those transformations as "eventful", right from the start, offers enough new recognition of how active of system change occurs to start thinking of a "biomimicry" approach to fostering or adapting to it.

Grounding the new method of observation on a form of digital narrative of natural events is what anchors the data images to the natural subjects of our world. By design it exposes the continuities and eventfulness of the emerging culture changes that are continually reorganizing our world. It's then also offers a way of reattaching our mental and natural worlds, an age old problem that our digital lives all seem to agree have made worse. Creating better information images of the eventfully changing natural organization of our world gives our words more real things to refer to, to replace purely invented images, categories as subjects.

Computer algorithms can be written, for example, to recognize potentially disruptive emerging change, locate its environment. That would give people very concretely defined subjects to discuss. That would be long before the later disruptions might have occurred, and with no real historical record either, uninformed stories are what we see in the news, both too late for active responses to be effective and to uninformed to learn from either.

It would pick up how sometimes it's our most celebrated solutions that keep us from looking at the disruptions they'll create. Having the data and learning to read the dynamics of how innovation changes the world it occurs in would possibly alert people to how radical efficiencies like industrial farming or ocean harvesting can triggering mass migrations of formerly sustainable communities. That would give people the chance to see those innovations as "tests" to respond to, things happening seen soon enough to creatively respond to.

Also very promising is how it could be a major new asset for public and marketplace decision making. By exposing how the parts of systems that work as a whole share responsibility for the whole system's costs, consumers, producers, investors, researchers and regulators would have far better information on the consequences of their common interests affected by their individual choices. With all groups of decision makers having significantly better information on what they are deciding, about both "how the world works" and the long term profitability of their choices, it would improve their choices. Individuals, society and financial interests would all benefit at once.

That would harnessing the "power of the markets" for true sustainable development, rather than the opposite as we've increasingly seen for many decades now. What it takes is learning to see the many kinds of eventfully changing cultures of both human society and nature as the real engines of creativity we live in and with, take advantage of, have responsibility for, and not keep thinking of nature as some "black box".

Having the data to let us see some of the organization of what's "inside" the cells of organization that cultures work with to operate exposes enough of the brilliance of their natural organization is what drives them for us to gain new respect and make much better choices. The two keys are:

- Recognizing cultures as whole organized systems of separate parts, of their own internal design
- Learning to read how they behave as whole systems, engaging with the world around them differently according to the stages of their natural life cycles.

What you discover is that the vast collections of data we already have, not collected for this purpose, contain lots of direct evidence of the cascades of innovation that that occurr within new and changing cultures. Existing data, not yet organized to display it, also contains lots of related contextual information on qualitative and quantitative aspects of these emerging chain reactions that drive and animate our active world… What we already have collected is enough for us to finally see what the phrase "everything's connected" really means. It means the organization responsible for the active change in the world around us is found inside its cells of innovative cultures.

Of course… this is suggesting somewhat new uses of some familiar words, for referring to their subjects as natural features of the working systems of nature. For example, it means using the word "culture" to refer to an actual working organizations, as indentifiable units of working design and "natural capital". So you could use "culture" to refer to the working organization of relationships that constitute a "business culture". The societal human cultures can then be referred to both as widely shared styles, traditions and languages, as well as the repositories for the whole community's inherited wisdoms for how to live and how to interpret the world around us. The general name of the approach is "Natural Systems Design Science", "Organizational Stage Models" (ref) [1]or whatever seems descriptive at the time.

The approach grew out of my needs as both a physicist and a designer… when in field studies on the animated behaviors of natural energy systems… there was a need to somehow a) have words for the units of physical organization and developmental stages found in natural system designs and b) my gradually realizing that natural language already does that, giving us all sorts of familiar words that refer to the things of nature we find useful to talk about. I just found a need to use them also to refer to the organizations of parts the words seem to already refer to, but people have not examined closely yet to see how they work.

II. USE OF "BIG DATA"

Aims

We've not previously had a way to visualize the world landscape of emerging and changing economic, ecological and social cultures. That's the aim, to use new methods of pattern recognition to turn the world's available data into a kind of map of the organized systems of the planet, that each individually develop and form their own internal designs and interactions with each other.

Data streams that are "coupled" and evidently grow together are likely to be of different features of the same thing, for example. The use of neutral data, not recorded for this purpose but just used for discovering behavior changes is a big advantage, as it both assures the objectivity of the data and reduced the cost. That allows the investment to go into the understanding of what the data indicates is happening.

If markets are becoming unresponsive to restoring stable supplies after normal random economic shocks, it's important for people to start asking why before much worse things happen. An example of that occurred over the past 12 years as the broad spectrum of food and fuel resource prices became unstable and rose to be prohibitive for large communities. You can find lots of research papers, but the problem is quite evident in the record of market prices, and still not being responded to effectively it seems[2].

Every kind of data stream will display some of the behavioral changes in a culture that come from its changing internal an external relationships. The benefit of having a way of recognizing behavioral changes in all kinds of data is of course the ability to then look for them, but of course, comes with the cost of looking for them too. So the aim would also be to give the tools for recognizing cultural organization change to the people in the cultures who would know what they mean.

It would give markets better questions and information about how their own worlds are changing, as well as the world's around them, perhaps to alert others to problems ahead in time to do something about them. Developing communities would perhaps be better able

[1] http://synapse9.com/NST-defnote.htm

[2] Recent world resource price explosion, see Section IV.1

to understand how their development depends on other communities, or is leaving some stranded, also in the interests to finding ways to successfully work together, rather than just take advantage of other less competitive populations, industries or businesses.

In either case, having some people in every culture able to interpret what is happening to and around it would give everyone an ability to see both the opportunities and the hazards from multiple points of view, and so helping to break decision makers out of their natural silo thinking. Having broader and less biased views of what actually is and may be about to happen, in a shifting social, economic and ecological environment, would also give much better guidance on what might be culturally accepted or objected to.

On the other side is the need to find culturally acceptable ways of responding to climate change, along with the numerous other swelling ecological and economic challenges demanding quite significant culture change for people around the earth. It clearly requires finding solutions that the vast majority of cultures can buy into, clearly addressing our common interests in a way that rises above our divisive interests. That naturally calls for developing a global point of view in which everyone can recognize themselves as having a stake worth cooperating to achieve. It's not certain that people who recognize each other's common problems will be able to all put together their part to their in responding as a whole. It's seems only certain that we won't be able to otherwise, the issues are too vast and contentious, for one thing, and sufficiently unprecedented no point of view seems possible to treat as authoritative. We need collaborative solutions that are profitable for the whole put above competitive solutions that disadvantage the whole, and design the information systems for helping people make well informed choices accordingly.

Data Strategies

The core systems science discussed in Section III. rests on a curiously unexploited consistency in nature and our information about the systems of nature. It's that naturally occurring systems have natural boundaries defined by the extent of their own organization, like cells with their internal organization separated from their external connections. The mathematical shapes of those boundaries may not always be easy to see, but are generally found to be "S" curves, like you'd see in a temperatures surrounding any person, making transition from outside to inside temperature near their skin.

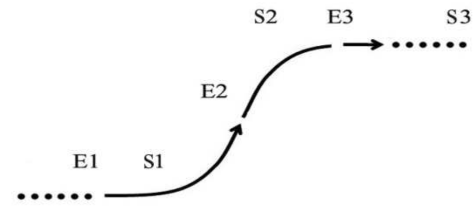

Figure 2. A natural "S" curve and data markers of thresholds and directions of change

Fairly simple algorithms can be written for recognizing these periods of regular proportional change with opposite curvature, and their beginning and ending points. The same kinds of recognizable features are found at the beginning and end naturally occurring systems of organization in time. What then confirms the identification of a boundary is whether it is found to originate from organizational transitions over time or in space. For data interpretation the difference is that of beginning with identifying naturally occurring organization, rather than beginning with correlations of data points on which to base artificial models of organization. The object would not be to replace one approach with the other, but to use each approach to augment the other.

One source of completely neutral global data this approach could be used with is the high resolution NASA satellite data, used for identifying the boundaries of emerging systemic social, economic and ecological change. Perhaps as or more important that the boundaries of the visible features to identify moving, is the boundaries of a similar map of the derivative rates of change, localizing where rates of change are accelerating. These analytical methods have not been widely applied as yet, but advanced methods for recognizing these features through the noise present are published pattern recognition methods or have been studied and successfully applied in practice.[3]

[3] Henshaw 1999 Features of derivative continuity in shape, *International Journal of Pattern Recognition and Artificial Intelligence* V13 No 8 1999 1181-1199 [applications page http://synapse9.com/drstats.htm]

This same approach can be applied to consumer, industrial and business market data, to visualize the culture changes in the cultures that most directly steer the world economy, mapping market behaviors and trade relationships, using published data. It would be a potentially powerful new analysis tool for any source of neutrally collected global data of many kinds.

For example it would allow trade data converted to ecological footprint measurements (EF)[4] to be used for displaying the changing organization world ecological footprints, and the trade relationships associated with them. With a UN sponsored software and publication effort those relationships could be displayed for anyone on earth to look at to understand what is happening, without compromising proprietary methods, data or privacy, while also increasing demand for the services of scientists able to analyze it for business other institutional interests.

The same general approach could be applied to mapping changes in language use, the emergence of what amount to new languages or word uses, to put in context how global or local these cultural shifts are. It's a common misconception, for example, that everyone's language and directions of current conversation that go with them, are universal just because throughout any one community everyone speaks the same way. This tendency of people to form "silos" of thinking, experienced as the center of the universe as far as they're concerned, is one of the most persistent of difficulties in developing productive partnerships cross cultural boundaries. Just exposing that natural structure would help to show how incomplete their "universe" really is, as a step toward recognizing the real needs of the earth.

NATURE'S OWN NARRATIVES

Narratives of emerging system development are found using a new technique of searching records of change over time to recognize natural patterns of organizational change, indicating how social, economic and ecological systems are changing the way they work. With time and experience people will easily recognize how meaningful the patterns of nature's language for change are, and realize how much what's happening around us we've been overlooking.

"Narratives" can serve a great many purposes, as the way people best understand complex subjects, and the way nature builds complex organizations. With experience, studying the indicators and signals of organizational change, we can bring the two together. People do also use narratives for the world around them to create "improved" stories of reality, making their own worlds of excuses for personal reasons or to make the agreements of social and professional relationships. Natural system narratives are designed for much the opposite reason. They're for opening up our stories with meaningful questions about the world of organized relationships beyond out control.

Consider the four dramatic examples of change in how our world works in Section IV. Each tells a great tale of events at the center of enduring complaints of people around the world have. They also depict events very largely undiscussed in public, as evidence of the systematically increasing great strains on the earth and our societies, caused by how our world works. So you'll likely look at them and not see how they would fit into any conversation on the pressing issues of our day.

Normal discussion overlooks our roles in such truly momentous events partly because they represent such large scale organizational changes, on a time scale either too quick or too slow to comprehend, either too global or too local. They're things that happened largely by themselves, so also naturally hard to respond to. Though "of our doing" somehow, they were not actually intended, occurring without our knowing. How they're shown here is as dramatic natural events, caused by nature's own hand, seen from something like her own point of view. They're various complex versions of an "S" curve, depicting explosions of organizational development and the presence or absence of their resolution.

Displaying the mathematical properties of emerging natural organization is how these momentous events were discovered. They were not found by someone looking for them. They are "found events" then, discovered just by looking at large data sets recorded for other purposes for stories of change displaying surprising evidence of how our world worked. They're examples

[4] M Wackernagel, W Rees, 1998, Our ecological footprint: reducing human impact on the earth. book

of great "eruptions" of developing systems, the formation their "natural capital" as the organization making these environmental systems work, some cycling into something else, and some not.

Each graph is a "window" carefully adjusted to the scale of the event, so momentous events can be depicted as a whole story. You might never see them depicted except for that. It's made possible by the somewhat magical feature of "S" curves that allows them to be adjusted to fit any scale to present their whole history of complex developments as a single whole event, a whole story and complete narrative of natural change in one view.

Indicators, Signals

This use of "big data" to help guide the SDG's would work by uncovering unplanned natural organization in the world we need to work with, and can if people combine their talents in the common interest. As people learn to recognize the natural materials they have to work with it will become a robust tool for validating or discarding our plans for equitable and sustainable development.

For example, **economies will be found to not actually follow national boundaries**, for example, but have money and product flows networks that don't respect any boundaries, that include and exclude various parts of various countries, linking the diverse inputs needed for high productivity. That may not produce equitable development, though. The resource rich may foster swelling populations of unemployed youth, and communities that are production rich find themselves as magnets for waves of migration, from formerly sustainable communities that could not keep up with the competition.

The ability of natural systems to respond to disturbance for their own wellbeing as a whole, is called "resilience",, whether they're biological, societal, economic or ecological. It makes that ability to respond to change a common indicator of wellbeing for any and all cultures, and for declines in resilience a signal to change themselves. More responsive cultures respond to limits to their resilience by innovating, like people do when they face a need for a career change, or businesses needing a new business model. People or societies may also respond more like plants, just stiffening their defenses by thickening their skins and shedding leaves in a drought, retrenching and retreating to a more defensible.

Resilience comes from the parts efficiently using their surplus resources for the good of the whole, something like a universal internal insurance policy any natural culture takes out for itself. As resilience is a kind of responsiveness to disturbance, it might be generally measured as an increase or decrease in the responsiveness, of the system or its parts, or a misdistribution of responsiveness such as growing inequity among parts in their ability to respond to disturbance. How quickly resource prices recover after temporary shortages, for example, measure the resilience of resources. How quickly job markets recover after a an economic disruption measure the resilience of an economy, at whatever level of development it is. For each as well, progressive or lingering decline in resilience is an signal for a culture change to adopt new strategies .

It's common knowledge, or should be, that resilience has been on the decline for many parts of the world's cultural and economic systems, and for the natural ecologies too, both globally and locally and seemingly to be progressively for many years. Drawing maps of that decline and rates of progression, would provide animated views of what's happening. That would help decision makers of all kinds understand there is a problem and the risks of different kinds if alternate strategies are not found.

Sharply increasing economic inequities in resilience, both between various cultures and within them, are also well known to be occurring, though not understood as threats to the organization of the economic and social cultures involved. Saying "well it hasn't killed us yet" is not really a meaningful response. The seemingly historic decline in the ability of governments to respond to crises, despite the enormous sophistication in recovering from all manner of disturbances is, well, disturbing, as one of the visible examples. Measurements of how it is progressing over time:

- a) accelerating and so quite threatening
- b) converging and so maybe manageable or
- c) episodic and needing close attention,

…would begin to tell us where it is an emerging threat to world society and where not, and frame the search for alternate strategies. With no map, though, there's no guidance, as just having complaints doesn't tell you where the problem is.

Systemic coupling of this kind, like between societal ineffectiveness in responding the perhaps dangerous rise in inequities, is one of the kinds of indicators computer algorithms could be programmed to search for. It would largely remove subjectivity from monitoring "what regularly connects to what" in the changing of our cultures.

The most classic case of overlooked coupling is the quite clear historic coupling of GDP to energy use and efficiency improvement, reported by Jevons in 1865. It is also readily seen in current economic data[5]. It can now be better understood as also indicating that the global economy actually does work as a whole, just as theory says it should, but that people just never talk about. It takes looking at it from all sides to be sure, but also makes it quite necessary to assume that any share of GDP is responsible for causing matching shares of all impacts caused by delivering GDP, at least till shown otherwise[6].

Systemic couplings expose how systems are organized, but that's not the same thing as "cause and effect". They just show one feature of how a whole system is working. Learning to associate those strong indicators with contextual indicators found to be associated with them is what will eventually convey their general meaning. That will take both accumulating the families of indicators and getting accustomed to interpreting them. In this case, coupling taking as evidence that:

shares of $'s = shares of responsibility

… means we have a potential scientific method for displaying the accountability of economic demands for the economic impacts they create. Considered as a cost of our profits it is information that could be presented as an ESG balance sheet, as valuable information for wealth generators, the people, businesses, investors, and regulators of the economy[7].

These most meaningful indicators of wellbeing generally can't be pre-defined, but are found by searching for them. It's really valuable to use indicators that reflect the real organization of the actual system you are measuring. Often what one is often looking for has gone on for a long time, but was previously undefined and unrecognized. Sometimes the search turns up truly emergent behaviors, and implicate the system's creatively evolving and/or learning parts. Both of those call for unbiased pattern recognition in neutral data sources, that displaying organization in the environment where people wouldn't generally think of looking for it.

The most important indicator and signal to recognize is *"regular divergent change"*, indicating the start of an "S" curve, and the start of something new happening. It suggests the presence of a regular feedback system developing on an exponential growth trend, as ALL systems of organization seem to begin. For the environment it's in it is also a quite direct indication of "invasive" or "destabilizing" organization developing, of course to be confirmed by identifying the organization doing it.

The second important indicator and signal to look for is, "*regular convergent change"*, *the second half of the "S" curve,* when the system will begin to display the reverse of the progression it started with. That is the normal progression for growing systems differing mainly with whether they anticipate and adapt to the necessary change in behavior or not. Living cultures and organisms nearly always using their growth to define their identity and increase their power in the environment, but then switch to securing their niche and roles in their environment, like everyone does in developing a career.

For natural systems that are guided by having actively learning parts, such as ecologies, societies and human cultures, the way to tell what they are doing is by looking what they are learning. How to anticipate what they are going to learn you look instead for what experiences they are going to learn ***from***. That ability to learn is the only thing that determines whether they will end their growth phase by "getting the signal" to adapt to the limits of their internal and external environment creatively or destructively.

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[5] Section IV.4 shows the current indexed IEA data
[6] Henshaw et. all. 2011, Systems Energy Assessment… Sustainability, 3(10), 1908-1943 [http://synapse9.com/SEA]
[7] Henshaw, 2014, A World SDG. For UN OWG 8 & UN NGO major group [http://synapse9.com/signals/?s=world+sdg]

Learning cultures may not respond if unable to notice the internal strains and external resistance that signal limits to growth. They then fail to stop using their reserves to continue trying to expand their control and consumption of their host environments while draining their own resilience and exhausting themselves doing so. Other cultures will respond to early signals of their decreasing ability to be responsive, their own internal loss of resilience, and switch to a strategy of preserving their resilience rather than expanding their control of their environment.

It's the finding of emerging continuities of changing organization, the "S" curves discovered in data collected for other reasons, that seem best able to ground other indicators to help us respond to change in how our world works. At a later point I'll add an appendix of further notes on interpreting and confirming signs of organization change.

- It's quite important for example to not give misleading names to categories of data, indicators or signals for response.
- One has to think about Type I, II errors of false positive or negative conclusions about what the continuities in the data show.
- Harder to find mistakes may often come from Type III, IV and V errors, of "asking the wrong question", "searching the wrong boundary of the subject of study", "not collecting diverse enough contextual information".

TYPES OF CONDITIONS TO LOOK FOR

All kinds of unexpected things turn up when you are looking for emerging change. Here are other examples.

- Unexplained rapid decay of crime cultures that resisted all interventions for decades
- Systematic over-response intended to correct balances, otherwise known as "fishtailing"
- Growing demand unresponsive to supply
- Businesses impact reporting omitting the impacts of the services they use, not included in the measure definitions, so they can have growing impacts and declining indicators.
- Changing use of words for problem solving: use of "complex" long following the complexity of the economy, until "information overload" rose in ~1970, and both now in rapid decline8.
- The US figures for GDP and Median incomes appear to have moved together for many years, and then started moving apart also ~1970

III. THE UNDERLYING THEORY OF PHYSICS

Continuity of Organizational Stages

Why this approach to recognizing the organization of natural systems works is because it uses a new interpretation of physics. Using it to help in finding good questions rather than for determine answers.

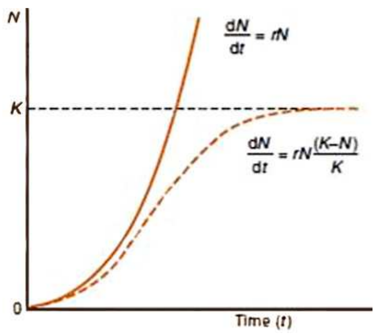
An "S" curve is the most ubiquitous shape in the nature, found in all transitions it seems. "Logistic Curves", the equations that best fit the shapes of natural "S" curves have close to no predictive or descriptive value for systems that require organization to produce them. The curves have no relation to the complex coordinations of separate parts within the systems that the curves represent the development of. The curves also display those natural systems as preexisting throughout all time, rather than as processes developing during their periods of development.

Transitions in nature generally don't really take place by deterministic processes, but developmental processes, that are each individually different. How physics responded to that problem was to study the phenomena for which equations seemed to work, the phenomena equations would successfully predict.

I eventually recognized that if the equation couldn't apply throughout all time, the beginning and end of periods when the system didn't follow the equations had to be periods of organizational transition. My first real progress with it, as a physics problem, came from trying to conform the shapes of "S" curves with the natural processes I was studying. So finding no way to do it, I first just mentally snipping off the parts that didn't work, their infinite tails out into the future and past. That is just how "S" curves were being represented as in Fig 1, ignoring the obviously irrelevant parts, but failing to ask "what happens" to begin and end the continuity of the

[8] Google Ngrams -
https://books.google.com/ngrams/graph?content=complex&year_start=1900
https://books.google.com/ngrams/graph?content=information+overload&year_start=1900

system being portrayed. I just marked where I cut off parts of the curve with question marks, and found that really worked to point to the answer!



1. Might fit the data but is unchanged throughout all time past present and future.
2. Is defined independent of the environment the system is developing from.
3. Represents the limts of the future as being part of the equation from the beginning.

From [Hyejin Lee]

Figure 3. Logistic Curve Equations

I happened to develop a curiosity about things that appeared to have deterministic behavior sometimes, but never seemed to at their beginnings or ends.

For the rapidly developing systems I studied, having marked the where the behavior seemed to become undefined with ? marks, got me to look for *other systems* that might first explain the initial start-up of the development process. So I just watched closely to let nature teach me what mysterious events were occurring there, to "begin the beginning" of the organized process, and also to "end the ending". I now call those "Event 1" and "Event 3".

I similarly found the middle of the "S" curve had to be undefined, for it to reverse directions of curvature without some reason to. So I broke the curve in the middle, calling that point "Event 2" to mark the need to ask how the development process changed from the design it started with, to incorporate conditions it found as it developed. The finite periods of time of fairly predictable behavior, before, between and after those events, I now call: "Stage 0", "1", "2" and "3".

After a time I accumulated enough observations of the smaller scale "bursts" or "surges" of start-up systems usually discoverable at the start of larger scale development processes. I began to think of what rules of energy physics they'd have to follow. Several years later an idea popped up that without so much work seemed to be just the right question to ask. It was to ask what are the limits of energy conservation for finite events.

Natural System Transitions
Timeline of Organizational Stages & Events

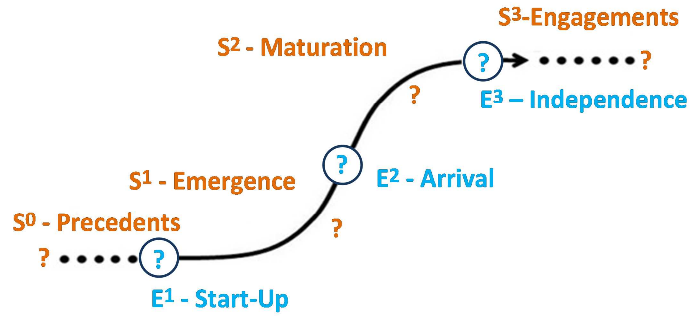


Figure 4. Organizational Stages Model

Precedents – A Environment of Potentials

Event 1: **Start-Up** 4. The "venture capital" and "germ" for building on itself	Stage 2: **Maturation** 7. Parts negotiating lasting roles internal and external
Stage1: Emergence 5. Expanding on the Kick Start taking every opportunity found	Event 3: **Independence** 8. Lasting commitment to new sets of relationships
Event 2: **Arrival** 6. a shift from developing without limit to choosing an objective	Stage 3: **Engagement** 9. Sustained peak of vitality, eventually wearing away.

End Result – Legacy of Potentials for Others

Organizational development stages for a tree

I just used the equations and established a pattern of derivatives of allowed rates of change and reintegrated it to produce the polynomial form of equation within which the natural phenomenon would have to develop, amounting to an "S" curve with transitions beyond the scale of observation, as my practical research method had led me to as well. Organized events beyond the information of "S" curves are both needed to satisfy the conservation of energy, and useful to look for.

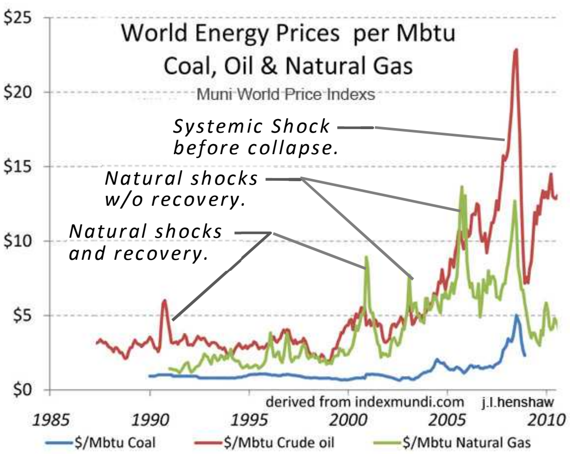
These requirements for describing natural systems are directly implied by the conservation of energy. The equations that show why are in a [General law of emergence and continuity in change].

IV. EXAMPLES OF IDENTIFYING CRITICAL BEHAVIORAL CHANGES IN CULTURAL & ECONOMIC SYSTEMS

To understand the systemic behaviors depicted, think of them in terms of more personal experiences of life change, as suggested for each. Think of them as histories of you more tumultuous relationships, those that totally changed your life, as that's what indicators of irreversible systemic change like these are all about. The particulars may be quite different, but these and many others are found in the transformations of all kinds of complex natural systems.

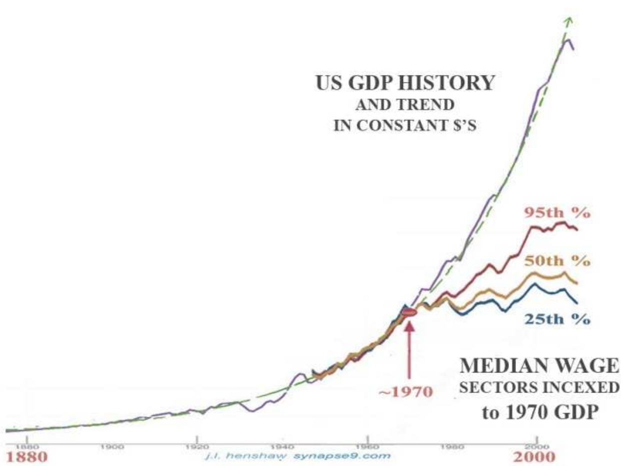
1. Loss of resilience in recoverering from natural shocks.

Text intro – loss of resilience, inability of the system as a whole to relieve local strains, that then grows and grows.



2. Diverging relationships of system parts

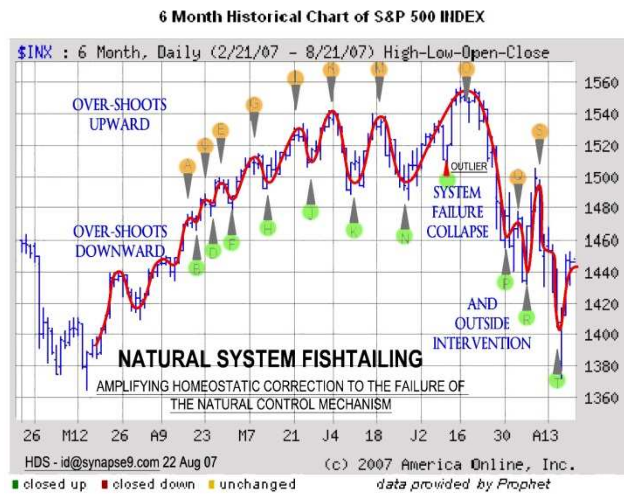
Text intro – growing inequities as a mode systemic failure US GDP & Median Wages



Fuel prices escalating to the 2008 Collapse

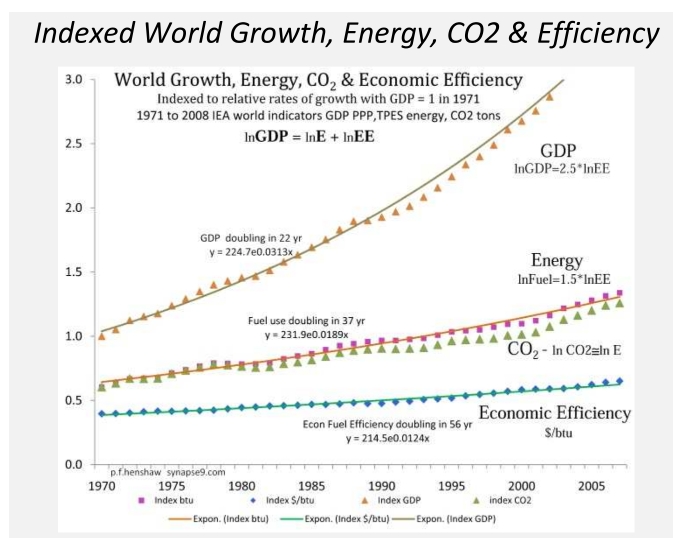
3. Uncontrolled Fishtailing in self-corrections

Text intro The Averted Financial Collapse of 2007



4. Coupling constants between growth rates

Text intro –



V. RELATED SHORT ARTICLES ON RESPONDING TO NATURAL SYSTEMS

These selected articles from "Reading Nature's Signals", my journal of research discussions. An (*) indicates some more important articles at the beginning of each list.

Policy & Practice

1. *UN Development Goals… leave out Common Needs. How focusing on the needs of constituencies tends to sidetrack the needs of the whole - 7/1/13
2. *Sustainability = growing profit then steady profit. Natural development, build to a point where you can comfortably maintain your profits -3/1/13
3. *Nature's Capitalism: "Homemaking" now, not competition over shrinking pies!. Making a home on earth is the missing goal of the economy - 11/20/13
4. *A World SDG – global accounting of responsibilities for economic impacts. A scientific method of assigning shares of GDP impact costs to shares of GDP, to help decision makers see what they're deciding - 2/3/14
5. *Review of Science for UN's SDG's. – A short report on a meeting of the UN Sustainability Science expert advisory group - 3/1/13
6. Multi-Stakeholder Partnerships. One collection of approaches to using cross cutting partnerships to find ecological solutions and resilience - 10/16/12
7. Wholes and parts in unaccustomed partnership. The difficulty of finding and working with neglected constituencies as unexpected partners - 3/9/13
8. Self-organization as "niche making". How a physicist sees the deterministic and self-organizing aspects of nature fitting together. Discovered rules that work the best also last - 3/6/12
9. Missing Principles of Ecological Thinking – in plans for the Earth. Issues of how to change a world not part of the discussions of what world we'd like - 4/27/13
10. Steering for the organizational Lagrange Point. The moments when whole systems are ready to turn on a dime - 7/20/12

Methods

1. *Finding Organization in Natural Systems – "Quick Start". Another brief introduction to Natural Systems and the use of Organizational Stages Models - 8/7/13
2. *3Step process for Working With Nature. Noticing the natural partners you need to work with in your environment - 7/3/13
3. *Telling the whole stories of how things change. Nature's way of telling stories is to tell the whole story, from the very beginning to the very end - 8/15/12
4. *Principles for detecting and responding to system overload. Strategies for preserving resilience, to avoid persistent depleting of systems for profit - 9/4/12
5. Easy Intro, "scope 4" use & interpretation. Measuring business environmental impacts as their total demand for economic services for in-house and external business operations - 4/8/14
6. Sustainable Cities: Caring for the Greater Commons. Methods of measuring urban environmental impacts caused by their total demand for economic services inside and outside city limits - 12/28/13
7. A World View of Off-Shore Energy use. Studying national economy resource dependence on across border energy use - 6/22/14

Conditions

1. *"Organizational Rigidity" as a natural limit of growth. Recognizing rigidity in previously flexible systems as a sign of crossing natural thresholds of organizational stability - 2/2/12
2. *The trap at the end of "Low Hanging Fruit". Extending productivity to the limit introduces rising risks of instability, undermining resilience - 11/29/11
3. *Decoupling Puzzle – a partial answer. Indicators of the behaviors coupled to each other as parts of the same system - 4/20/14
4. Are the holes in your map helping you read the territory?. The difficulty of seeing from the outside that there are hidden worlds within the cultures nature builds from the inside, making it seem as if they're not there - 2/5/12
5. Can we shut down the system for repairs? Continuity of change requires the old system of the past to build the new system of the future - 9/18/11
6. Complexity too great to follow what's happening?. The start of declining use of the word "complex" and rapid rise in use of "information overload" coincided with ~1970 introduction of computer programs to make our decisions on complex subjects - 12/24/10