Understanding Nature's Purpose in Starting all New Lives with Compound Growth

New Science for Individual Systems

For 2021 ISSS theme – Future Society

- Draft Supplemental Topics for the paper:

~~https://synapse9.com/ISSS-21/Henshaw-NewSci-IndividSys-MS.pdf~~
https//synapse9.com/ISSS-21/ISSSJul11NewSci-IndividSys-MS.pdf

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Author's Note: the following edit of supplemental topics is a bit casual and not always completely consistent with the tight edit of the paper. Further edits are expected, but not expected to change figure numbers.

Green indented text marks draft paragraphs

Figure #'s coordinate with the paper

1 Questions About Growth

1.1 Short essay on growth

Growth is a lively process, seeming to be both responsive and opportunistic, found in every lively thing throughout nature, notably in every work people do. It is how things start. This conclusion is the author's observation offered to prompt the reader to question it for themselves, as are all the observations suggested here. Growth in nature appears to adjust over and over from start to finish, as people do in the course of doing work of any kind, the endless cycle of all crafts, do work, reassess, and repeat (Henshaw 2018). It seems to be the *continuity* of those adjustments, connecting one after another, in how people work that corresponds to the physical continuity of the organization-building process of growth. It is often in plain sight but hidden from human eyes for making assumptions, lack of interest and perspective. The very general pattern fits a three-part development cycle, much like any life story, of beginning, middle, and end. The story has two immature stages, first branching out – *differentiating* – then narrowing down – *coordinating* – to reach a point when the mature new life begins.

Like most strategies and histories, early steps of growth are immature in design. The gains in strength and resolution of challenges are step by step, as new challenges are confronted in new environments. One of the main findings of this study is that, looked at carefully, the three phases of growth are really six, three longer periods: *divergence*, *convergence*, *life*, each beginning with a short change-in-direction, *germ*, *turn* & *release*. You could also say growth starts with a concept (natural or human) for a life that leads to a vehicle for life, then life. We can also observe that the six-stage model of growth as a process of emerging organization that does not fit very well with models of "cause and effect." The six-stages of growth roughly correspond to the *internal* *animation* that drives its *opportunistic building* process, of systems behaving as a whole, not “cause and effect.”

Another remarkable feature of growth is its usual climax at a state approaching perfection in every part. That applies to the growth of animals and businesses, communities, relationships, and snowflakes, that maturation is a process of refinement from an immature beginning. It also applies to the design of houses and garments and most other kinds of work people do. The first phase of growth differentiates the parts, creating a framework of designs for the second phase to fill in and refine. The first phase builds on the past, expanding on the seed pattern by steps of *divergent* positive feedback. Then it shifts to building toward fitting in with the future by smaller refining steps of *convergent*, negative feedback from both internal and external, to climax prepared for a mature life.

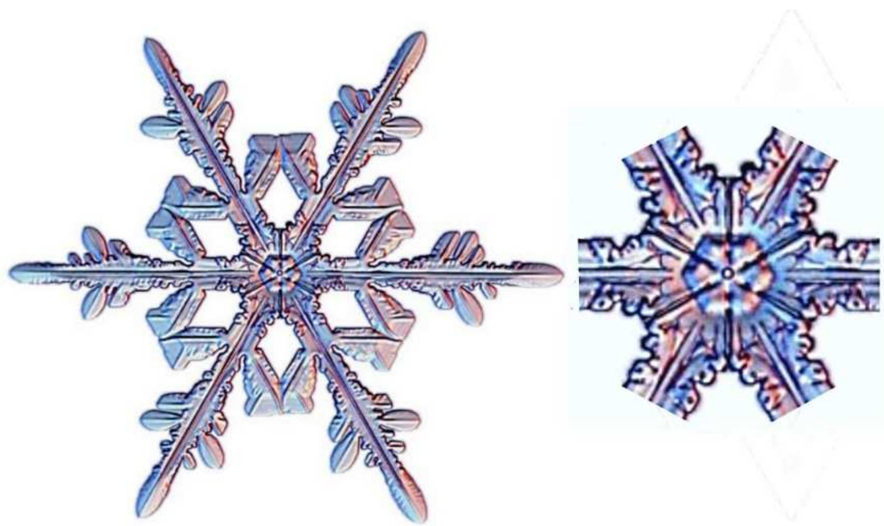
Perhaps the most puzzling feature of growth systems is how they seem to invisibly emerge from small beginnings with a contagious pattern of system-building. Examples are 1) the moment when two people notice each other that begins a relationship, 2) the flash of insight leading to the “napkin sketch” that an architect develops into a graceful building, or 3) the joining of sperm and egg, leading to the growth of a new human being. It is also quite mysterious how so many growth systems first expand with a burst of acceleration, to then get some sort of signal to switch in mid-stream to slowing down for taking the building process to its natural finished end.

Sometimes there is an easily identified reason for the turn forward. The genes of a person, for example, somehow coordinate the growth of all the parts then end in perfection all at the same time. That shift from ever-faster expansion to slower and slower perfection of the design of organisms seems to occur at their birth, ending explosive growth in the womb to begin a long process of slowly preparing for adult life.

For a home builder, the turn often comes as the frame is up and the challenge is to finish on time and make a profit. Both the builder and client will work like “the genes” of the building process first takes off and then properly finishes, A then B, making sure all the needed parts fit together. For the office project, that change tends to come with a degree of panic as the team solidifies the design and the huge amount of work needed to finish becomes clear.

Another clue to what is happening is that explanations for these two stages of system design seem always to lack the “requisite variety” (Ashby 1991) for what happens, how such apparently simple signals produce such complex and individually perfected results. It takes the magic of teamwork, obvious in the office project, mysterious in nature. Clearly, something happens, but it seems hard to explain using ideas of cause and effect; growth always seems to behave as an organized whole.

We can see the same thing in more varied forms in business growth. Some businesses take growth only far enough to make a steady profit and satisfy family needs. Among other strategies, some will develop a small business only far enough to sell it and leverage its wealth to start something bigger, climbing a ladder of start-ups, risking everything on each one. The growth of a snowflake (Fig 7) also shows both the beginning and finishing stages. Growth starts with the tiny dot at the center, a speck of ice condensing on a dust particle in the super-cooled humid air. Adding layer upon layer, it differentiates into its final form, build a symmetrical jeweled crown of ice crystals that is individually unique.



Snowflake details *Central kernel*

Fig 7. A Snowflake and its Central Kernel: The design builds up from a tiny central crystal. The smallest visible hexagonally differentiated shape is still quite simple, with the next rings of shapes quite complex. The six spines that emerge develop nearly identical filigree as if organizationally "entangled" in that first crystal core.

1.2 Key Observations on Growth Systems

1) Growth as a non-linear radiating acceleration, a converging deceleration building process, leading to new life.
   a. nature's primary way of individually building organized systems
   b. a rising then falling momentum of things falling together, to then carry on

   c. that will also, at some later point, fall apart.

2) Close observation reveals distinctive stages of growth exposing their organizational process,
   a. seen in time series data as an "S" curve (Fig 5)
   b. as the lively succession of six main stages
   c. Seed, Start-Up, Turn-Forward, Finish-Up, Release, Life
   d. Nucleation, Individuation, Pivot, Maturation, Assent, Engagement
   e. Divergence - Convergence
   f. the stages proceeding from immature beginnings to mature ends,
   g. organization emerging first with functional differentiation, then articulation,
   h. at non-linear rates, of first bigger than smaller adaptive layers of development,
   i. sometimes flowing smoothly as if automatic, sometimes opportunistically, by exploratory learning, adaption, and relationship innovation processes
3) Growth systems also recognized by their,
   a. individual organization found within boundaries between internal and external systems of relationships, sometimes with a physical barrier such as for a cell or an organizational barrier such as for an environmental niche.
   b. various growth trajectories (Fig 4), growth to exhaustion, disruption, or resilience.
4) Case studies (§3 below) highlighting
   a. fitting the model of the six growth stages to partial data on individual cases of growth
   b. special cases (case study III) repeated growth to disruption called "try, try, again."
5) The eco-economy and growth
   a. Features that ecologies and economies have in common, suggesting levels of granular details of living systems to keep in mind:
      i. all parts access to energy,
      ii. productive working units combining different specializations,
      iii. learning, adaptive and homemaking parts,
      iv. thriving on sustainable disruptive innovation,
      v. strains relieved by the spread of surpluses, or reverse by the spread of shortage.
   b. Main Centers of productivity: cultural and societal, people and technology in organizations, government and non-profit services, profit-making business and industry organization, business and financial profit maximization.
   c. The steering centers of the world eco-economy, individual choices, government and non-profit services, business choices, finance, and investor choices, and how they respond to disruptive innovation, environmental distress,
   d. Diminishing returns from undermining capital resources hidden by growing income.

e. Alternative sustainability models for individual organizations
f. When to turn:
   i. Once aware of any limits to growth a *turn forward* for investment to end growth early hardly slows the path to the limit
      1. Delayed response quickly becomes extremely dangerous
   ii. biomimicry “reset” for the world eco-economy to resolve its increasingly vulnerable and increasingly disruptive “try, try, again” cycle
      1. Perhaps by a regulated distribution of profits to limit the compound investment of unearned income,
      2. Perhaps using an assets tax on savings from unearned income, waved for unearned income invested in the common good.

1.3 Growth Pattern Guides

The original nucleus, seed pattern, or impetus may be hard or impossible to find, like the moment a cell is fertilized, or some other deep 'idea' of nature occurs. Those germ patterns seem to reflect continuities from unobservable levels of organization in nature that give birth to more observable scales of organization. Any system's history-dependent stages may be opportunistic, too, like budding tree branches bending to the sun (a source of the zig-zag pattern of tree branches). The same applies to entrepreneurs seeing an opportunity to capitalize on which steers their business in unintended ways. If developing systems have living parts, one can expect they might also be actively learning and inventive, evolving with the local emergence of branching cultures.

Growth also often presents an endless *live-or-die* challenge, ending without reaching a stable climax. Long-lived systems that develop by growth would include social and ecological cultures, large and small of all kinds, individual organisms, including cultures, communities, individuals, businesses, convection cells, and even weather systems that survive their own growth for some period, as well as civilizations. The differences between short and long-lived growth systems are many, but most often turn on whether their initial period of opportunistic positive feedback is replaced by opportunistic negative-positive feedback (climaxing) for stabilizing the system at a sustainable climax.

To start the study, one first needs to learn to identify growth systems from indicators of their organizational parts, as in Table 4:

Table 4. Indicators of organizational parts A.

1.	the seed pattern and the environment the system grows in
2.	regular proportional change, indicating controlling feedback loops
3.	system individuals that have "lives of their own," with a history and future
4.	signs of internal system instability, perhaps indicating competing feedbacks
5.	recovery from external shocks, indicating sources of resilience
6.	decreasing recovery from external shocks, indicating a loss of resilience
7.	escalating systemic distress and crises, like the world is now experiencing
8.	invasive species and cultures as internal shocks, pointing to loss of resilience

Paying close attention to how work efforts expand then contract toward a finished end (Henshaw 2018) can help expose universal patterns of starting and completing development. The most general pattern is the cycle of *events* that set directions for *periods* of development and then *periods* of development, preparing the system for other *events*, a full stage of growth consisting of three pairs. Of greatest importance seems to be the turning point in the middle. That is when system development switches from expanding the seed pattern, building on the past, to building toward the future in two ways. One is by adapting to the future environment and the other is by proceeding by successively smaller refinements. The change in direction is readily visible in time-series data as the *inflection point* in the middle of the organizational process's "S" curve when the initial expanding (divergent) steps and challenges give way to successively smaller (convergent) ones. In one's work, there is an emotional and attention turning that occurs at that point, too, that one can develop an awareness of and watch how the reorientation happens.

Tasks like cooking, preparing designs, manual labor, and other efforts are all creative processes requiring an animating *germ* for *build-up, turn,* and *finish-up* stages, making repeated decisions in review steps along the way to guide the work as an extension of the first idea. They all start from an initiating idea and circumstance followed by the creative process of expanding on the starting idea with initially small steps that build up. Then as the end is in sight, the progression proceeds in reverse with large steps that build down again, ending with finishing details. What's most important is noticing that the work adapts to the expanded idea and new conditions at every step (Henshaw 2018). Those repeated adaptations are the steps of steering the work process to a successful end. For various other suggestions on observing guiding patterns of design in nature , see Henshaw (2015).

Table 5. Indicators of organizational parts B.

1.	Centers of organized design;	A rust spot, a city
2.	Boundaries between sets of relationships	Neighborhood lines
3.	Rising, then falling action	As a story line
4.	Continuity and momentum of connecting steps	Flowing relationships
5.	Shifts to more or less organizational stability	Varying resilience
6.	Coordinating multi-level designs	Systemic character
7.	Where nature or people are doing something new	Inflections, eruptions

1.4 Added notes on recognizing new lives

"There is this hope, I cannot promise you whether or when it will be realized - that the mechanistic paradigm …, will be replaced by an organismic or systems paradigm that will offer new pathways for our presently schizophrenic and self-destructive civilization." — Ludwig von Bertalanffy (1968)

Growth can be understood as a series of tests too, drawing attention to the granular character of organizational development. Each development period of growth can be viewed as having an immature beginning and mature ending too, like an S curve development in itself.

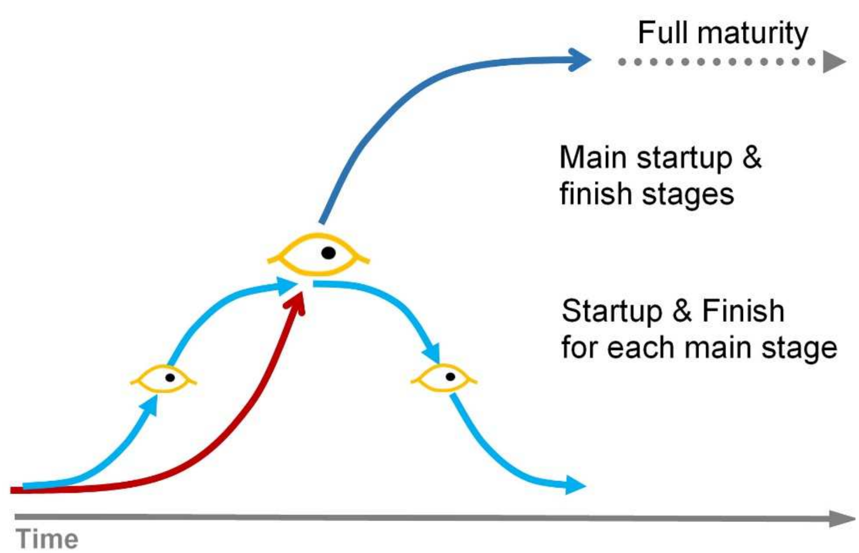


Fig 8. *The Startup and Finish Stages for Each Main Development Stage*: New directions of development begin slowly, and a bit disorganized, needing to mature taking some time to do so, also an implication of continuity.

Needing to mature in time to move on to the following stages is one of the main challenges. We’re all familiar with one on the common variations on that theme, the annual tests in school for graduating to the next level, and the way each new level starts in some confusion and then *settles in* and builds momentum and organization through the year. While it is a general pattern and quite useful for diagnosing what might be causing lingering disorganization and other issues, the added complexity is also hard to follow. So, it is only studied when the need arises.

How common it is for new endeavors to fail is evident from the frequency of failure new businesses and personal relationships. The opposite is also common enough; in how often people surprisingly rise to the occasion to meet unexpected challenges (Henshaw 2008, 2010a). The kinds of growth failures also include unsustainable success, from failing to see environment change, like the tragedy of successful communities not watching their environments. Our world economy is a prime example, of course, accidentally measuring success as the fastest possible way of accelerating our depletion of the earth’s resources.

Some conflicts arise from familiar deterministic ways of thinking. Noted ecologist H. T. Odum (1983, 2001, 2007) proposed a now widely accepted ecological and economic principle called the “maximum power principle” (MPP). It states that “any self-organizing process [organisms, cultures or businesses, etc.] will capture the most energy and use it with the best efficiency possible without reducing power." This is similar to Boulding’s “Principle of Equal Advantage” (1953) that parts of a system will seek their highest potential. It is also similar to Friedman’s principle (1970, 2007) that maximizing profit is always the best.

The general caution to take with all three is to add the phrase “depending on the context.” Many natural growth systems grow to reach a stable climax at their peak of vitality and longevity, and many human-designed systems do so. It shows we have insight into how to do it that might serve our deeply troubled world.

The initial growth curves, rising with steeper and steeper slopes, will often display very regular proportional change, changing by a constant % over time, fitting an exponential function, and periodically doubling, Eqn 1. This regularity of a system’s escalating rate of internal reorganization displays both considerable elasticity of the system’s feedback loops as well as a means of self-regulation.

Growth curve $Y = Y_0$^r*t (1)

Y_0 – starting value, r – proportional rate of change, t – units of time

However, no physical system of relationships is infinitely elastic, being much like bucket brigades passing buckets back and forth. The parts can only be separated so far before the supply chain breaks down or demand for more buckets cannot keep up, or the ships get too big for the canals, etc. So only the mathematical expressions are limitless. Growth can then also be thought of as a preprogrammed off-switch, quite sure to run into either the system's internal or external limits. That growth systems get as far as they do, changing from one resource to another, for example, does indicate they are partly in control of their own limits. That is also clear from how very smoothly the feedback loops within so many natural and human-designed systems respond to change. More importantly, it is evidence that growth is inherently "*exploratory,*" constantly finding new development paths.

So, growth's regular initial exponential shape naturally prompts the question: "What's going to change?" Any positive feedback process will run into negative feedback, either taking the system to either a stable climax or some kind of collapse. Expecting that growth curves won't continue, one then looks for shifting trends of adverse effects growth and inflection points to help pull together information to discover how and why the system is changing. A narrative of change is then pieced together by turning attention back and forth between available evidence and plausible hypotheses as causes for responding are considered (Henshaw 2010a, 2018).

2 Sample Case Studies

Case studies present a practical problem, varied solutions, and the principles demonstrated.

The three case studies below demonstrate using the natural growth models (Fig 4 and 5) for interpreting partial data sets. The exercise teaches a kind of guided exploratory guesswork. You might think of it as like steppingstones for illuminating the natural behaviors behind the data, teasing out new hypotheses to test, and gaining some insight into what at first is unseen. The life stories of natural systems are more varied, of course, so starting to ask whether the models fit at all is a needed first step. Again, and again, the surprising questions that come up when investigating time series data associated with continuous organizational processes are the main benefit.

2.1 Case Study I - Human Gestation

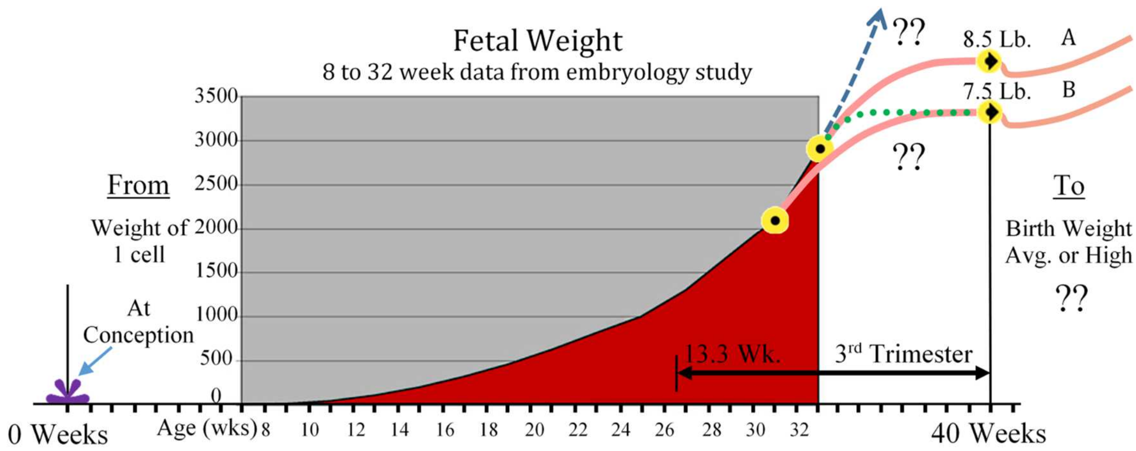


Fig 9. Case Study I. Human Gestation based on partial data on fetal weight.

Case I - Observations

Stage	**Observations**
0 Context	The data shows only 26 weeks on an expanded 40-week scale. The maternal environment is a protected and nourishing place for the descending unfertilized egg.
1 Seed	Fertilization marks "Week 0," the blastocyst (~200 cells) implanted in about ~5 days.
2 Start-up	The growing embryo's weight does not register until "Week 8" but has been doubling in size about every 5 ½ days, some 42 times, by week 33 [1]
3 Turn Forward	To locate the Turn Forward, we first try Week 31 ( ) then Week 33 ( ). *Do you see why? Is there a better guess?* Placed at Week 31 assumes the last data point is a little high. That choice allows a smooth curve to the 7.5 lb average birth weight at 40 weeks.
4 Finish-up	There are four choices. The **dashed blue line** extends the data trend to a 40 week birth weight of ~1000 lbs? (NO). The **dotted green line** levels off suddenly to hit the avg birth weight of 7.5 lb? (NO). Is either lower and upper **pink curve** ( ) best, both showing weight gain curving smoothly toward either 7.5 or 8.5 lb? (OK) *Which 3rd Trimester growth curve seems most natural, A or B? Which is more likely birth weight 7.5 or 8.5 lb*
5 Arrival	Birth at 40 weeks ( ) leaves a newborn stressed and needing to recover, a dip in the curve.
6 Life	*How does weight gain during infancy and childhood proceed? In big spurts? Might physical growth be slowing the whole time, explaining why it takes 20 years?*[2]
7 New Context	Leaving home for a bustling world and further developing skills for Life.

[1] Data source- Univ of New South Wales Embryology Study - https://embryology.med.unsw.edu.au/embryology/index.php/2009_Lecture_22

[2] Mayo Clinic "Pregnancy week by week" https://www.mayoclinic.org/healthy-lifestyle/pregnancy-week-by-week/in-depth/fetal-development/art-20045997

- The study shows expanding the interpretation beyond the limited data as a guide to asking new questions, here trying to determine the final shape of the growth curve at birth. The primary constraint for all the options is maintaining the smooth natural shape of the growth curves seen in the data (the continuity).

2.2 Case Study II - The Growth of Publishing on Sustainability 3, 4

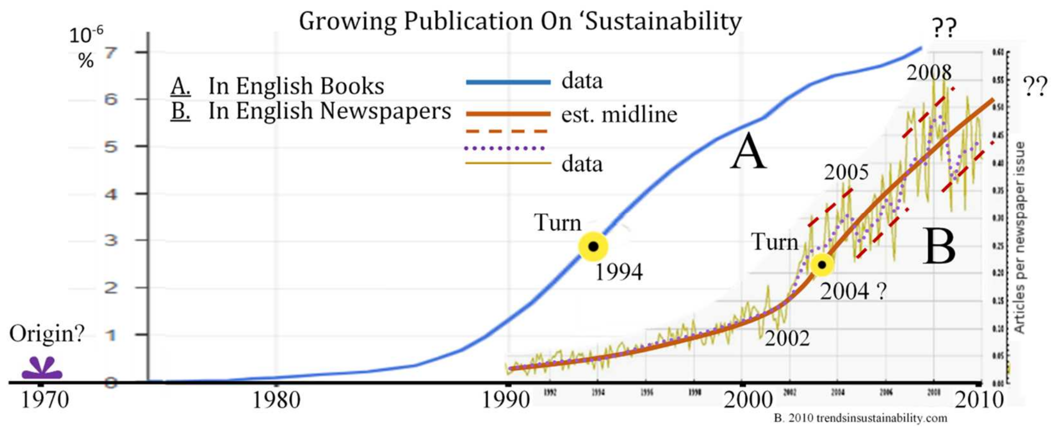


Fig 10. Case Study II. Data on book and newspaper publishing on 'sustainability.'

Case II - Observations

0 Context	Concern with growing environmental harm began centuries ago. A great modern wave of concern is evident in the publication of books and newspaper articles on "sustainability" in the 1980s and 90s.
1 Seed	Curve A (in books) traces of the rise of "sustainability" in books from the 1940s, growing steadily from 1970. Curve B (in papers) might have had a long gestation too.
2 Start-up	Growth of Curve A is about ten years ahead of Curve B. Why? *Did sustainability start as a matter of private debate before becoming a matter or public debate? Was it that reporters were not reading books? Why else would covering it as news be delayed?*
3 Turn Forward	Curve A turns from curving upward to forward in 1994, seeming to mark the maturation of the book audience. For curve B it is less clear, marked as 2004? The newspaper audience shifts from smooth growth to wild fluctuation. *What might have caused the large swings of newspaper interest? If not signaling the resolution of the issue, what else might the turning points indicate?*
4 Finish-up	Curve A shows slower steady growth after 1994. Curve B after 2004 was very hard to estimate. First midpoints of the data's largest fluctuations (••••) were traced. Then the extremes of the data's largest fluctuations (– – –). Finally, the smooth curve (▬) threading the first two. Neither data source is available after 2010. *Where might the*

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[3] Google "Ngram" for Sustainability - https://books.google.com/ngrams/graph?content=sustainability

[4] Global Sherpa.org http://globalsherpa.org/news-trends-sustainability-development-issues/ publishing research by trendsinsustainability.com

	trends have gone since 2010? Are the issues headed for resolution yet? Interest seems still strong. Was there a peak or a plateau? Is its promise fulfilled or the opposite?
5 Arrival	The resolution of the sustainability issues would mark our arrival at a model for living in the future. *When might that occur? If not directly ahead, what is in the way? Is the discussion still searching for direction? What has become clear?*
6 Life	As in life, maturity is still a very eventful kind of steady-state. *In that sense, what is needed for the discussions of sustainability to fulfill its promise?*

- The study shows how departures from the model can start a useful narrative. All that is needed is some evidence hints of beginning, middle, and end.

2.3 Case Study III - An evolutionary case of "try, try, again."[5]

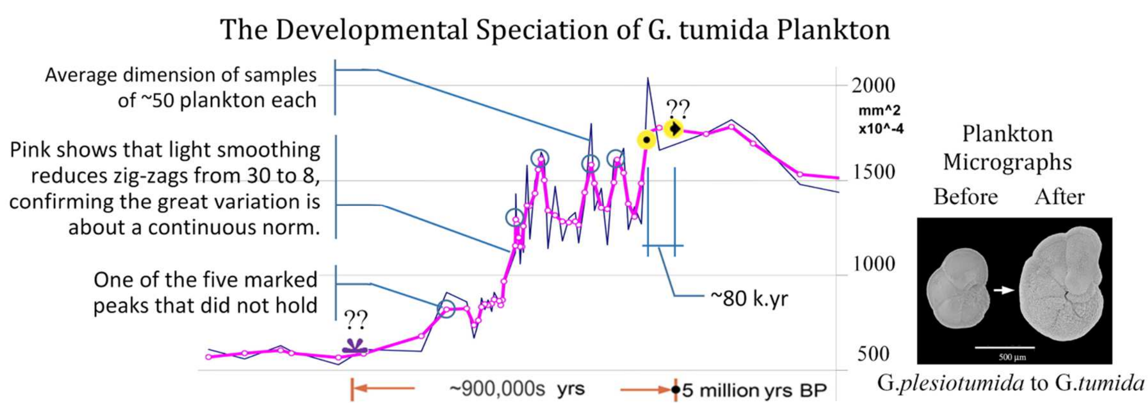

Fig 11. Punctuated evolution over 900 k.yrs of the G.tumida plankton, showing repeated bursts of increase in shell size, that then fall back until finally, one holds ( ).

Case III - Observations

0 Context	The jittery data line (blue) and more regular running average line (pink) trace a 900 k.yr evolutionary transition from one species of open ocean plankton to another (Henshaw 2007). Statistical tests show that the noise in the data is variation about a continuous norm. Light smoothing then approximates that trend, revealing several periods of rare continuity in evolutionary change.
1 Seed	The initiating seed event (??) for the G.*tumida* transition is placed at the estimated earliest point when the instability in the species genome might have developed.
2 Start-up	Five spurts of growth then collapse ( ) establishing a "try, try again" development path. *Why might the evolutionary spurts have collapsed? Might study of similar patterns of repeated failure help?*
3 Turn Forward	After the highest of all growth peaks, the trend Turns Forward ( ) after some ~820,000 years. *What are examples of "try, try again" efforts that that finally succeed? In personal or business relations. In cultural struggles?*

[5] Ocean core data collected by Bjorn Malmgren (1983), Further analysis by Henshaw (2007)

4 Finish-up	In the end, the resolution is unclear, except that it came relatively quickly, within only an estimated 80,000 yr from the Turn Forward to the estimated point of Arrival.
5 Arrival	After the estimated point of Arrival (◆), the trend line returns to the kind of lazy drifting as before the long wild transformation struggle began.
6 Life	*What is life for a new species?* Here it is hard to say without a lot more understanding of how tripling the size of this common open ocean plankton changes its ecology.

- Think about "try, try, again" patterns and what drives them in personal, business, and political struggles. Natural systems do not have human motives, of course; however, they might have fixations with similar effects. A self-organizing system might be disrupted repeatedly by some innovation that persists, like a handicap, only resolved by some future innovation. During such a period, the system would have struggled between its own old and new orders. Are *all* great struggles perhaps like that, facing issues that come back repeatedly until finally resolved? Can the resolution of today's human fixations be informed by other long struggles, like the evolution of G. tumida appears to display?

2.3.1 A brief excerpt from review comments

The following is from peer reviewer comments and replies for the prior paper that included the above case studies, submitted here for the new paper as supplementary. The exchange perhaps suggests answers to some of the common questions of this unconventional approach, using mathematical tests for continuity rather than assuming irregular data is noise.

Rev1 - This is unconvincing. In the case of the evolving plankton, each stage of this nearly million-year process might most simply be described as natural selection at work. Plankton exist by the billions with minor heritable variation in size and short life cycles.

Auth - Yes, that's why clear evidence of long periods of directional evolution, apparently by some means other than random variation, is interesting.

Rev1 - As conditions in the marine environment fluctuate, different sizes (or some critically important associated characteristic) may be favored over different time periods lasting tens of thousands of years. In short, the observed fluctuations in size reflect selection by changing environmental conditions.

Auth - Yes, those were studied and found quite stable during the period

Rev1 - Any resultant evolution is not a directed process; the plankton at each stage are those possessing characteristics best adapted to contemporary conditions; persistence of the species over the entire period implies evolutionary success throughout, not repeated but failed "attempts" to evolve.

Auth - Yes, resultant evolution is not supposed to be a directed process. The mechanism for such rapid directional evolution, and for all the many other examples of "punctuated equilibrium," is quite unclear. Where evolution is so rapid that we can find no evidence of, it deserves systematic study, though.

Auth - If I could get the funding, images of the G. *tumida* shells could be animated as a film, to see if the spikes in evolution represented a flowing process as the data strongly suggests. Do they represent trends in the whole population or just a rising and falling frequencies of outliers? One cannot know till someone looks.…

3 Special Data Studies

3.1 The shapes of Gamma-Ray Burst BATSE 551

The source of gamma-ray bursts is still uncertain, though they are clear evidence of extremely short and extremely high energy explosions or collisions of some sort. A NASA FAQ[6] offers, "One explanation proposes that they are the result of colliding neutron stars -- corpses of massive stars (5 to 10 times the mass of our sun) that have blown up as supernovae. A second theory proposes that gamma-ray bursts are the result of a merging between a neutron star and a black hole or between two black holes."

Figure 12 shows what was recorded by the BATSE satellite. Each dot in the raw data plot (rt.) represents a single gamma-ray entering the detector. On the Lt. is a careful smoothing of the continuous curve linking all the raw data points. The data was divided into six subsets using every sixth point for separate smoothing, using derivative reconstruction, a mathematical method for minimizing irregularity without changing the shape (Henshaw 1999). We see the six subsets have much the same shapes, showing that the smoothing does not create the regular fluctuation. If the data were noise, the six subsets would be randomly different, but they are not.[7] So what does it say? The main burst has a very sharp seven millisecond "S" curve rise that abruptly shifts to a more gradual 35 millisecond "S" curve decline, with no period of stabilization. So what kind of process does that? Breaking and egg comes to mind, something very hard abruptly followed by something soft. Lots of things do that.

[6] StarChild Question of the Month Jul 2002 https://starchild.gsfc.nasa.gov/docs/StarChild/questions/question47.html

[7] See also https://synapse9.com/drpage.htm#batse

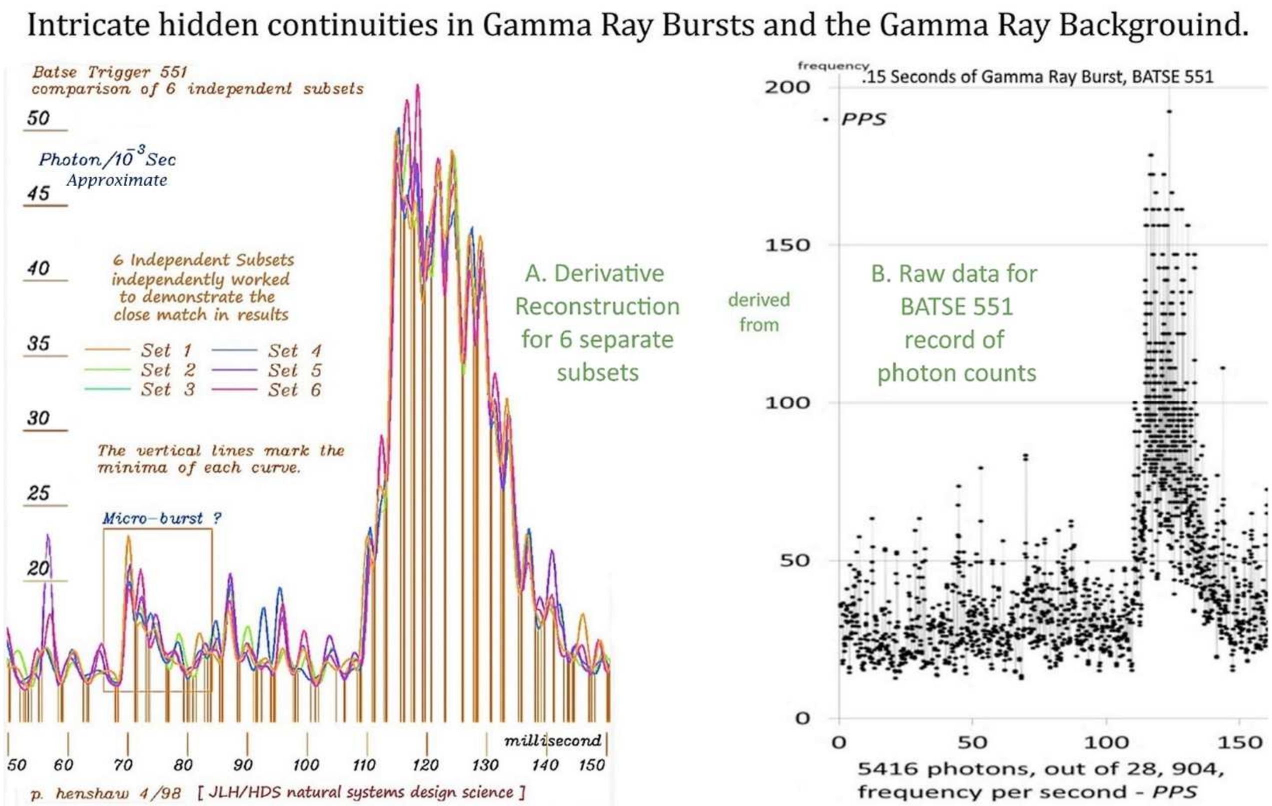

Fig 12. A) The flowing continuity found in analyzing a ~0.15 sec. burst of gamma rays. B) The raw data plot of the BATSE 551 gamma-ray burst, each dot representing a single flash of light in a photo multiplier for recording these extreme high energy cosmic events.

3.2 The dynamics of the Great NYC Crime Wave

One of several remarkable features of the collapse of the murder rate in NYC starting in 1990 is that the rate of decline only slowed down during the administration of Mayor Giuliani. That and the alignment of the peaks and inflection points of the murder rate in each borough make it clear that the data shows culture change. The murder rate declines so fast in the Bronx; it is as if not a single youth joined the drug culture after 1990 (allowing for the normal ten-year crime-prone age from 20 to 30). The study was not published because the criminologists had never looked at the data this way. From interviews, every interest group credited itself as the cause of the rapid decline. The best guess from all sides is that in 1990 "crack became whack" in the culture, and all the interventions began to work, and *the kids fled en masse into Hip-Hop*. See also https://synapse9.com/drpage.htm#crime and https://synapse9.com/cw/crimewave_nys2.htm

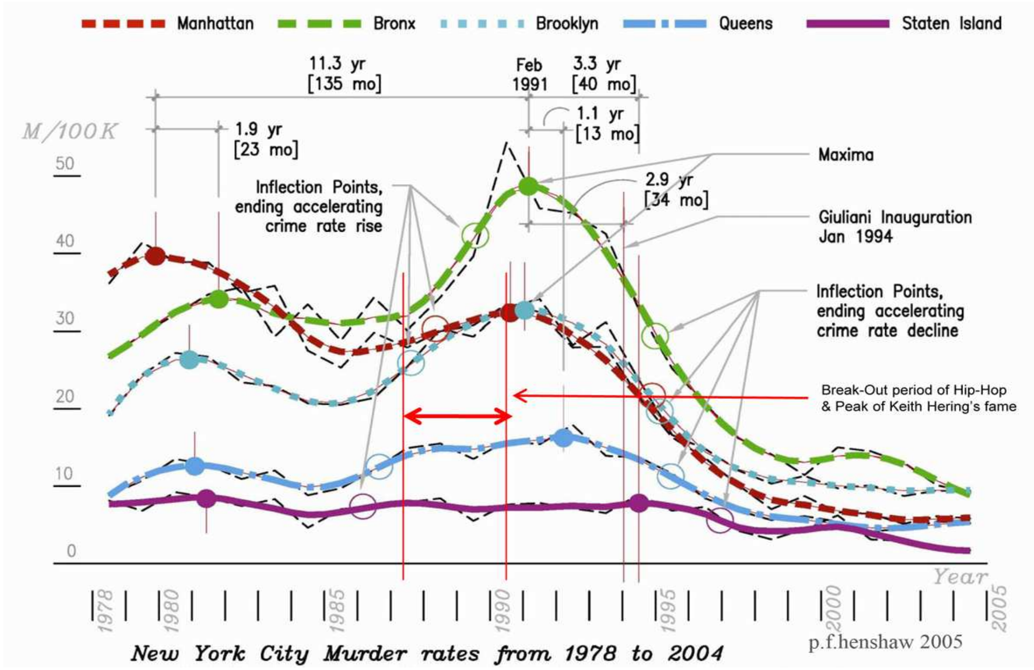

Fig 13. New York City Murder Rates by County – during the great waves of drug culture violence of the 1978 to 2004, breaking in 1990.

3.3 Homeostasis of the world economic growth rates

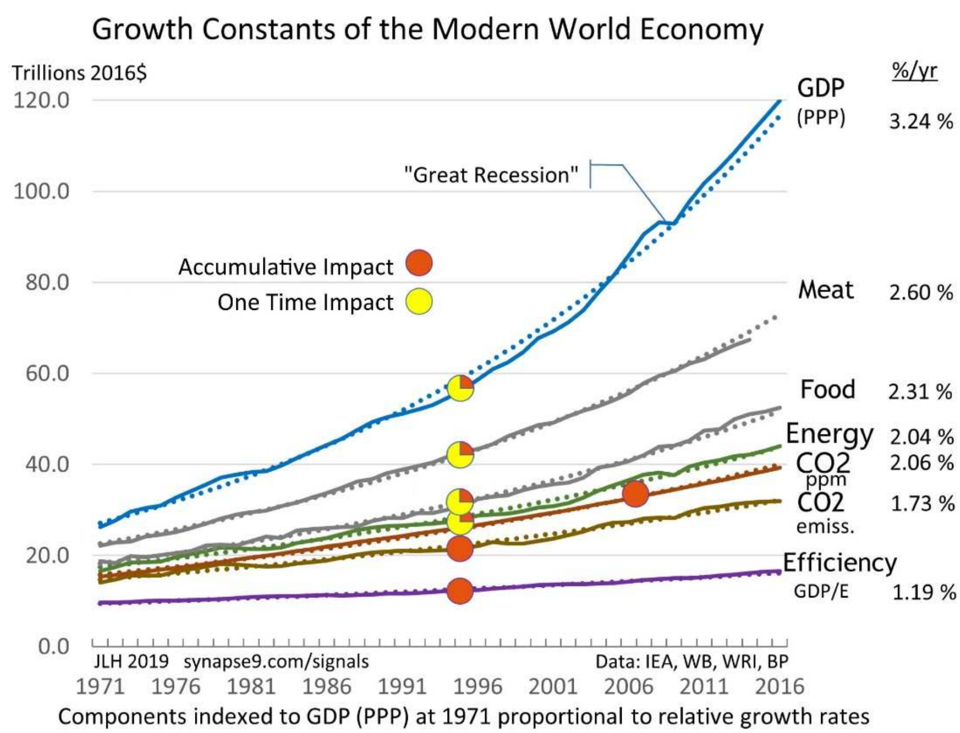

Fig 14. (Figure 2 from the paper) A family components of world economic growth, most from 1971 to 2016, indexed to world GDP PPP in 1971 in proportion to the ratio of their average growth rates to GDP's

text

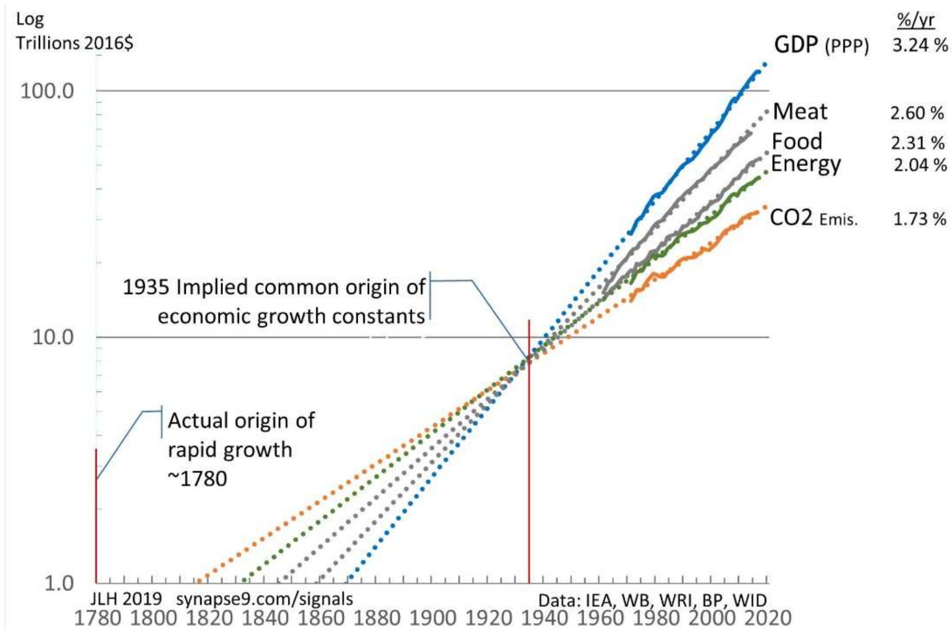

Fig 15. Log plot showing back projection of growth rates from Fig 14 intersecting in ~1935.

Figure 15 shows a very unusual mathematical test, using a log plot of the curves in Fig 14. Why five of the growth rate constants calculated for the 1971 to 2018 world economic components intersect at ~1935 seems to indicate two things. One is that these five growth constants are part of the same system, a system that virtually originated in ~1935. The second implication is that these five growth constants are accurate reflections of the homeostatic state of world economic system as it existed in the 1971 to 2018 period.

4 Roots in the Sciences

(Expanding on the section of the paper)

4.1 Important Influences

A number of scientists whose work helped lay the ground for the present study were not mentioned in the paper: Thomas Malthus (1809), W. Stanley Jevons (1877, 1885), Stephen A. Forbes (1887), John M Keynes (1935), Alan Turing (1952), James Miller (1973a, 1973b), Kuhn (1970), Walter Elsasser (1987), Joe Tainter (1988), Robert Rosen (1991, 1993), John Sterman (2001, 2002), Stephen J. Gould (2007), Stuart Kauffman (2008). Notes on their contributions are below.

This list notably overlooks the probably greater influence of scores of correspondents and extended conversations with friends on wide ranging subjects. One of those was Stan Salthe, the theoretical biologist and another was John Blackmore, a close friend and social scientist. Important online conversations occurred in Santa Fe Systems Research Institute discussion forum and in various systems thinking forums on Facebook and Usenet.

Thomas Malthus was not the first observer to notice the natural instability and the urgency of knowing where growth curves would climax. But he was the first to formalize a language of organic growth. That awareness of 'things erupting' seems essential for the success of any shepherd, farmer, cook, entrepreneur, leader, banker, or any parent too. However, Malthus did find a new way to connect the mechanics of unconstrained growth with the social trap of overpopulation. The problem persists too, but now more urgently for both boundless growing wealth. Malthus's observation that compound growth of any physical system is inherently self-limiting was incomplete, however. Compound growth is also the beginning of all stable systems too. In those cases, growth becomes self-limiting without causing chaos, pointing to what our world needs to learn about now. If one looks, one finds people remarkably skillful in responding to natural limits of all sorts and so needs to expand on that talent.

Stanley Jevons' famous so-called "paradox" that industrial efficiency most often increases rather than decreases industrial resource consumption (1885) illustrates how humans are confused by growth systems in another way. No one is hiding the fact that businesses use efficiency to help expand output and increase profits. Virtually worldwide, though, people have latched onto the hope that efficiency would also reduce resource use, even as the global data is remarkably clear that the opposite is happening[8]. That makes popular faith in using efficiency for solving economic problems misplaced. The increase in unit efficiency is what lowers the price and allows a business to multiply the units produced, its impact on the environment and income.

A less well known but equally important contribution of Jevons was his earlier work describing the scientific method (1887). His view was that the progress of science rests first on recognizing natural phenomena of interest to study, driving scientific progress by asking the right questions. That defines science as being nature-centered, relying on:

> "…a rare property of mind which consists in penetrating the disguise of variety and seizing the common elements of sameness [..] which furnishes the true

[8] Evidence of Decoupling Still Zero, Henshaw research notes: https://synapse9.com/signals/2018/06/18/evidence-decoupling-still-zero/

> measure of intellect.” (Jevons 1877, p5 The Powers of Mind concerned in the Creation of Science)

Jevons’ view rests the progress of science squarely on forming hypotheses that illuminate nature. That differs considerably from Popper’s (2002) general view, exemplified by modern physics, that the progress of science rests on the rigor of data analysis. Most working scientists would want to have both, of course, but there has been a split for a long time.

Stephen A Forbes (1887) was an early ecologist who wrote a remarkably clear paper called “The lake as a microcosm.” It was one of the sources of detailed description of ecological complexity that helped fill out the mental models of the way living systems form niches by searching out their surroundings.

John M Keynes (1935) is most famous for devising the current government role in stabilizing the unregulated free-market economy's constant boom and bust behavior. His least known contribution may be laying out how the economy could shed its instability more generally, in his chapter on “Sundry Observations on the Nature of Capital,” when forced by natural limits to end its continuous compounding of financial capital. Some further discussion of it will come near the end of the paper.

Alan Turing (1952) wrote a conceptual paper on biological morphogenesis suggesting emergent forms of organization developed by a growth process from stable states of organization, like from a calm before a storm, not from shocks or noise at instabilities. The novel organization was the operative instability. That image was helpful in forming the connection between the dynamics and organization of new lives.

James Miller (1973a 1973b) provided a credible model of the universal functions of parts of living systems. That was one of the seeds suggesting there could be a model of the universal dynamics of growth in living systems

Thomas Kuhn (1970) popularized the concept of science progressing by changing paradigms of belief systems, and scientists not able to change the ways of thinking they built their careers around. That dilemma is also presented by the Buddhist story on sectarian divides, “The blind men and the elephant,” (Henshaw 2018) and the Gestalt concept of “functional fixity,” that have been central to many discussions on what is wrong with human minds. Tracing the root of it led to the realization that mental concepts themselves are defined in our minds without environments, like equations, as artificial realities. We like them very much and easily become attached to them. That thought process led to the recognition that natural language is much the opposite, a rich source of contextual information one can mine by exploring the wide range of uses for words referring to natural experiencing.

Albert Bartlett (2004) was a physics professor at the University of Colorado, Boulder who became famous for his many stories of the impossibility of continual exponential growth, and one of the original inspirations for exploring the role of growth in nature, leading to the discovery that virtually every kind of event seems to begin with a growth process.

Walter Elsasser (1987) was a noted physicist who then studied biosystems, and Stuart Kauffman, a noted theoretical systems biologist. Both were suspicious of the random theory of evolution. Elsasser found that if there were only random variations, the chance of persistent order anywhere in the universe would be smaller than one chance is the estimated total number of particles in the universe. Kauffman (1993) struggled with the same problem; only he saw it as a need for evolution to have a way of restraining mutation. In either case, they concluded that the statistical laws of physics, however useful for engineering, could not have been how the complex designs of nature developed. The answer may be in plain sight. Life and nature are processes of accumulative change, with past developments the necessary foundation for following ones. The rings of a tree trunk are added one at a time, for example. Though other cases differ in design, all growth seems to follow the same general rule of building on the pattern before.

Joe Tainter (1988) made a tremendous impact with his view of "The collapse of complex societies", particularly for confirming my own early insight that the limits of growth were preceded by observable "diminishing returns." He associated that with observed increasing societal complexity, as the natural limit, rather than as a natural warning as a general natural systems view sees it.

Robert Rosen (1993) is a noted theoretical biologist who seems to have started his critique of the standard scientific model of nature by observing that natural change is open-ended and accumulative, unlike how science defines equations to have predetermined answers. That growth processes are also adaptive makes them seem opportunistic as well, further reducing the applicability of deterministic models. Modern complexity science has responded with accumulative and adaptive computer models; however, still using deterministic statistical rules. That has generated lots of applications for complex deterministic problems, robotics, and artificial intelligence without seeming to explain the emergent properties of natural system organization or to replicate them (Pines 2014).

Rosen may have made his most significant contribution by turning the light of biological reasoning on the process of science itself, depicting the accumulating adaptive design process by which science itself works (Fig 2). The figure shows science as a loop of knowledge formation and testing, a rising spiral if one likes. The systematic process we see in science today starts with observations of nature and “encoding” them in the formal language of science and studied for their implications. That is followed by “decoding” the implications to test their application in nature, to see if natural causation matches, then using those observations to repeat the cycle.

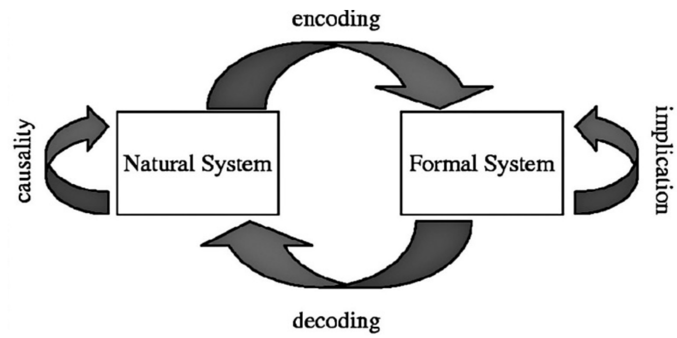

Fig 16. Robert Rosen’s Heuristic Model of Scientific Learning: A cycle of first *observing causality* in nature for *encoding* into the scientific language of *implications,* to be used for *decoding* into test applications, and repeated with further *observation and testing.*

Similar alternating cycles of exploratory adaptation are central to most human endeavors. Almost all work involves an alternating cycle of progress and evaluation, taken from start to finish. A standard model for it calls the process “action research” (Henshaw 2018). One can observe the same general kind of exploratory adaptation in animal behavior of all kinds as repeated exploration and adaptation. Animals are not applying human values, of course, but do display similar opportunistic exploration that gives the impression of intelligence and results in accumulative learning (Henshaw 2008). The same pattern seems evident in economic cycles, as alternating periods dominated by one paradigm of production followed by a period of retooling to create the next paradigm, organically changing the direction of history. So, taking some care, of course, it seems one can use the Rosen model as a general guide to the exploratory learning process of natural growth systems of all kinds too.

Interest in this kind of granular detail of natural systems may have been on the minds of scientific thinkers for a long time, of course, but limited by the scientific vocabulary of determinism. The occasional poetry and wisdom of many scientists suggest it. To curious observers, it would also seem hard not to be struck by how coordinated the interactions of most natural systems seem to be.

John Sterman (2001, 2002) was leader in creating advanced systems dynamics models, following Jay Forrester. However, that presents equations for the complex systems of nature. Sterman was notable for also diagnosing the failure of models to reflect the natural world, writing on "All models are wrong." Expanding on that view contributed to the discovery of how to construct dynamics that more accurately reflected the continuities of natural dynamics.

Steven J. Gould (2007) wrote extensively on the beauty of life and the mysterious fact that the evolution of new species most often goes in spurts, called "punctuated equilibrium." That partly inspired the work on the punctuated evolution of the G. tumida plankton species that proceeded by a complex growth process (Henshaw 2007). Why that evidence of rapid organizational change in species did not seem to disturb the paradigm of random variation and selection is something of a mystery.

Stuart Kauffman (1993, 1995, 2008) extended mathematical complexity to evolution theory as a theoretical biologist, expanding on the ideas of emerging order at the "edge of chaos." That is somewhat the opposite of what Turing explored, emerging by growth at the heart of order. Kauffman's writing was influential, though, as offering another general systems theory exploring some of the same questions.

4.2 Individuals in Environments

A Chinese child might ask its mother, "How did I grow?" which is an entirely different procedure from making. When you watch something growing, it works from the inside to the outside... And it happens all over itself at once. −Alan Watts (2011)

One of the most troublesome words for the study of natural systems is the word "is," the equivalent of an "=" sign often used to tie something in nature to a concept. It is hard to use it without fooling oneself about the great inequality of things and concepts if we don't notice that substitution happening. As concrete things are defined by their growth, independent of our noticing it, organisms, cultures, ecologies, businesses, and economies all exist as individuals and seem properly called living systems. Energy systems like storms and lightning are certainly lively but not properly said to be alive; though looked at closely are found to have lives of their own, developing and maturing by growth and subsiding by decay, so understood here as uniquely "individual systems."

The curious thing about the quote from Alan Watts is the way it is also very Western. Making things is often a holistic growth process that starts in the mind of the maker with little more than a motivating idea to make something that then evolves in the mind's environment, not the mechanical process Watts suggests. A simple example is making lunch. It starts from some inspiration to proceed and taking out various ingredients to see what will go together. As the main work is done, adjustments are then made for the occasion, and finishing touches are added to complete the creation to be enjoyed. That growing and climaxing assembly process going back and forth between steps in the work and the mind, conceived of in the process as a finished whole; very Chinese, you might say.

That holistic design growth process was first noticed in architectural design. Building designs go through all the main starting and finishing stages of growth that living systems do, particularly the big step in the middle, when immature designs start to mature, shifting from expanding on the starting idea to fitting in with the world they are being made for. You could see it as just three stages, first "dreaming things up" then "fitting them in" and "having a life." Successful growth follows the startup direction of development with a mid-course change in development toward fitting in the future environment and then the life to be lived.

The start of growth is usually too small to observe, a tiny organizational development in a highly protected environment. For human development, fertilization and the rapid growth turning one cell to a trillion all occur in the womb. After a child's birth, its growth slows to span 18 to 20 years of maturing physically and preparing for adult life. Similar growth stages are followed by a new seed sprout, simple business startup, or new personal relationship. After a period of rapid growth to define the unique individual's basic patterns, there is a *turn forward* that slows growth for maturing and becoming fully ready for their new environment.

If one thinks of those earliest moments when fledgling organisms, relationships, and organizations, are first exposed to new environments, is often a time of real danger. If survived, it is a long series of increasing challenges testing their readiness to fully participate in life, too. Generally, physical growth first proceeds at a rapid pace, and maturation slows to a crawl, leaving plenty of time for adjusting to a complex world. That usual automatic and natural turn following rapid growth toward maturing is what our world economy seems unable to do, however, and in trouble for. It is something we do need to learn to at least yield to, though, in the interest of both nature and all humanity.

4.3 Cohesive and Distressed Wholes

The individuality of such widely varying systems is having developed from a common seed or nucleus and maintaining a cohesion of the parts bound in a growing whole. That might only be surmised from direct observation of behaviors connected with an environmental niche, not possible to observe as growth. An occasional home is still a home, though.

The organization of environmental systems is mostly of intermittent connections and locations, in any case, making it harder to identify. You might think seeing a nod to a friend signals their connection to a social group, though it might signify separation too. Does a wandering wolf signal the range of a pack? Well, probably, but one needs more experiential data to say so. In any case, what is in our minds is indeed what binds some environmental systems, but we may be quite unaware of others.

Individual systems with intermittent connections may still have a continuous influence on each other through shared environments, though, through having lasting impacts. Recognizing such local or widespread environmental effects is one of the more sensitive observations one can make and may also be why people say, “everything is connected." It is really that lots of both separations and connections are hard to notice, though. One case we can see clearly is how large systems like the world economy, pressing hard on its natural limits, is spreading escalating stress on all its parts. However, disconnected the parts seem, like the home from the office or Northern and Southern communities, local cultures will be exposed to global strains. Of course, the economy also demands everyone achieve ever greater performance, pushing people ever harder against their own limits and nature’s, spreading both struggles throughout the system. What was invigorating becomes exhausting as it develops, degrading cultures, environments, and the economy’s capital resources, too, at compound growth rates. Knowing that is not how people want to live, frustration with it should be focused on relieving the financial system's habits ratcheting up the pressure, not on each other.

This global economic crisis caused by excessive growth in extracting wealth from the earth and humanity is formally called a *tragedy of the commons* (Hardin 1968). It is not caused by investment per se, but by investment allowed to increase to destructive extremes, destroying the natural capital being invested in, in the world economy’s case. That is done by adding profits to investments so both investments and profits multiply exponentially, called compounding. As it approaches the limit, it still showers investors with money as it destroys the basis of value. Hardin's classic case is of a community's cows overgrazing their shared meadow, causing the cows to starve and turn neighbors into enemies. The tragedy is quite confusing, feeling like losing a human birthright, the loss of the earth as a trusted and forgiving partner today. All suffer the disaster, the people causing it mostly blind to it until it is too late. It would not be happening to us if we did not almost all tacitly support the source of our riches…

5 How to turn

5.1 The World Tragedy of the Commons

Humanity seems to face a growing array of all too real dilemmas. Disastrous climate change is only one of many catching us by such surprise, and don't know quite what to do about. Even though all our crises clearly seem coupled to excessive economic growth the world economy continues to maximize profits for accumulating financial wealth without making any account of the costs of increasingly destabilizing the earth. That presents a classic global case of Hardin's Tragedy of the Commons (1968), of multiplying investments destroying capital. The general thesis here is that throughout nature the purpose of growth is for beginning new lives; compound growth only the first phase of viable development. So we should yield to environmental pressures steering us onto a safer path, listen to nature. The second phase of successful natural growth is always maturation, perfecting the immature designs that growth creates. So, we should learn from our many experiences of guiding new lives to maturity, and use our experience in bringing new things to life to facilitate the maturation of humanity.

Keeping in mind the big picture helps say on track in wrestling with the details. It is not small, but one of the details is our multiplying languages, dividing the world into multiple realities, generating threatening levels of cross-cultural conflict, like the wealth of the earth leaving trails of desperate poverty, or labor interests creating jobs that eliminate work. The earth is becoming very unforgiving, too, as we continue to accelerate the processes that are causing our loss of freedoms on all sides. With time we could get the forgiving earth back, but it would mean reducing our pressure for ever increasing performance from the earth and from each other. The key seems to be to retain a creative economy as our model, so things improve all the time on a steady course.

How mankind built the trap we are in is one of the questions to ask, apparently by much of humanity mentally appropriating the environments and planet they live in, so we dismissed the damage we did not directly see. We would need to culturally decolonize the earth to cure that, with great inspiration and forgiveness, as well as making sure we are on a practical road forward. Here we will focus on making the systems of nature we have taken for granted more visible, learning a natural systems method for recognizing growth patterns that indicate where nature is forming new lives.

5.2 Discussion of strategy

Given the long-studied boom and bust cycles of growth driven eco-economies (Tainter 1988, Diamond 2005, Odum 2001,2007) there is something wrong with humanity’s learning. It appears we are on a fatalistic course of “try, try again” as discussed in Case Study III, suggesting the blind efforts to achieve the impossible do sometimes resolve with substantial gains, and not always trigger collapse as in Fig 3. Of course, you might point out that there are tremendous differences between an oceanic plankton eco-economy and the global eco-economy of human civilization. That the same behavior appears in systems so many worlds apart does indeed call for being careful in making the comparison. That there are also familiar cases of start-up businesses and personal relationships eventually resolving in success after repeated unbalanced growth attempts suggests the pattern is more universal than anecdotal, though. In fact, we also quite endlessly need to take care not to push new efforts or relationships too far or too fast. So, for curing the world eco-economy of that misguided habit might not be so impossible at all, more a matter of raising consciousness.

(Keynes 1935) Ch 16-IV savings would still accumulate.

In ecological terms the question in then how humans started as a K-selected species (surviving on efficiency, developing skills of a top predator with small population) and then became an r-selected species (surviving on productivity, maximizing population as a prey species to survive) (Pianka 1970, Livingston 1995). Humans, on the other hand, have evolved to do both use their skills to multiply their productivity and efficiency, tuned for maximum rates of growth, producing ever more disruptive change for both human societies and the niches of the natural world.

Again, in ecological terms, it appears we need to use our genius to go back to being a K-selected sustainable species, using our genius to stop being overrun by our own productivity. In nature r-type species, that maximize their population growth, serve as prey populating the bottom of the global food chains, their productivity supporting the rest of the food chain. K-type species consist of expert predators that minimize the time they need to spend feeding and maximize their time engaged in other things. Are we at a point where we open a discussion of which way we’d want to go, to turn forward or not? We clearly seem to have the genius to do it, but are we responsible enough to treat it in a practical rather than a political way? That “turn forward” in our cultural norms seems to have to come first.

These kinds of observations are part of an exploratory method of identifying patterns and testing them on the way to build up to informative narratives and testable hypotheses. Having to do with development processes and their continuities the search goes back and forth between identifying continuities that seem to tell a story and then checking the departures, to see if they are “exceptions that help prove the rule” rather than “exceptions that invalidate the rule.” That makes it unavoidable to carefully study each “bump on the curves” to extract the useful information about the organizational transformations reflected.

The question, of course, is also how adaptive humans can be, and how to make soft decisions that leave room for real progress and adaptive design. We have centuries of habits to re-explore and change. We indeed do have a long-standing growth maximizing eco-economy. It is not clear that it could discover that it is also an ecology too. It is only theoretical at this point that its common interests in limiting the growing pains from the growing demands on all its parts.

Nature makes the task look simple. At the very steepest part of the growth curve is the time change from ever upward to ever forward acceleration. There would need to be innovation in science combined with societal pressure on both governments and wealth holders to set new rules stabilizing the eco-economy and making good on the world we started building. There are lots of real questions that need to be answered in time, most importantly, how to know when to do it, to know “when to turn.”

That so many kinds of systems can change from fluidly maximizing their growing power to fluidly stabilizing their designs indicates that the phenomenon can either be part of the original design, or not, and can be brought about intentionally or not. It suggests there is sure to be a smooth way to transition from growth capitalism to climax capitalism, too, if we could tell when to turn and how to let it happen. There is also little doubt that if we could make that turn before the global growth economy becomes even more unstable and overshoots our ability to manage it, the future would be far more profitable. It is something we would have to do intentionally, however. So, for a large community of people to understand the process, they would need to study some of the familiar transitions.

There would be many ways to manage the limits on finance. For a simple example there might be an increase in capital gains taxes to help persuade wealthy investors to use their profits for non-profit public interest purposes, such as the SDGs. Having a wealth tax limited to the retention of unearned income is another way. It is how the accumulation of profits multiplies without limit that most directly drives the growth imperative and extremes of financial inequality. Since any solution would need to start locally and apply globally, it would be critical for it to seem practical and, on balance, profitable for all sectors, and to make the eco-economy purpose-driven, distributive, and regenerative on the whole. The resulting stable eco-economy and its pool of investment funds would then provide successive generations of creative inventors and entrepreneurs the resources needed to remake the economy again and again, for a thousand-million years or more, of living well while continually reinventing itself.

It appears that businesses and investors are not yet obligated to act in the public interest, only to act as financial fiduciaries to their shareholders or clients. According to Lynn Stout[9] they can make any decision about what to invest in and whether to reinvest profits to maximize investment growth and concentration of financial power without limit, if they have a "good business reason" for it, such as maximizing profit. It is also a common practice for "good business reasons" to include ignoring long term societal costs. That also appears to include creating risks to the financial system, the interests of others, or of the whole economy. Global warming is as clear an example as one could want that forms of suicidal behavior are OK if they are profitable in the short term.

5.3 Challenging Situations

Family and Individuals: Many individual and family financial choices are hidden from view. The most hidden it perhaps the most obvious, how one chooses to live one's life. There are also hidden choices people make about their savings. More people with substantial assets have been spending on targeted societal needs in recent times, but they usually still grow their unearned incomes by reinvesting financial profits. Those hidden choices have lasting impacts, as much or more than their roles in family, work, and society. It is good to save and have reserves, of course, but perhaps not to save more in unearned financial income than earned income from labor. Also hidden is how little direct environmental impact individual consumer choices have. Research shows that the environmental impacts of individual spending depend much more on our total income than on what we buy (Henshaw 2011), so what helps make one's life meaningful is quite likely to be the most rewarding as well as the most impactful choice.

Government and Non-Profit Sectors: The role of each level of government in steering society includes conveying a vision to inspire constituents and delivering essential services; including courts, defending voter, civil and legal rights, maintaining infrastructure, public services of all kinds, protecting the environment, regulating business and finance, supporting scientific research, providing for the common defense, and national and international relations. Non-Profits, like service organizations and schools of all kinds, guide society with their more specialized societal inspirations and services. Both help enable the living-economy's ability to make good collective

[9] NY Times Apr 16 2015 "Corporations Don't Have to Maximize Profits" Lynn Stout, distinguished professor of corporate and business law at Cornell Law School, author of "The Shareholder Value Myth: How Putting Shareholders First Harms Investors, Corporations, and the Public." https://www.nytimes.com/roomfordebate/2015/04/16/what-are-corporations-obligations-to-shareholders/corporations-dont-have-to-maximize-profits

choices. Given the increasing global risks the world faces, perhaps the most critical role for government and non-profits is advancing a genuinely sustainable “new normal.” Change is always difficult, but that does not make it safe to forge ahead with our consumptive and disruptive habits of old, repeating Hardin’s Tragedy of the Commons (1968).

Business and Development: The most direct way business and development determine the living-economy’s future is by investing in new business and infrastructure, physically building its new directions. Product development and advertising can either support or redirect new societal development choices too, often creating needs where none exists, such as to make consumption more glamorous. Where it becomes unethical is when growth-driven businesses pollute or disrupt society and the environment, maximizing growing paper profits and ignoring growing material side effects. Lots of small businesses limit their growth to just optimizing their services, to become anchors of their neighborhoods and communities. They only need to grow to a point they can pay off their debts and then devote their profits to family and community.

Finance, and Investing: The primary steering role of finance is moving money to wherever it can reliably make the most profit or serve other needs of investors. That shifts financial support from less to more desired uses. At a healthy level, it produces continuous healthy turnover in the economy. If the profits produced are regularly reinvested, that “compounding” of profits drives system-wide compound growth and ever-faster increasing and so disruptive turnover. That start-up kind of growth is essential in a new living-economy’s early stages. It becomes self-destructive if carried too far, destabilizing society or its environment.

Because whatever grows the fastest in a living-economy naturally takes over, that rewards those investing their profits in whatever is growing fastest, giving the greatest reward to people hoarding their wealth and ignoring the side-effects. In a maturing living-economy, facing complications of growing environmental resistance to growth, compounding adds to its conflicts with ever more 1) stimulus, 2) competitive pressure and struggle, 3) disruptive turnover, 4) financial and social inequities, 5) concentrations of wealth, 6) and deteriorating societal and environmental conditions, all the worst effects of capitalism in crisis. What gets overlooked is that investors might also choose, or be persuaded, to invest in their own and the common interest, distributing wealth when that is what allows the whole living-economy to thrive, rather than foolishly trying to extract it all (Keynes 1935 Ch16-III).

There are quite numerous alternative economic proposals for how the world economy can achieve a thriving steady-state. The ones that seem most compatible with the natural systems view voiced here seem to be Kate Raworth’s “Doughnut Economics” (2017) and Bill Baue and Ralph Thrum’s 'r3.0'[10]. Both models propose a transformation to a living-economy of sufficiency that is equitable and distributive while respecting the whole spectrum of now threatened planetary boundaries. What we propose here differs strategically, focusing on the steering role, and natural fiduciary duty, of business and financial investment decision-makers, as they make decisions about everyone's future. It seems they are both the people most responsible and in the best position to assess good lasting value as we all move on from just maximizing our shares. Financial decision-makers are also the ones most caught in the trap of perpetual self-inflation and may need a little firm persuasion to try something new. That is, of course, only one sector of the natural steering of the world living-economy. The roles of all the parts are critical for achieving a soft climax for our growth-driven world living-economy. Perhaps it is reasonable to hope we could all rise to the occasion, and the result would retain much of the prior living-economy's creativity and profitability while leaving behind its dependence on its ever-growing disruption of the earth and piling up unearned income.

6 The Key Domains of Growth – *egg, nest, world*

6.1 Growth events: *germ*, *turn-forward*, *release*

Whether called the *germ, nucleus,* or *seed* that starts a new life in a receptive environment, it is hardly ever seen except by implication. It is generally too brief and small and hidden in a deeply sheltered place where it can develop undisturbed. Interfering with that to watch it happen is likely to prevent it from happening. Examples are an egg quietly accepting the entry of an individual sperm or waking up in the morning to a fresh insight after days of mulling over some set of issues. In business, it is the napkin sketch or handshake at dinner that, in retrospect, cements a partnership, or in relationships, the glance that catches someone's eye later recalled as what led to big things. After that fortuitous start, early development occurs in the protected *egg* environment, broken for the *launch* of the new life in its *nest* environment. That is also the moment of *birth* for an animal, a time of self-recognition, also when a new personal relationship starts to mature. The point of *release* is when both the new life and its relationships with its *world* are mature enough to be gain independence.

[10] https://www.r3-0.org/about-us/ r3.0 promotes Redesign for Resilience and Regeneration. As a global common good not-for-profit platform, crowdsourcing recommendations for transformations across diverse fields and sectors.

6.2 Growth periods: Takeoff, Fitting In, Life

The *takeoff* period is the burst of initially immature development during which the parts of the new life *differentiate* and organize. As the *takeoff* matures, the pards define their relationships, becoming the whole *individual* that *arrives* in the *nest*. That *launch* also marks the critical *turn* in growth toward *fitting in* with the new relationships with the *world* ahead. That coincides with the inflection point when development shifts from increasing steps of departing from the past (*divergent)* to decreasing steps toward the future (*convergent).* In effect, or in reality, that is also when a system expresses a *will to live,* often seeming to voluntarily let go of its past to assertively turn forward to its future. That may sometimes be in gentle or sharp anticipation of running out of room for continuing the *take-off.* The turn to *fitting in* can also be in anticipation of perfecting the internal and external relationships that give the new life its identity as a whole, or to resolve variations in the search for an identity. Complications aside, when the new life finds its identity and way of fitting in the world it is then graduates and is released to begin the growth of its independent relationships in the world that become its active *life*.

6.3 Notes on the Key Milestones

The usual learning journey of people goes through many levels of growth and graduations during school, passing tests each year as they mature physically, socially, emotionally, getting ready to set out on their own. The last turning point is the moment of *release* at the end of physical maturation when it leaves the *nest* with its essential preparation for independence in the world. For people, of course, that means “starting a new life” of growth and learning, forming new relationships, and taking on ever-changing roles in life. This also applies to the phases of work projects as well as life projects. The time of release for designing a new building, for example, is when the drawings go out to bid, after which it goes to the contractor to start construction. Then when the building is finished it has been taken through its growth phases to start the life it was built for, as a place for the gathering of people with common purposes. The same kind of graduation to growth on a larger scale occurs when a finished manuscript goes to the publisher. That begins the growth of its readership.

Another issue for growth is whether the essence of the beginning, it is first promise, is realized in its end. That is often a matter repeated experiment and adjustment, such as for fostering a new person’s character development and fulfilling their passions. It is also very much a concern when designing a building, the aim of expressing the building’s true original intent and concept, treated as if revealing a genuine personality to be honored. A life of any kind can easily go off track, too, wandering away from its initial character and promise for either internal or external causes. Getting “back on track” usually seems to require retracing the original character to guide the turns going ahead, sometimes just withdrawing to let the interruptions fade, and various other marks of the “hero’s journey.”

Staying “on track” in following one’s true purpose calls for a sensitive and open inquiry into how one’s life path is developing, as it is fundamentally a creative process, a vehicle for change. That lets one ask at any point: “Is this the right way?” Narrowly interpreting the original intent can be misleading, too, of course. One needs to sort through one’s choices to sort through risks to take or pass up. So, one both wants to feel and be free while also having confidence in taking steps that cannot be reversed. So repeated holistic assessment is needed, repeated progress on multiple tracks and assessment, to choose new directions. One can examine any new venture using the *egg, nest*, and *world* progression.

To practice interpreting growth by the *egg, nest*, and *world* model, start by studying familiar changes or ones that seem most intriguing. Then look for their interior and exterior, identifying the self-contained development of the internal organization and how it connects with its niche of external relationships. The internal/external union comes together differently as the development moves from one environment to the next. In each one it forms a different kind of environmental niche in each.

One might think of any growth process as a story of a journey, and mentally or physically draw the dynamic arc of its development, labeled with the influential events or shifts in direction. This way of diagramming the continuity of a development process is a bit like how one often talks with friends after a big party. Everyone wanting to know how it started, what happened and how it ended. Diagramming only treats the party as a growth process to study. The same can be done for an office or neighborhood organizing event, drawing the curve, picking out points, creativity or change of direction, success or disappointment. Another good subject would be discussing how a child overcomes their hurdles growing up. The same insights into child learning might apply to a business or a world economy struggling to find its way because growth at any scale goes through the same significant transitions.

More formally, an office project can be discussed as a narrative journey of *egg*, *nest,* and *world* phases, to help see the creative learning process as building a whole. The germinal stage, the starting team: its work of taking the concept to maturity, then expanding to use the full resources of the office, then taper off for shepherding the result after delivery. Just as individual new lives, projects of all sorts have variations on the same six-stage organizational building process, with each stage needing to work as the foundation for the next. The same general model can be further developed for almost any professional practice too. Work is inevitably a growth system embedded in environments and worth having a practice of self-reflection for insight. Every profession has its own methods of organizing their work and fitting the *egg*, *nest,* and *world* model to those could give them clarity and flexibility. Study of related project design methods, "action research," and Alexander's architectural "Pattern Language" is in (Alexander 1979; Alexander et al. 1977; Henshaw 2015, 2018). In a nutshell, "design patterns" are roughly the seed patterns of adaptable trade craft, such as architecture, software, welding, performance, stage craft, etc. formed by coupling matched tried-and-true design elements in search of innovative structure for unifying environmental *forces.*

6.4 General indicators of growing eco-economy distress

The following signs of systemic distress and of approaching failure were the basis for the experimental table of "The Top 100 Disruptive World Crises Growing with Growth[11]" The intent is to be informative and to serve as a general kind of checklist of reasons to bring growth to a natural climax. As one user said: "I find what you have put in as a good crib sheet to review as we work through the chapters [of their report] but also at the end to relook to see if we have missed anything that we should include.] Additions would be quite welcome.

Table 1. Eight signs of vulnerability

1) Crowding, Overload, Congestion, Imbalance, Unmanageability
2) Misunderstanding, Information Overload, Misread & Changing Signals
3) Increasing Solution Failures
4) Economic And Social Disruption
5) Environmental Disruption
6) Human Resource Depletion And Degradation
7) Natural Resource Depletion And Degradation
8) Rising Societal Overhead costs

Table 2. Twelve Signs of Approaching Systemic Boundaries of Strain and Failure

1. **Growth:** Is itself an accelerating systemic instability, harmless or highly creative if its development brought to a conclusion in time, but often ignored until too late.
2. **Increased Rigidity:** Pressing limits of response; The balloon only pops after its surface stretches to the point of rigidity

[11] https://www.synapse9.com/_r3ref/100CrisesTable.pdf

3. **Strains and deformities:** Destructive wearing; Distributed threats; Divergent growth rates a sign of growing strains; Scattered spots of new intrusions, chattering or shuddering
4. **Loss of resilience:** Slower or recovery time; Loss of cushions, tolerance, generosity
5. **Sacrificing standards:** Living on debt, ignoring infrastructure, pressed into making mud bricks without straw, the appearance of demigods in place of politicians
6. **Abnormal interruptions:** Increasing downtime, people finding they have multiplying responsibilities
7. **Abnormal behavior:** Mice jumping ship and birds going silent; declining responsiveness; shakes or unfamiliar tremors. Divided interests in times of crisis needing common effort.
8. **Silence as a messenger:** When the canary in the mine dies. Silent Spring, when there are no more birds or insects, silent and vanishing without warning.
9. **Unusual silence:** Nature 'abhors a vacuum' and emerging systems initially need an orderly calm to develop. Like kids getting into mischief may be signaled by an unexpected calm, or the calms before a local storm.
10. **Increasing overhead costs:** Approaching systemic bankruptcy, rising resource costs and diminishing returns EROI, rising environmental costs, societal budget inflation
11. **Growing systemic conflict:** waves of crises of all kinds, a systemic "plague of plagues" like the whole world coming unglued.
12. **Top 100 Disruptive World Crises**: Experimental list of research topics (Henshaw 2020), categorizing the disruptive anthropic pressures on nature and society growing with growth.

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