An Ecological Economics of Growth:
Learning from nature when to turn

Supplemental Topics - Draft

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General Questions About Growth

Growth is a lively process, seeming to be both responsive and opportunistic, found in every lively thing throughout nature, as well as in every kind of work people do. That is an 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 (ibid.). It seems to be the continuity of those adjustments that corresponds to the organization-building process of growth, generally in plain sight, but often hidden from human eyes for 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 then narrowing down to when the story's mature life begins.

Like most strategies and histories, early growth is immature in design, and gains strength and resolves challenges step by step as it confronts new environments and matures. One of the main findings of this study is that looked at carefully; the three phases of growth are really six, three longer periods each begun with a short change-in-kind and new direction.

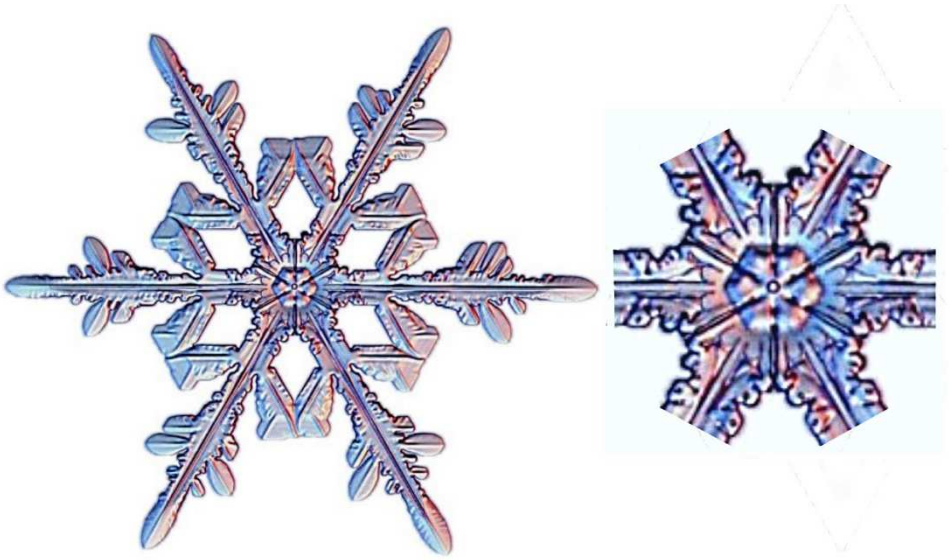
Perhaps the most useful viewpoint is of growth as a continuity of organizational stages, like a series of milestones along an "S" curve assembly line, first stage rough design, second stage refined design, third stage

the systems service life. That makes it somewhat like the stages the Panarchy model (Holling & Gunderson 2002) but observed as going from start to finish as a one-way process of organization, not in an endless loop. We can also observe that the six-stage model of growth as a process of emerging organization 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, and "cause and effect" more corresponds to its external limitations.

Another remarkable feature of growth is its usual climax at a state approaching perfection in every part. That applies to the growth of animals, but also businesses, communities, relationships, and snowflakes. It also applies to the design of houses and garments and most any other work people do. That addition of perfecting detail as the second phase comes from infilling the frameworks of design established in the first phase, a period of positive then negative feedback, as the design first diverges in kind, then converges on a finished end, to then live out its mature life. What prompts growth to begin may be very different in each case. However, the general pattern is so common that it serves as a very useful model for comparison to any individual case. We can most closely study it in the most familiar processes of creative system-building, like examining the steps of making a successful dinner, getting an office project to work, or developing a new personal relationship or community negotiation.

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 organisma 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, it is the limited fee he will get that assures he will perfect the work in time. Both the builder and client will work like "the genes" of the building process, making sure all the needed parts fit together. For the office project, that change tends to come with a degree of team panic as the need to finish what they started becomes clear. Another clue to what is happening is that explanations for these 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. Clearly, something happens, but it seems hard to explain using ideas of cause and effect, growth seeming to behave as an organized whole.



Snowflake details Central kernel

Fig 1. 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.

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 1) 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.

Key Observations

1) Growth as a non-linear accelerating and then decelerating building process,
   a. nature's primary way of building organized systems individually
   b. a rising then falling momentum of things falling together,
   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 4)
   b. as the lively succession of six main stages
   c. Seed, Start-Up, Turn-Forward, Finish-Up, Arrival, Life
   d. Nucleation, Individuation, Pivot, Maturation, Fulfillment
   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 then smaller adaptive layers,
i. sometimes flowing smoothly, sometimes by exploratory learning processes

3) Growth systems also recognized by their,
   a. individual organization found within boundaries between internal and external relationships,
   b. various growth trajectories (Fig 3), growth to exhaustion, disruption, or resilience.
4) Case studies highlighting
   a. how to fit the model of the six stages of growth 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 surpluses or spread globally by shortage.
   b. Main Centers of productivity: cultural and societal, people and technology in organizations as the basic units, 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, and diminishing whole system returns.
   d. Alternative sustainability models, for individual organizations
   e. 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. a 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.

How to turn

- Edit in process below -

Given the long studied boom and bust cycles of growth driven eco-economies (Tainter 1988, Diamond 2005, Odum 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[1] 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, as long as 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 eco-

[1] 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

economy as a whole. 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.

Appendix

I - Alternate terms for the phases and turning points of natural growth

Table 1. Organizational shifts (1, 3, 5) to begin growth periods

1	3	5
Seed	Turn Forward	Arrival
Awaken	Inflection	Completion
Germ	Transformation	Release
Innovation	Purpose	Delivery
Outbreak	Reaction	Finishing touch
Bloom	Fertilization	Fruit
Nucleation	Transformation	Integration
Fertilization	Birth	Freedom

Table 2. Names for minimal growth periods (2, 4, 6) and origins for successful growth

0	2	4	6
Environment	Start-up	Finish-up	Fulfillment
Context	Takeoff	Landing	Service
Climate	Gestation	Maturation	Life
Situation Etc.	Sprout	Youth	Adult
	Feedback	Feedforward	Homeostasis
	Develop	Refine	Deliver
	Elaboration	Integration	Maturity
	Individuation	Actualization	Performance

II 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[2]" 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.

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

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
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.

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

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 (Henashaw 2020), categorizing the disruptive anthropic pressures on nature and society growing with growth.