Understanding Nature's Purpose in Starting all New Lives with Compound Growth
-
New Science for Individual Systems

For ISSS theme – Future Society

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Abstract

We often associate compound growth with the Anthropocene and our overwhelming economic impacts on the Earth. Today our actual choices for future society appear to lie more with why nature uses compound growth to begin *individual new lives* – natural complex adaptive systems (NCAS). For future society to follow nature's plan for success, we need to study and prepare for it. We propose studies of the milestones for new lives as an introduction. It teaches a natural systems science for understanding new lives of all kinds: plants, animals, ecosystems, weather systems, civilizations, economies, communities, businesses, cultures, societies, social groups, personal relationships, work habits, home, office, and artistic projects, etc.

A general study of new lives also exposes how much we already know about participating in, creating, avoiding, guiding, and admiring them. The biggest discovery, and heart of the discussion, is how human methods of creating and guiding new lives seem learned from nature. Both display the same milestones of developmental challenges. Learning to recognize the milestones of new lives in familiar cases is easiest at first. Insights gained from one case will then often apply to many others. For the Anthropocene, the pattern suggests how nature's design for starting new lives can relieve our fixation on growth and guide future society to a thriving, sustainable climax, reversing our threatening global tragedy of the commons. As facts of nature, hidden in plain sight, perhaps they can rise through the dark clouds of contentious argument preventing the world from acting.

The pattern of milestones for new lives includes 3 critical events initiating 3 feedback periods and related organizational stages, occurring in 3 development environments, *egg*, *nest*, & *world*, and also referred to as *natural growth*. Studying those milestones informed by our own life experiences teaches guiding questions about new lives and their internal and external relationships. The model is so broad partly due to being built on the first principle of thermodynamics, the conservation of energy. It implies that for self-organizing change to develop requires continuity in energy processes, the ubiquitous "S" curve being the simplest form.

The critical middle event is often the greatest test when the immature new life leaves its protected egg environment and enters its exposed nest environment as it exhausts its starting resource! Then it must radically adapt, discovering internal resources for using new external resources and prepare for its future. That turn-forward marks a major change in development feedback, too, from extending past patterns to homing in on future patterns. For a future society to do it would take more than a technical change, of course. It would seem to require a *well-informed planetary sense of community*, *a* general recognition of nature's design for new lives, and a willingness to take the risk. Our seeming universal interest in the success of new lives could help with the ongoing formation of a common language.

<u>Electronic supplementary material</u>

Supplementary topics: http://synapse9.com/ISSS-21/NewSci-IndividSys-supl.pdf (draft)

Figures Talk Slide set: [http://synapse9.com/ ISSS-21/NewSci-IndividSys-talk.pdf](http://synapse9.com/ISSS-21/NewSci-IndividSys-talk.pdf) (draft)

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1 Introduction

"We know when something tries to grow forever within a healthy living system; it is a threat to the health of the whole. So why would we imagine that our economy would be the one system that can buck this trend?" — Kate Raworth (2004) TED Talk

We offer a scientific study of how natural growth develops self-organized little worlds with lives of their own, *new lives*. To be inclusive, the term used is *individual new lives*. It refers to a broad category of natural complex adaptive systems (NCAS) related to Miller's (1973a, 1973b) and Varela, Maturana, and Uribe's (1974) models of living systems. This study uses observable stages of organizational development and transformation as windows on the otherwise hidden internal worlds of growth systems and their environmental relations to form a general natural systems science. Examples of *new lives* include individual developing plants, animals, ecosystems, economies, communities, businesses, cultures, societies, social groups, individual relationships, and varied other processes of organizational development, projects, and all kinds of projects and tasks. There are also interesting but more primitive forms of new lives to consider, such as self-organizing individual thermal, electrical, and chemical systems, like tornados, lightning, and fire, among others.

We introduce methods of testable observation to support a diagnostic method of studying the growth of new lives and their contexts. We focus on the growth process as a whole, composed of 3 transformational events, 3 following development feedback periods, and organizational processes in 3 corresponding environments: *egg*, *nest*, & *world*. Figure 5 provides a graphic aid illustrating each stage building upon the last, pictured as milestones along an "S" curve assembly line of increasingly mature stages: a total of twelve milestones forms a complex hierarchy[1]:

egg {*germ, takeoff, individuation*} *nest {turn-forward, fitting in*, *maturation*}
world {*release, life, engagement*}.

The term needing more explanation is *turn-forward.* It is a more general neutral term for the event of *birth,* the often very challenging transition from compound growth in the self-contained *egg* environment to the first exposure to the wide world and the work of *maturation* in the more open *nest* environment. New lives are extremely immature at the end of the compound growth, *fully formed but quite undeveloped,* and need to find new resources or perish quickly. Depending on the context, other terms for the *turn-forward* to adapting to the world may be useful. *Turn-forward* is just the better general term. In architectural work, that same stage is called *conceptual design,* when the intentions are fully formed, but the work is still quite undeveloped. It also applies to mental concepts that may express a clear intent but remain undeveloped. People new to an organization or a profession may be called *novices* or *newbies*, referring to the same fully formed but quite undeveloped stage. Emerging plant *sprouts* or *seedlings* are fully formed but quite undeveloped too, organizationally advanced but highly immature as they get their first sheltered taste of the real world.

The reason for so carefully choosing terms is that the biggest discovery, and heart of the discussion, is how similar natural and human methods of creating new lives are. Both display the same developmental milestones. Thus, for example, home and office projects, large and small, start with some seed idea, a *germ* that first develops as a concept for doing things, going through a process of *individuation* in someone's mind. When the concept is fully formed and ready to develop, the focus *turns forward* to making specific plans and preparations, *maturing* the idea in its *nest* environment. Once ready, the plan is *released* into the world. That release may then be the *germ* of a second *egg*, *nest, world* process, on a larger scale.

At first, these new terms may feel a bit unfamiliar. Our normal work creating and guiding *new lives*, is non-verbal, and the milestones recognized intuitive. The new terms are for enabling discussion of what may often already be familiar. We raise children, organize and enjoy dining and travel events, develop careers, arrange home and office projects, guide businesses, participate in movements, learn new subjects, and build personal and professional relationships. We also try to steer our governments and the world. Each is an organizational effort likely to be better understood by studying the universal growth milestones. To start, first, identify something interesting from the lists above. Then see if you can identify the *enclosed egg* it started in, the *sheltered nest* it matured in, and the open *world* in which it was or will be *released*. After trying a few very familiar subjects, the terms should fall into place.

[1] Note that the terms for the twelve growth milestones are selected for generality. More specific terms may fit better in specific cases. There are also *new lives* that do not seem to fit the pattern, like new cells born by cell division.

The detailed growth model for *new lives* is in §3, and a further introduction to the general theory is in sections §4 and §5. The above brief sketch is enough introduction, though, to follow a "core pedagogy," starting in section §2 with a deep dive into how to relieve the world economy of its threatening fixation on endless compound growth. That fixation may be the principal barrier to our ability to respond to natural limits and thrive in the natural world. We use a simple model of the system's basic financial plumbing to illustrate the coupling of finance and commerce. Those represent two main kinds of financial circulation that are increasingly out of balance: the circular flow of money in commerce and the exponential concentration of money in finance. There are also signs of a natural turn-forward already beginning culturally but also blocked. Just seeing the problem does not offer an immediate fix, of course, as the current system is deeply engrained. It does permit wider study and comparison to how less troubled systems handle it, though.

The change needed in the world economy is like the natural change in many family businesses as they mature. Having put most of the profits into growing the business, they can switch to using the profits for family and community needs once it succeeds. That way of climaxing growth for a thriving system can be as very smooth. The world economy is also a family business, for a big family having achieved a big but very troubled success and threat to itself. Part of the problem is our not seeing humanity and nature as family to care for we become able. So, we have big family decisions to make and need a common language.

2 Steering for Home

2.1 The Economic Challenge

How misguided the growth of the world economy has become is clear from the growing number, variety, and scale of its impacts on the Earth and humanity, threatening our future (Bradshaw et al. 2020; Rees 2020; Steffen et al. 2015, 2016; Meadows et al. 1972, 2004). Institutional research reports on systemic risks[2],[3] display the same broad pattern, termed the Anthropocene's *great acceleration,*[4] of humanity's ever-escalating disruption of the Earth. An experimental list of the Top 100 World Crises[5] adds less studied systemic societal and economic threats caused by how growth forces people to reorganize how they live ever faster. Organizational dysfunction and failure are the ultimate limits to growth, sadly left out of other threat assessments. We might call that threat of excess acceleration of change *disruptive jerk,* referring to the mathematical name of exponential growth's 3rd derivative, also exponential. That produces such symptoms as systemic interference and congestion, growing cultural miscommunication, and disrupts efforts to cooperate. These threats are harder to measure than material impacts like $CO2$, of course. If unrestrained, they would equally catch us off guard and be as disruptive.

Several past civilizations have rapidly risen, as we have, but then collapsed, such as Rome (Tainter 1988; Diamond 2005; Lent 2017). Garett Hardin seems to have been the first person to identify the real reason civilizations sometimes aggressively destroy themselves, called the Tragedy of the Commons (1968). People managing resources fall into the trap of mistaking growing income for wealth. As a result, they keep growing investments in income as it depletes their real wealth. However one reads history, the model perfectly fits our situation, with our global financial imperative to maximize income growth. That systemic force easily overwhelms sustainability in an increasingly competitive world. In Hardin's model, village milk cows graze on a shared meadow, and the farmers find they need to put more and more cows out to pasture to get the same amount of milk. The grass and the cows, of course, both wither and die.

That trap seems to be why as the world became ever richer, ironically, people still feel they increasingly need to struggle. Both are true, and it is related to how we respond to amplifier feedback. At first, it doesn't bother us; then, we try to ignore it until it becomes painful. The one available remedy is to find the relief valve and turn down the feedback, understanding that many other *new lives* in nature solve it quite simply.

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[2] 2019 WEF Global Risks Report http://www3.weforum.org/docs/WEF_Global_Risks_Report_2019.pdf
"Global Risks out of Control - Is the world sleepwalking into a crisis? Global risks are intensifying but the collective will to tackle them appears to be lacking. Instead, divisions are hardening. The world's move into a new phase of state-centred politics, noted in last year's Global Risks Report, continued throughout 2018. The idea of 'taking back control'—whether domestically from political rivals or externally from multilateral or supranational organizations—resonates across many countries and many issues. The energy now being expended on consolidating or recovering national control risks weakening collective responses to emerging global challenges. We are drifting deeper into global problems from which we will struggle to extricate ourselves".

[3] 2019 UN Global Assessment Report on Disaster Risk - https://gar.unisdr.org/ Conclusion: - "Disaster risks emanate from development pathways, manifesting from the trade-offs inherent in development processes. In some ways, this has always been well recognized. What is new in today's increasingly interconnected society is the diversity and complexity of threats and hazards, and the complex interaction among them, which result in "an unprecedented global creation of risks, often due to previous socioeconomic development trends interacting with existing and new development dynamics and emerging global threats." P 418

[4] The Anthropocene – documented by the Intnl. Geosphere-Biosphere Program http://www.igbp.net/globalchange/greatacceleration.4.1b8ae20512db692f2a680001630.html

[5] Experimental comprehensive list of The Top 100 World Crises Growing with Growth (Henshaw 2020): https://www.synapse9.com/_r3ref/100CrisesTable.pdf

It will eventually get the whole world's attention, of course. For now, though, responding to it conflicts with popular belief systems all over the world. If our beliefs were logical, there could be a practical fix, but they are not. Human knowledge is developed in our cultures, and our cultures are divided into separate worlds that do not easily talk to each other. That leaves humanity without a common language for saving the Earth. Still, people worldwide are keenly interested in fostering successful new lives. Perhaps that could foster the new common language many see gradually emerging.

2.2 When and How to Turn-forward

Strychalski says: "We still don't know the mechanism by which these things[biological cells] divide. That blows my mind— it is one of the basic aspects of life." — Mitch Leslie (2021), Science Magazine

There is much we do not know about what surrounds us. Still, we also often see danger ahead and know to turn away. We find it easy to turn away from risks, such as steering a car, developing relationships, estimating budgets, or meeting deadlines. That may not work for dangers that only come around every few hundred years. What physically gets us to respond to risks is rising gut-felt anxiety, a clear signal to face the future. We should be feeling that when thinking about the world's future. Making that *turn-forward* to deal with a fast-approaching particularly applies to any growth process that might go out of control.

Figure 1 shows a growth curve with a series of start time delays (S1 to S4) for responding to approaching limits that should trigger increased anxiety. The scenario is fictional, and reality could be more complex, but the simple principle would be the same independent of the units of time, scale, or limits. Early start times S1 and S2 cause no real disruption. Late starts time S3 and S4 do. Response start time S5 never comes. The main lesson is that early and late responses both end up around the same place at around the same time, so there is little sacrifice for responding early.

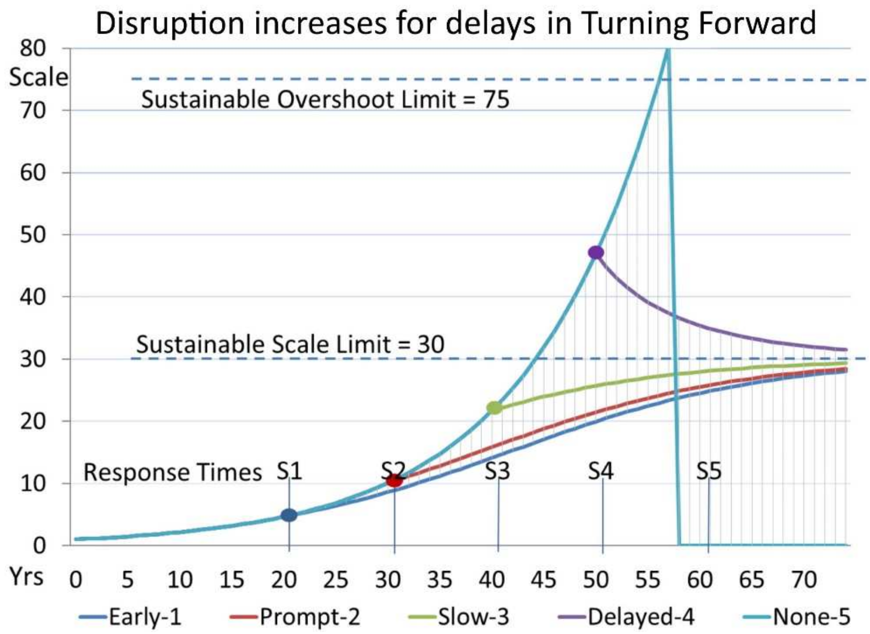

Figure 1. Increasing Urgency for Delayed Turns Forward, Successive delays, S2, S3, and S4 result in increasingly disruptive responses to limits. The system has collapsed by S5 and so does not make the turn. (Henshaw 2010a)

One exception is the possible knowledge gained by dangerously overshooting and recovering, however, at some real cost. We all know increasing delays generally add big risks and complications. Look at the chaotic way nations worldwide responded to COVID 19. Giving people too little time or too vague a plan and is either causes panic or rebellion.

What Figure 1 does not show is the *point of timely response* when the approaching threat is enough to motivate and not so late as to cause panic. The familiar way we time turns when driving, canoeing, sailing, making moves in politics, and other steering arts can tell us a lot. Responses need to gather first to make the right move and not be too soon or too late. Good steering waits for the right time, not just reacting as fast as possible. In reading Figure 1, imagine your anxiety rising on approaching the limit the way one feels making turns in one's favorite sport.

2.3 Steering the Living-Economy

Nothing fails like success because we don't learn from it. We learn only from failure. — Kenneth E. Boulding (1978)

The world economy has had a long success in repeatedly doubling our conversion of natural resources into wealth every 22 years or so (Figure 2). Judging from the atmospheric CO2 records (Henshaw 2019), rapid global economic growth appears to have started in earnest in about 1780 with the invention of Watt's rotary steam engine for powering boat and train travel and replacing waterwheel power for mills.[6]

[6] Watt steam engine https://en.wikipedia.org/wiki/Watt_steam_engine

What is remarkable in these recent economic trends is that they each have 1) a constant growth rate and 2) remain in constant proportion to one another. That fixed mathematical *coupling* is clear evidence that each series reflects the world economy behaving as a whole. Moreover, they also all move together, indicating the whole economy has a stable driving positive feedback. Given the many forces driving economic growth, the pattern of growth constants says, they all appear to work together. So it is possible that to change, one might take the lead or that none would change until they all move together.

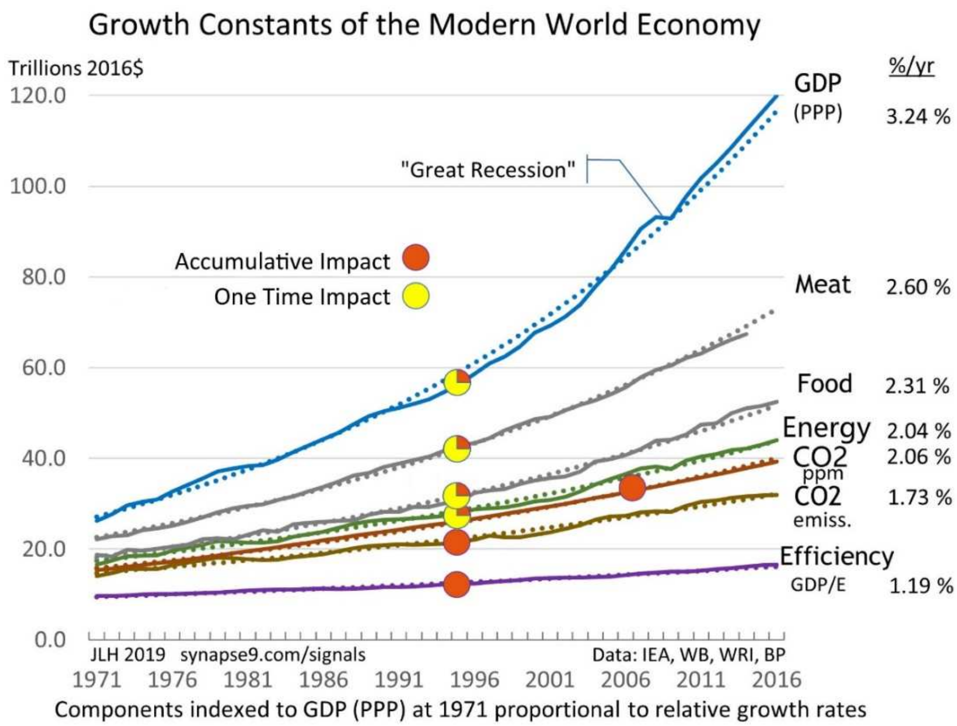

Figure 2. *Steady global economic growth rates*: Components are indexed to GDP (PPP) at 1971, scaled by the ratio of each one's growth rate to GDP's (%/yr). Data sources §8

All the data curves in Figure 2 (solid lines) closely fit the dotted lines for average exponential growth constants (Eqn 1). In general, that seems to be what is getting out of our control, the excessive amplifier feedback of income amplifying income, depleting the wealth of the Earth. Further confirmation that these patterns are whole system behaviors is seen in the convergence of the growth constant log plots.[7] But what is the unifying whole system driving force?

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

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

We seem to hear about that driving force every day in the news, everyone's desperate struggle to make the economy grow faster, as if necessary to escape from threatened poverty. There is a force of habit, of course. There are also many others, like the motivation of the scientists and entrepreneurs to invest in more productive innovations. Individuals also invest in themselves to increase their productivity, also an important contributor. There is also a systemic global feedback loop, the financial and business practice

[7] See §3.3 stat. test for homeostasis. Fig 15 http://synapse9.com/ISSS-21/NewSci-IndividSys-supl.pdf

of taking profits from every source of income and using much of it to increase new investment. Tragically all three make the problem exponentially worse. It sets up what one might call a *maximum carrot-and-stick* economic stimulus as finance and business drive commerce to produce exponential returns, creating a combined virtuous and vicious feedback.

As the economy presses planetary limits, businesses still seem to benefit from the investment, but the profits go back to investors for increasing the competition. So the pressure to overstep natural boundaries grows, destroying habitats and escalating everyone's struggle. The more the economy grows, the more intense and the competition, not less, the vicious feedback loop as a negative return on investment. If we recognized the problem, it might cue the needed gut-wrenching response to "flatten the curve," as many learned to do for the pandemic.

Many global efforts aim to steer the world economy to safety, evident in the global sustainability movement. On might mark the start with the 1972 Limits to Growth study (Meadows et al.), largely confirmed in 2004 (Meadows, Randers & Meadows). The global waves of government and business sustainability efforts, including the UN's SDGs and the European degrowth movement *(Kallis et al. 2018) and so many* others, growing urgency of economic system change. Today, many philanthropic investors are looking for environmental, social, and governance (ESG) impacts rather than only growing profits too. However, the best-known sustainability efforts, corporate sustainability policies, the IPCC's climate change mitigation efforts, and the UN's SDGs all still seek to maximize growth to pay for correcting the harms caused by growth. They have also all focused on the growing symptoms of our collision with natural limits, though, and neglect the structural feedback in the financial system and other driving forces.

Figure 3 shows a simple model that partitions the economy into two ways of making money, investment finance and commerce. Finance consists of banks, investor funds, and the finance operations of businesses that put money into *commerce* to finance the exploitation of nature and society in a way to maximize growing returns for reinvestment. Commercial operations also seek to maximize profits income is spent, not compounded. Of course, the model is imperfect, as some profits for finance are spent without a promise of growing returns and some profits of commerce invested. There are those two ways of making money, though. So, in *commerce*, money circulates freely in exchange for products or services without attached obligations for growing returns. The figure also loosely suggests the necessary financial solution; having finance discover the natural wisdom in spending (divesting) its profits to balance *finance* with *commerce and commerce with nature*. It is just a mental model with a sticking point.

How the two come into balance matters greatly too. One might avoid an environmental collapse but not avoid a general financial collapse. Ironically a steady-state economy achieved by a steady divestment of profits could still be just as profitable as before, just like the family business that chooses to stay profitable and stop growing to take care of family. Hopefully, the model also shows our tragedy of the commons for what it is, an obsession with putting so many cows on the meadow it leaves both exhausted.

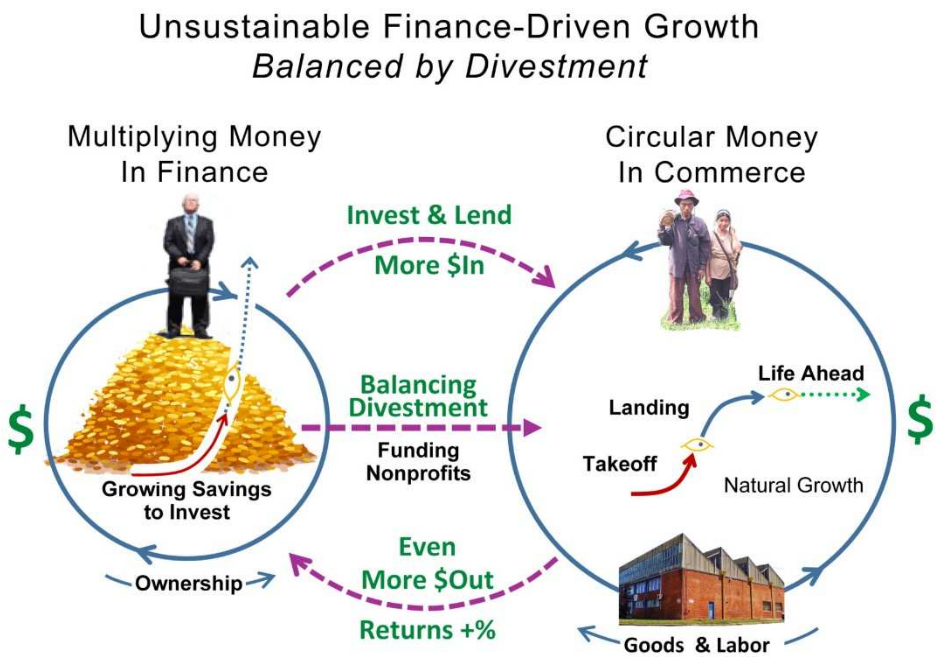

Figure 3. Steering a Finance Guided Economy: Business and Investor financial choices determine the use of the system's profits. Usually, it is to put money into commerce to take more out exponentially, called compound investing.

If once there's a broad consensus to go in this direction, any sector might take the lead. It could be government, finance, business, nonprofits, social networks, thinkers, activists, or even liberals or conservatives, one at a time or all at once, like the broad consensus for sustainability, but focused on giving humanity a new life. In nature, the *turn-forward* from exponential growth to maturation can be disruptive if delayed or disorganized. So we'd want to find a smooth way forward. It'll have to be more than one approach, it seems, considering the diversity of human cultures and deep sectarian divides.

Spending capital to limit unsustainable growth is not entirely a new idea. In a conversation with Ken Boulding in 1983 about these general issues, he said repurposing the economy's profits to limit compounding as compounding starts to produce diminishing returns was one of JM Keynes' great ideas that did not catch on. In his General Theory (1935 ch 16 III, IV), he said (paraphrasing) that society might find better ways to spend the economy's profits as the worst of capitalism shows at its limits. Following that confirmation, it took years to tie together the many loose ends and find a general systems theory with a chance of being widely understood. Wide understanding seems to be the key requirement. Without a well-informed *planetary sense of community* (Francescato 2020), the world cannot effectively act as a whole and give itself a new life.

At least as important, Keynes also wrote about why people generally do not take risks based on their information. He saw that to take risks, people need to have information but then put it aside to act on intuition, what he called “animal spirits” (Keynes 1935 Ch12 VII; Akerlof & Shiller, 2010; Dow & Dow (2011). For society to take big risks, such as setting out to make a new life, the strategy would be to study information of every kind and then put it aside. It is taking a risk to set off on an uncharted course, and the world would need both great inspiration and a true desire to work together. It calls for collective motivation, a tidal wave of animal spirits, to see that making a new life for our world family is doing the right thing. Not the least benefit being that rebalancing *finance* and *commerce* would greatly speed up adaption to climate change both from making the problem smaller and releasing needed finance (Keyßer & Lenzen 2021).

3 Growth Models for New Lives

3.1 Learning Nature’s Creative Process

The cells of a human embryo multiply furiously during its first nine months — multiplying to over a trillion cells at birth to start the long process of maturation on the way to vibrant long adult lives. If we had not learned that in school and had it so central to caring for others, it might be unclear what the many developmental stages of new lives are. To start, as this approach does, from discovering continuities of change, the study of new lives generally begins with noticing that something has changed and then looking for how. A good starting point might be noticing that one’s interests, or the country’s, have moved on to something new. That makes the growth process that just completed available for study. Growth processes have continuities to follow and milestones to discover and often have environmental centers for different stages. Finding some of those opens up the possible study of developing internal and external relationships that do the real work of natural system design.

An interesting example is how a house party or dance normally starts after some delay after people arrive when a little contagious process seems to affect everyone at once to mark the real start of the party. There is also often an after-party too. Then one of the favorite conversations is often the ups and downs of the party that preceded. That same kind of thinking is what one builds on to notice organizational changes of new lives in general.

Another familiar example to study is “making dinner,” either for oneself or a crowd. Preparation starts with an idea for an anchor recipe and shopping or taking food from the fridge and cabinets. After various smaller steps of getting organized, the plan usually solidifies, and the bigger preparation tasks get underway. Then when new ideas for the finishing steps arise and the effort is seen as a whole, it leads to taking out new ingredients and putting others away. At the turning point from starting things up to finishing them, attention shifts to side dishes and timing the end, adjusting the plan once again. Then others may pitch in as finishing touches are added, and cleanup starts before serving the meal. Then dinner is put on and takes a life of its own.

As we learn more about recognizing where and how new lives are developing, what may be most interesting is looking for their internal steering and external influences. For example, helping someone with learning challenges calls for a combined internal and external search for openings to the next level. It may take either a limited or extensive effort, trust-building, and rewards. That applies to the growth hurdles of personal relationships too. Numerous internal and external forces need to have their say. It applies to new businesses facing marketing challenges with start-up funds run low.

To study new lives, we also need a new scientific approach to using a fragile source of information, our recall of personal observations. We trust personal observations by default, but that is risky, especially when one's observations matter. So, it is important to learn how to make them reliable. We also need to rely on personal observation as a sole source of rich information about contextual relationships, or "warm data," as Nora Bateson calls it (2017). The scientific method is neutral about numbers but remarkably biased about complex living system relationships. Statistical modeling and abstract theory can still help raise good questions; however, representing nature with numerical models also strips away the evidence of contextual relationships one might like to investigate. Of course, personal observations often get cluttered with biases and suppositions, too, and social networks can reinforce the craziest kinds of ideas. So learning to be an honest observer is itself a challenge. One basic method for learning to trust one's observations is to make a point of learning something new each time any issue comes up, not just triggering the same old answer over and over. There is always something more to learn.

Common language terms are another source of information on meaningful experiences and attached contextual relationships as *warm data*. To retrieve some of it, one can think through the varied usage of any term to search through its associations. Take words like "book" or "breeze." If you think of their uses, a rich variety of natural experiences and relationships comes to mind. Thinking about words that way helps one unpack the deep meanings of the cultural experiences we associate with our words.

We also need the association of natural language with natural experiences for a special task. That is to help us distinguish things defined by nature from the perceptions of the world we define for ourselves. Just asking how what else you might learn about things helps with that. The point is that to use an *unscientific* data source scientifically; we need a way to keep ourselves honest, developing techniques for testing our observations in exploratory ways to see what we can trust. There's mor on that in §4.2

3.2 Partial and Full Growth Paths

> *Every system is a "holon"--that is, it is both a whole in its own right, comprised of subsystems, and simultaneously an integral part of a larger system. Thus*

holons form "nested hierarchies," systems within systems, circuits within circuits, fields within fields. — Joanna Macy (2014)

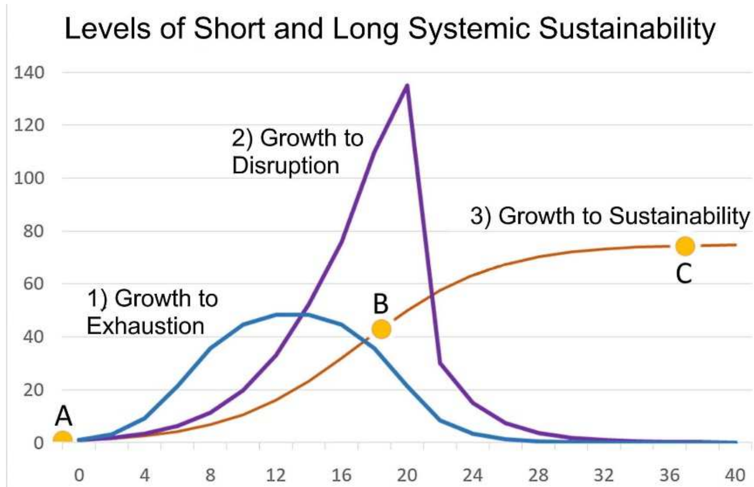

Figure 4. *Levels of short and long-term systemic sustainability*: Systemic limits for maximizing growth: 1) consuming a limited resource, 2) hitting disruptive limits, 3) being responsive to both internal and environmental limits.,

The three simple growth curves in Figure 4 represent systems that fail or pass the tests of sustainable growth. All three curves start with a period of steady growth — curves 1 and 2 show new lives that fail to mature.

1. *Growth to Exhaustion*: A growth system organized to multiply the consumption of its starting resource, but failing to find any other, such as — matches that flair but do not catch on — seed sprouts that fail to put down roots — a business that consumes its seed capital without attracting a market — enjoying a dish of ice cream.

2. *Growth to Disruption*: A growth system that finds more resources as they grow but overreaches internal or external relationships to become unstable, such as — seeds that sprout but become spindly and fall over — businesses that grow too fast and collapse in confusion[8] — diversified economies that die by killing their renewable resources.

3. *Growth to Sustainability*: A growth system that accesses new resources, responds to internal and external limits, develops resilience, and adapts to a secure niche, such as — plant and animal growth to maturity — the formation of communities and ecologies — self-limiting cultures, industries organizations, of professions — lasting family and personal relations — local businesses and nonprofits focused on serving their needs.

Read in this fashion; growth is an ascending scale of tests, familiar to all young lives, new businesses, and new personal relationships. To survive their growth, they need to pass the critical midpoint test of

[8] Eight Dangers of Growing Your Business Too Fast https://www.inc.com/cox-business/eight-dangers-of-growing-your-business-too-fast.html

turning toward responding to the future, the turn-forward, a gateway to self-preservation often enough. Success and failure do not always follow simple curves, of course. It is only easier to learn from simple cases. Success may often come from surviving multiple failures, with every attempt a trial by fire. Then you might say it is following a strategy of *try, try again*.

3.3 The Principal Stages of New Lives

"It always seems impossible until it is done." — Nelson Mandela

What makes the growth of individual new lives an endless surprise is how they always come from such remote and unique beginnings and then take on a busy world on their own terms. As a guide to the paths to follow and questions to ask along the way, consider the series of environments, events, and stages of development diagrammed in Figure 5. It is a universal "hero's journey" of small beginnings and great challenges for individual systems with lives of their own. New lives also need to be opportunistic to survive and so appear to also have *minds of their own* (Henshaw 2008). That notable self-animation of growth systems also means having the ability to concentrate and control energy use, making growth a *syntropic* process in an *entropic* world.

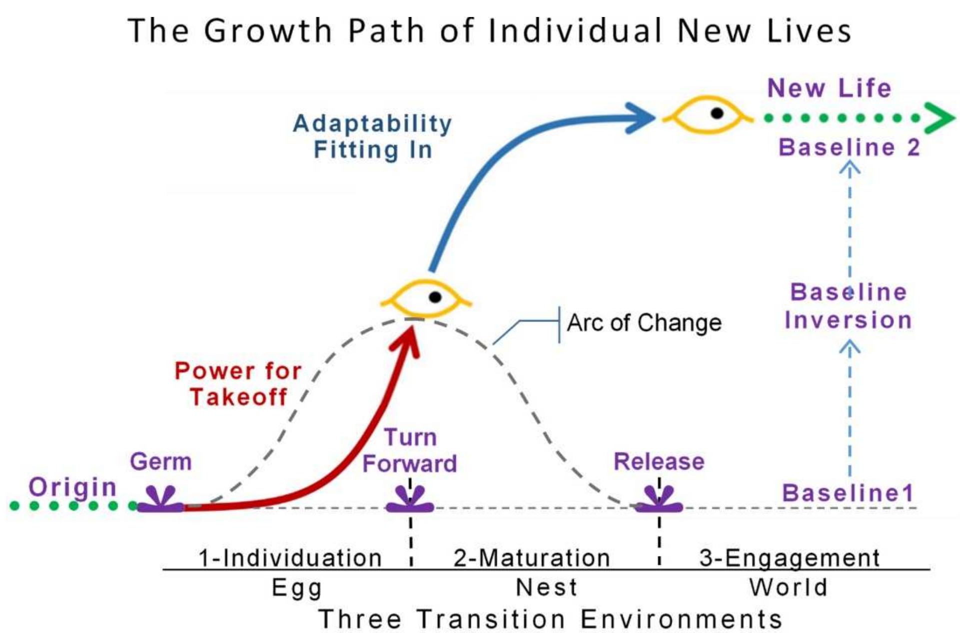

Figure 5. *Nature's Integral (the curve)*: With three events (Germ, Turn-Forward & Release) initiating three directions of growth (Individuation, Maturation & Engagement) in three successive environments (Egg, Nest, World). The 'eyes' between periods indicate likely anticipatory changes in direction.

Figure 5 shows the series milestones for new lives associated with the minimal "S" curve continuity for lasting systemic transformations. Depending on the individual system and environment, growth might take a more complicated path, with detours, backsliding, recovery, and delays. The curve itself is "Nature's Integral," referring to how nature uses growth to build up new forms of organization by adaptive accumulation. The shape of the curve is like that of a logistic equation. It is used here for raising questions about punctuated organizational changes of natural growth. Nature is not predetermined and needs adaptive building processes to determine how systems will develop. Here the "S" curve is labeled with milestones to look for in natural contexts, the minimal events, processes, periods, and environments. The aim is to help people notice and respond to growth processes in their experience, past, present, and future.

The complex series of changes highlights the complications nature needs to go through to create a smooth process of organizational development. The red curve represents what occurs in the protected confines of *the egg*, or womb, garage, or other quiet places where new life can germinate and multiply to gain power for during its takeoff period of *individuation*. That big leap of positive feedback relative to the past needs to give new lives the ability to fend for themselves in the *nest* environment after the *turn-forward.* Then as their physical *maturation* begins in the *nest* environment following the blue curve, the growth rate slows by a negative feedback trend for homing in on the future. That period of exposure to the new *world* they will enter prepares the new life prepares for the next big leap of *release* for *engagement* in that world. The dotted green lines at the beginning and end represent the busy *worlds* that new lives emerge from and enter into, open environments where complex niches and new forms of relationships develop[9]

Let us look more closely at the most hazardous transition, the turn-forward when the new life moves from its *egg* environment to its *nest* environment. At that risky midpoint of development, there is a somewhat abrupt switch from backward-facing to forward-facing development, from multiplying a seed pattern to getting ready for a new world ahead. One might ask why that switch from backward-facing to forward-facing adaptation happens? It appears that is what evolution discovered for sustaining life, a whole system test of adaptivity. A seed pattern cannot possibly encode a whole future environment, so it appears life had to become exploratory and actively adapt to unfamiliar environments as the future arrives. It makes life possible.

That shift from referencing the past to referencing the future is also clear in the shapes of the red and blue curves. Each step along the red curve is a change proportional to the total change in the past (referencing baseline B1). Each step along the blue curve is a change proportional to the distance from the destination (referencing baseline B2). That change in baselines for growth can also repeat. Everything we struggle to learn can be the foundation for learning more, a series of growth processes. A familiar example is the annual succession of grades in school, each year a separate growth process.

In Figure 5, the dotted grey curve in the middle labeled *Arc of Change* shows a rising and then falling pair of "S" curves, showing the arc of the physical development process beginning and ending. It offers a new perspective of the curves of beginning and ending of growth, as a derivative process of two "S"

[9] See also §2.3 "Notes on the key milestones" http://synapse9.com/ISSS-21/NewSci-IndividSys-supl.pdf

curves, each with a beginning and ending processes. That view lets one focus on the beginning and end of the beginning or of the end. If you have data for the growth process, that arc of change is a plot of the slopes of the growth curve, or first derivative, and exposes the growth process as even more as an assembly line of processes linking together.

3.4 Basic Study Tips

A study of the growth of new lives can start with making a list of the many kinds of new lives you are already familiar with, including the growth of one's own life, career, endeavors, relations. Then add others you might be interested in. Next, using Figure 5 as a model, practice with pen and paper and post-it notes, drawing the intuitive shapes of growth stages for some of the items on the list. Keep it simple and let it get a little messy at first. Subjects might include the preparations for a memorable dinner, events over a summer season or school year, or the history of a business or social network campaign. If data is available, use that as the *primary indicator*. If not, what works best is to pick a primary indicator intuitively and try some *secondary indicators*. Then label the development milestones you see, the *germ*, *individuation*, *turn-forward*, *maturation*, *release,* and *engagement* milestones, that shape the arc of the whole story.

Next, on the same timeline, redraw the curves until they most accurately reflect the rise and fall of the main developments and turning point events to represent the arc of the story (Henshaw 2018, 83-87). Then put the work aside for a while and come back to redraw and relabel a final version of the curves and edit your notes on the *individuation*, *maturation,* and *engagement* periods and the influences of their *egg*, *nest,* and *world* environments, adding notes on what you learned. One might then move on to other subjects; events in history, familiar social movements, one's school or work career, or current problems like growth hurdles of children or organization projects.

Basing the curves on time-series data is needed to compare one situation with another. It also lets nature speak for herself in reflecting the continuities of change one is studying. Several case studies for working with data are in the Supplemental Topics.[10] To collect data, one might also ask the accounts manager at the office to plot curves of staff time spent and expenses for office projects or campaigns. One can request data from one's business, town, or city to start researching their *new lives*, too. When those are plotted over time, with markers for various milestones, see if the growth trends and inflection points show the liveliness of a living system. Published environmental and economic data is a good source to study too.[11] Unfortunately, stock market data does not work, so influenced by rumors and tricks, it rarely reflects continuities.

[10] Supplemental Topics - Case Studies §2: http://synapse9.com/ISSS-21/NewSci-IndividSys-supl.pdf
[11] Data transformation: Google Trends https://trends.google.com/trends/?, Google Word Use History - Ngrams https://tinyurl.com/myxbpwh5, NY Times https://www.nytimes.com/, The world Bank

3.5 Related Transformation Models

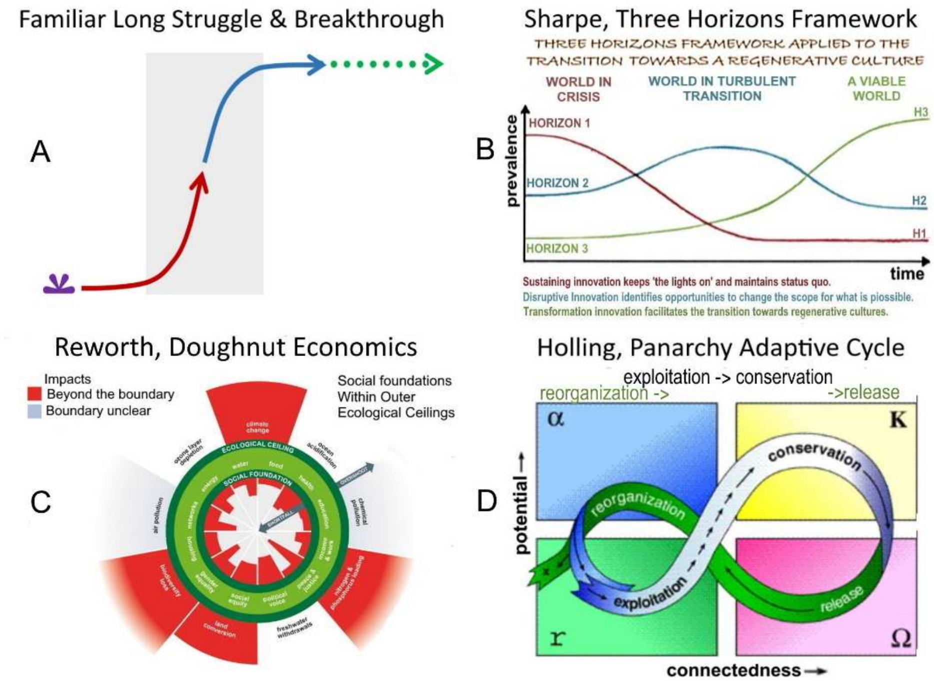

Figure 6. *Four popular related system transformation models*: A) familiar "Long Struggle & Breakthrough," B) "Three Horizons" Sharpe (2016), C) "Doughnut Economics" Reworth (2004), D) "Panarchy Adaptive Cycle" Holling & Gunderson (2001, 2002).

It is valuable to learn from several transformation models, combining complementary strengths. The four popular models of whole system transformation in Figure 6 are all related to the general model of *individual new lives* in Figure 5. Any of them could be one's primary reference depending on circumstance, with the others referred to for enrichment and finding what pieces fit best. Together they help expand the tool kit of principles and intuitions about whole system transformations. Over time, as people gain experience and others study the subject, various perceptions will combine, and community standards develop.

A. *Long Struggle & Breakthrough* – Everyone is familiar with repeated failures that lead to success, shown here as a compressed version of Figure 5. Long-delayed breakthroughs might come from delayed maturation, the appearance of new openings, or dramatic leaps. One way or another, the environment eventually opens to the efforts before they are exhausted. A good example is the delayed breakout of hip-hop as a national culture after 20 years of circulation in local New York neighborhoods. Then, in the early 90s, it met economic success coincident with New York youth cultures turning away from previously dominant drug cultures[12].

https://data.worldbank.org/, Our World in Data – https://ourworldindata.org/, WorldData.AI https://worlddata.ai/

[12] Unpublished 2005 field study notes - https://synapse9.com/cw/crimewave_nys2.htm

B. *Three Horizons Framework,* Sharpe (2016) – The strength of the Three Horizons Framework is its ability to coordinate three groups to work on different phases of a long-term strategy. One group can work on breaking away from outmoded practices (H1). Another can work on transitional stages (H2). Finally, a third group can build the long future (H3) as they all coordinate. It is like fast-tracking building designs with demolition and design starting together. Parenting also works on short, medium, and long-term horizons. Business planning and community organization do too. Long-term world plans have followed multi-phase models, too, like the rebuilding from WWII.

C. *Doughnut Model of Sustainable Economies*, Raworth (2004) **–** The doughnut model combines thinking on internal services and external restraints so that urban plans can optimize community benefits within planetary boundaries. The limitation is that the nine planetary boundaries of growth (Rockstrom et al., 2009) are far from inclusive[13] and mostly are not traceable to individual business or municipal choices. Collaboration is needed to distribute shares of responsibility fairly for all GDP impacts and thresholds (Henshaw 2011; Baue 2019).

D. *Panarchy Adaptive Cycle*, Holling and Gunderson (2001, 2002) – Panarchy is a cyclic model of environmental evolution, similar to seasonal cycles. It also partly fits how economies evolve, with cycles of growth, climax recession, and reorganization. The Panarchy cycle starts with new growth (called *exploitation)* followed by maturation (called *conservation* — leading to stasis), then system breakdown (called *release), and reorganization,* after which the cycle repeats. For ecologies, cyclic regeneration is not recovery from a disordering collapse, though. So one reads the model metaphorically. The phases of Panarchy roughly correspond to the *egg*, *nest* & *world* for *individual new lives* if one adds phases of decay and rebirth. Those phases were left out of the *new lives* model to focus only on the details of how growth can lead to long lives.

Left out here are also a great many other models for system transformation. Salk & Salk's "A New Reality" (2018) offers a very compatible 'S' curve development model to turn the reader's attention to global transformations fast approaching. It is particularly easy to understand and even suitable as a children's book. Duane Elgin's *Choosing Earth* (2020) is another helpful view of changes to future society in the Anthropocene, emphasizing a well-researched but more stark view of likely societal crises ahead. The book takes the reader on an extraordinary journey, extensively documented with authoritative references, for appreciating the large changes to living on Earth our children might likely face.

The transformation models of leading world institutions, like the UN's IPCC and SDG efforts, and world governments unfortunately still project a regular doubling of the economy's demands on the Earth and society, ignoring the role of growth in nature for creating new lives, a strictly one-way and relatively short-lived process. Yet, even steering the world looking in the rearview mirror, as we are, many new directions can already be seen emerging.

[13] Experimental categorized list of 100 World Crises https://synapse9.com/_r3ref/100CrisesTable.pdf

Complexity science is another highly funded approach for studying complex systems and their behaviors. Unfortunately, its experiments with complex systems models have been economically important but less successful for interpreting real economies in real environments. Worth mentioning, though, are two examples of often forward-thinking complexity science, the consulting work of Yaneer Bar-Yam (2004) and David Snowden (2021). They associate the statistical properties of complex systems with informed decision-making, creating practical search strategies for real-world applications.

3.6 Systemic Strategy

I may briefly remind the reader how little we can trust to our unassisted senses in estimating the degree or magnitude of any phenomenon.
— Stanley Jevons (1887 p 276)

Developing a successful way of intervening in or managing living systems depends on reliably observing available openings. Every stage of development is an opening in some directions and a closure to others. That enables some kinds of efforts and inhibits others. Because conditions frequently change, one needs always to be ready to rethink and look for new openings. Because of the human attraction to magical fixations, people often commit to misguided efforts, too, so a way of carefully vetting commitments is needed. One way is to impersonate the system in question, asking what it would ideally want to be to search for holistic insight. Louis Kahn, the marvelous 20th-century architect, was famous for seeking out the intentions of a building during design, frequently asking: “What does it want to be?” In one case, that led him to discover that the inner sanctuary of a great new mosque wanted to be the building’s main entry (Kahn 1998, p 44), a method of design for places that come alive.

Elinor Ostrom (1990, 2009) and Donella Meadows (1999) have provided quite helpful lists of guiding principles for managing (Ostrom, Table 1) or intervening in (Meadows, Table 2) complex living systems. Notice how Ostrom’s principles have more of an external view of the subject. Meadows’ principles are more for working with living systems from the inside. Some of the author’s related systems steering principles are in Table 3.

Table 1. Eight Principles for Managing a Commons Ostrum: (1990):

1) Clearly defined boundaries.
2) Graduated sanctions for respectful compliance
3) Govern the use of commons goods according to local needs and conditions.
4) Allow those affected by the rules to participate in writing the rules.
5) Make those who monitor the rules accountable to those regulated.
6) Low cost and accessible dispute resolution.
7) Right to self-organize regulation systems.
8) Organize governance of nested boundaries in layers under the whole.

Table 2. Twelve Leverage Points for Intervening in Systems (Meadows 1999):

1) The power to transcend paradigms.
2) The mindset or paradigm from which the system, its goals, structure, rules, delays, and parameters arise.
3) The goals of the system.
4) The power to add, change, evolve, or self-organize system structure.
5) Information flows.
6) Material stocks, flows, and nodes of intersection.
7) The driving positive feedback loops.
8) The strength of negative feedback loops relative to the forces to mitigate.
9) The lengths of delays relative to the rate of system changes.
10) The sizes of buffers and other stabilizing stocks relative to their flows.
11) Constants, parameters, numbers (subsidies, taxes, standards).
12) The power of small nudges

Table 3. Eleven General Principles for Self-Organizing Transformation (Henshaw)

1) Local solutions also need to support larger system change.
2) Staying in touch with diverse channels of communication.
3) Noticing emerging new lives opening channels.
4) Building the common human language while respecting individual cultures.
5) See systems as having lives of their own, having wisdom, and needing guidance.
6) Noticing that humans, like animals, spend their time searching for new paths.
7) Noticing the openings for change, each stage of growth a different one.
8) Noticing there may be no technical fix for economic transformation, but it will also take great technical sophistication.
9) Noticing how productivity comes from connecting complementary parts.
10) Noticing where diversity thrives, like in ponds, forests, towns, and cities.
11) Noticing how self-organizing systems distribute the pressures put upon any part, like rising competition for productivity.

4 Roots in the Sciences

"The impossibility of a truly comprehensive account of growth in nature and society should not be an excuse for the paucity of broader inquiries into the modalities of growth" — Vaclav Smil (2019, p XIX).

The origin of studying growth as nature's formative process seems to go back to proto-Greek nature-science. The common Greek word, Φύσς, pronounced *phúsis,*[14],[15] refers to nature's productivity, growth, and birth. However, when the same term for nature was adopted by Greek scientists, it came to refer to abstract conceptual properties and theories for nature (Aristotle ed. 1941, Bäck 2006). The term was then later used for the modern discipline of physics. History is difficult to read, but the two meanings do exist, and nature is both creative and determinate. It is also clear that the abstract theory meaning is what later became dominant. There could well be more to the story, but the Greek language is much older than Greek science. Greek science is also often referred to as being a rebellion against what the scientists called *nature-religion*[16]. Perhaps *nature-religion* was just a pre-abstract form of science that abstract science chose to erase and perhaps should not have. In any case, that interpretation is reassuring for the principled *post-abstract* form of science offered here.

We are, of course, also greatly indebted to modern abstract science for all the rules of nature we can know with certainty. Moreover, the scientific revolution and method offer a wonderful discipline for converting data to useful equations and for guiding innovation. Still, representing nature as following our rules limits the questions one can ask, blinding us to living systems. Just converting nature into equations strips away all the contextual information about the organization of the natural systems influencing the data. Some kinds of graphs expose evidence of contextual relationships, such as presenting raw data and theoretical curves together. Thaat encourages readers to think about the real environment and its systems.

There have also been many scientists who bucked the trends, too, more than one can name. Some of the notable scientists who challenged precedent contributed to the development of this diagnostic view of nature include: Johann Goethe (ed. 1996), D'Arcy Thompson (1942), Ken Boulding (1953), Garret Hardin (1968), Gregory Bateson (1972), James Miller (1973a, 1973b), Maturana, Varela, & Uribe (1974), Brian Goodwin (1982), Elenor Ostrum (1990), Robert Costanza (1997, 2014), Donella Meadows (1972, 2001, 2004), and Vaclav Smil (2019). Brief discussions of the contributions of Boulding, Hardin, Smil, Ostrom, and Meadows are below. Discussion of other contributions that helped lay the groundwork for this study is in the Supplemental Topics.[17]

Vaclav Smil's (2019) study of a wide variety of growth systems is related to the present study as a diagnostic study of growth systems aided by simplified models. His approach is to construct mathematical models to depict environmental, societal, and economic processes of all kinds. Smil does not plot raw data with the growth curves discussed, though. For Smil's figures, showing raw data might

[14] Wiktionary: Φύσς) Translated "gro.sis" and pronounced "fi.sis."
https://en.wiktionary.org/wiki/%CF%86%CF%8D%CF%83%CE%B9%CF%82
[15] – Merriam Webster: physics; History and Etymology https://www.merriam-webster.com/dictionary/physics
[16] History of physics https://en.wikipedia.org/wiki/History_of_physics
[17] See also §4 Roots in the Sciences: http://synapse9.com/ISSS-21/NewSci-IndividSys -Supl.pdf

add contextual understanding of the metabolic processes discussed. Still, the growth curve model plots do help illustrate the carefully researched metabolic processes he discusses.

Ken Boulding's "Toward a general theory of growth" (1953) is the only prior general theory of paper on the subject found. He was an economics student of Keynes, and perhaps they influenced each other. Both seemed to study growth as a process of natural system development from a diagnostic rather than an abstract theory approach. The paper identifies several general metabolic principles, paraphrased here for clarity:

1) *Nucleation principle*: Three examples: a nucleus is needed to initiate growth are: a) the condensation of raindrops requires a dust spec to start, b) the retention of information on new subjects requires some insight to nucleate in student's minds, c) the student ability to improvise greatly improves whey they realize that language has grammar.
2) *Nonproportional scales principle*: Changes of different dimensions of a whole tend to have different scales, such as length, surface area, weight, volume, temperature, appeal, etc.
3) *D'Arcy Thompson principle*: The proportions of natural systems come from the relative extents of their growth, i.e., growth defines form.
4) *The Carpenter Principle*: Growth exhibits unexplained coordination of the whole as if a carpenter is in charge of making the parts fit, requiring the parts to mutually adapt, as if to a common plan.
5) *Principle of Equal Advantage*: The parts of systems fit together to maximize their potential (as if for economic advantage), a corollary to the carpenter principle.
6) *Principle of Natural Pace*: The coherence and cohesion of a growth process may break if growth continues too long or ends too soon, or if growth rates are too high or low, potentially even causing collapse. (fragility rule)

Garrett Hardin (1968) explored the class of systemic problems with no technical solution. His first example is of an arms race, in which adversaries increase their military power but decrease their security. His most famous example is of an economic crisis caused by blind self-interest in a small village. The villagers share a meadow for grazing milk cows – its commons which becomes overgrazed. At some point, someone pastures one too many cows, and the productivity of the commons starts to decline. To keep getting enough milk, each family keeps increasing the number of cows it puts out to pasture. That tragic strategy of growing investment in a depleting resource spirals out of control, leading to the meadow and the cows both becoming barren. The "tragedy" is then really of the villagers' fixation on a failing strategy. They do not see the harm until it is too late, if even then. The problem is conceptually simple, but why do so many kinds of living systems make the turn-forward and adapt to natural limits, but Hardin's villagers cannot? It appears they are acting to preserve fictional realities instead.

That dilemma closely matches our global fixation on compound growth in income from multiplying investments in exploiting the Earth's diminishing resources. Unfortunately, we, too, can act blind to escalating dangers. Like Hardin's villagers, we have been mistaking *ever-rising income for increasing wealth*, not noticing it has become the opposite. Today our growing income comes from exponentially spending the Earth's wealth. That probably started some 60 years ago, when it first became big news. As a result, our endless growth policy and the fabulous riches it seems to create is an extremely dangerous Faustian bargain, severely damaging our primary asset just like an overgrazed meadow.

So, we have a problem we are collectively blind to and has no technical solution. To solve our tragedy of the commons, we likely need virtually everyone to understand the problem. There does seem to be a growing worldwide feeling of unease and awareness of the growing swarm of serious environmental and societal challenges. However, our financial and government institutions are still pursuing the same old solution, causing the problem.

4.1 Notes on the Method

The subject here is a broad new paradigm for understanding the growth of *new lives* that combines direct observations and simplified models to raise questions that expand with use. The intent is to help observers turn their attention to the organizational stages and environmental relationships of growth systems they observe, using the diagnostic questions to further direct observation. For example, when time-series data is available, trends and fluctuations might suggest the behavior of systems to investigate. Even data that departs from trends would *not* be assumed to be "noise," but as evidence of other signals, possibly evidence of systems on other timeframes or scales.

For example, a break in conversation might signal a distracted partner or possibly something more that needs to be said. In either case, it might well not be random. In this way, various kinds of analysis can help raise useful questions and expose subjects to investigate. The raw data for complex flows is also often mistaken as noise. For that, a combination of careful statistical tests for implied continuity and careful methods of derivative reconstruction to partly recover it are needed (Henshaw 1995, 1999, 2007). That gives raw time-series data a special role in investigating natural systems because it captures traces of the complex continuities of the physical processes it reflects. The implied continuities in raw data are a type of *warm data* hidden in *cold data*, exposing deeper relationships.

The principal model for natural growth used here, *Nature's Integral* (Figure 5), originated from many years of observing similar dynamics and then tracing its origin to an obscure implication of the first law of thermodynamics, energy conservation. That energy is neither created nor destroyed also prohibits infinite energy transmission rates and so requires nature to rely on developmental processes (Henshaw 2010b). The study of developmental processes then exposed the complex organizational development and decay processes that nature uses to build small and large-scale systems: the minimum possible progression, the “S” curve, symbolizing the universal pattern. Of course, more complicated processes are also common, but it is the smoothly flowing processes that exhibit the highest degrees of organization.

4.2 Origin of Natural Systems Science

This work started in the late 1960s with a series of physics lab studies of why every run of experiments somewhat misbehaves, curiosity about why natural shapes and transitions all have soft edges and corners, and discussions with grad school friends in a Brooklyn apartment about the source of *individual differences*. Those interests bore fruit a decade later, after studying architectural design when doing field research on the microclimates of homes (Henshaw 1978). Each home study combined 24-hour chart recordings of temperature and airflow with smoke tracing individual air currents and current networks to map out the indoor climate. In each home, airflow networks repeatedly formed and were replaced throughout the day as the sun moved from east to west and then faded throughout the night. Sometimes a column of warm air would rise from a warm surface and accelerate as it grew until it broke its connection with its source, creating a free-rising individual vortex. That led to the insight that growth systems inevitably change conditions until they interrupt their designs and turn into something else (Henshaw 1979, 1985a 1985b).

In the 1980s and 90s, research turned to algorithms for finding and diagnosing continuity in time-series data, an apparently novel approach. It was a chance to experiment with ways of decoding creative natural processes reflected in time-series data. Research journals show lots of raw data and mathematical curves. However, they do not generally show diagnostic studies of data reflecting the continuity of systems, such as using simple mathematical tests of whether apparent noise is local and implicitly follows a hidden continuous organizational process. So the algorithms developed to study the continuity of complex ecological, astronomical, social, and economic systems, called *derivative reconstruction,* all explored uncharted territory (Henshaw 1995, 1999, 2007).

General theory papers followed, focusing increasingly on the active learning exhibited by many kinds of natural and human systems (Henshaw 2008, 2010a, 2010b, 2011, 2015, 2018, 2019). Over time the shapes of the data curves started being studied for the implied internal system organization and environmental processes. Networking and work in UN and civil society organizations broadened the perspective. Then the conceptual models began to focus on the critical twelve stages of development, as shown in Figures 4 and 5 as a learning method.

5 Background on Individual New Lives

In summary, *individual* n*ew lives* are systems that develop energy concentrating (syntropic) organization, short or long-lived, growing from an individual seed pattern or nucleus to develop internal and external systems of relationships. They are also uniquely individual, both due to unique seed patterns and unique conditions of development. Later, their growth takes them into new environments, where they need to adapt individually. There are also energy distributing (entropic) systems. One might call them i*ndividual new waves*, for symmetry, from the energy thrown off by the syntropic processes of individual new lives. For example, a person might throw a pebble in a pond, creating entropic waves. Generally, the organization that allows *energy concentrat*ion is temporary, and energy dissipation follows. The alternation of energy concentrating and dissipating processes appears to be what makes life lively, though not necessarily alive or animate. The latter terms seem best to reserve for biological life.

Organization at any level seems to rely on the continuity of intermittent relationships. That is particularly clear for the open organization of ecologies, societies, communities, organizations, etc. Many ecologies and societies are old enough to have uncertain origins, too, so though they may have emerged by growth, now they evolve in both drifting and growth-connected ways as new cultures within them emerge, change and fade. Nevertheless, they also appear to be positively energized and have sustained individuality over time. They also support the growth of diverse sub-cultures such as the social, political, artistic, and other human cultural movements we recognize. So, the *new lives* model needs to expand to a *multiple individuals model* for environmental systems. One might also use Miller's (1973a & 1973b) or Varela, Maturana, and Uribe's (1974) ways of defining living system boundaries in place of the feedback loops of growth. One might also identify functional features like neighborhood boundaries, sharing a common language, or having the same employer (Henshaw, King & Zarnikau, 2011).

Individual people can also have active roles in multiple communities at the same time. This fluidity of cross-connection is a property Alexander pointed to as responsible for why ecologies can thrive, referring to it as a *semilattice* in "A city is not a tree" (1965). Such loosely bound communities, cultures, and economies also very interestingly can retain their identities without being contiguous, relying only on intermittent connection. Having self-contained feedback loops seems to be the common thread. They are only a little easier to follow when exposed by being dynamically bundled by growth as a tracer.

Perhaps the most important distinction for new lives is whether they mature and remain lively after they end their growth. That is a common property of successful biological lives, their organizations, cultures, ecosystems. It is also a property of many storms and other energy phenomena that grow to last for a short or long time. Individual businesses and institutions achieve thriving stable states for long periods, such as family businesses, business centers, schools, and other local institutions that anchor many communities. One of the clear indicators of these elevated stable state *new lives* is *exploratory behavior*. Stable states in active environments are the result of an ongoing adaptive search for useful new connections.

5.1 Recognizing new lives in formation

"There is a rare property of mind which consists of penetrating the disguise of variety and seizing on the common elements of sameness."
— Stanley Jevons (1877)

To get comfortable with this approach, spend some time looking for growth patterns related to subjects with which one is fascinated. It is even possible to practice by watching thoughts and emotions as they develop, those that develop slowly enough. For example, as we try to quiet our thoughts, we may also notice new thoughts blossoming from feint intuitions to seemingly arrive full-blown. That image can provide clues for retracing where it *took root* or *drew reactions*.

An office environment is another good place to watch things grow. Watch how new office plans or conversations come together, noting contributions from multiple sources. If things develop too fast and overshoot their limits, notice how they fall apart and what is leftover. Try to find the germinating center and see if the end preserves the original inspiration. Many offices have established methods for growing their projects. Compare them with the classical methods like Action Research and Pattern Language (Henshaw 2018).

This approach to understanding living systems relies on a combination of honest personal observation and holding onto raw impressions. Journaling is a traceable way to collect raw data while looking for things to study in patterns of growth and change. Signs of things worth looking into include troubling or curious discoveries, unexpected environmental or social change, absence or calm, places where things often develop. So, look around to see if things happening come from some quiet place nearby.

Once you find a clue, retrace events mentally as far as possible and then find ways to test what you think might be happening. If the evidence is regularly developing, either a sign of growth or decay, it is likely to have internal energy and momentum to look for. It could also be on a path of greater change, to either avoid, oppose, or befriend somehow. For growth, look to see if that center of design might fit the *egg*, *nest*, *world* pattern of succession. Also, look for signs of its initial energizing growth taking off only to quit at its limit, or whether a maturation process kicks in before the system breaks down.

Growth processes in nature begin with multiplying from small beginnings for another reason too. If a single cell in the womb grew at one cell per second rather than doubling every week, a pregnancy would need to last 900 years, not nine months. That *egg* phase growth is a radical way of speeding things up; and takes another dramatic process to slow it down again, dividing change, again and again, in the *nest* phase of reaching a secure climax. That is what maturation does, slow down growth for perfecting rather than expanding the systems of a new life. What makes life exploratory and how deep it is in living systems is metabolically unclear.

5.2 Natural language

Natural language is a particularly rich accumulation of meanings people have found for natural experiences throughout the ages, making it a great source of information about relationships. It is not neutral, of course, but an excellent source of warm data on many subjects of interest. Common ancient terms, like "journey" and "home," tend to have especially rich associations. It brings out both the connecting and diverse meanings to think of all the many variations of their use. Words that are easy to connect with root experiences are common words like *cold*, *stick*, *fruit*, *wave*. Other terms like *confusion*, *congestion*, *practice*, and *anticipation* also raise somewhat Pavlovian reactions to common experience, seeming to recall taproot meanings. Reconnecting with those root associations can clarify both basic issues addressed and help identify cultural meanings that have been added (Henshaw 2015).

Fortunately, most natural language terms were coined for recalling important natural events and experiences and still retain those root associations. It makes language a rather faithful recording of what people found worth referring to, a kind of map of life one might learn to read. Because growth processes are fundamentally self-similar, and occur on every time and spatial scale, the meaning of familiar ones exposes meanings that apply to others, too, like the study of growth in air currents initiating this general study.

5.3 Distinguishing Terms

“Remember, always, that everything you know, and everything everyone knows, is only a model.” — Donella Meadows (*2001)*

Though statistical data is useful, it is also limited due to the common practice of decontextualizing the focus of inquiry.
— Nora Bateson (2017)

The method used here for validating observations involves shifting attention back and forth between new impressions of things and old interpretations, not to affirm our interpretations but to enrich them. It is a kind of archeological view, like studying a fossil to discover new details each time to become part of the interpretation. As a scientific method of observation, we distinguish *what is defined by nature* as distinct from *interpretation,* understanding that interpretation generally distorts the original form. That is kept in check treating interpretations as questions and preserving raw impressions from which to learn more.

To be honest with ourselves, new observations need to produce new information. So, to validate observations, we need to be open to the unexpected and explore new approaches rather than only check to confirm what one already thinks. It does take practice, though. It means actively approaching observation in new ways and making a point of learning more each time to avoid simply reinforcing old interpretations. This openness to what else is there sharpens the mind and keeps it honest. It is not always simple, of course, as we all have unexpected assumptions. Trying to see more of what is there does bring improvement, though.

In the introduction, we referred to a class of energy systems that develop internal organization through a growth process: *natural systems,* and *individual new lives*, referring to natural phenomena like communities, cultures, organisms, and storms and how they develop. We observe that they also have individual histories and environmental *lives of their own,* distinct from theories. The intent is to be expansive in defining the class of *natural systems* with loose boundaries while still distinguishing *life* as one kind, reproducing biological systems. The term *growth* refers to the common understanding of the term and the *self-organizing* processes by which *new lives* and *natural systems* develop. A *growth curve* is then a symbolic shape associated with a *growth process*.

Terms referring to things defined by nature may often need clarification. Scientists need terms for what they observe and explore in the natural world and other terms or meanings to discuss their abstract concepts for natural properties and patterns. Mixing them up is easy to do and hard to correct sometimes, such as if scientists think of nature as the information science has developed. In his living systems theory, Miller (1973a, 1973b) also maintained a distinction between naturally and mentally defined subjects, referring to them as *concrete* or *conceptual*. There is also terminology confusion for words with different meanings in different cultural contexts. Language is so rich it lets us refer to all three, the cultural, abstract, and natural definitions, all at once, without realizing it.

For a simple example, the meaning of a phrase like *the box* depends on the context. Without clarification, it can refer to a particular container, a physical or mental trap, a sporting formation, a shape drawn on paper, or perhaps the strictures of a new business or personal relationship. Each of these interpretations attaches a cultural meaning to things defined by nature. Distinguishing between them may be hard to do without practice. Artists and archeologists, as well as detectives, parents, and scientists, often have practiced methods for seeing nothing but what nature has defined and then connecting that with other values. The idea here is to point out the need to develop those skills for observing the many kinds of *individual new lives* around us. An experienced observer will recognize change as steady or dynamic and check with return observations from new perspectives. One learns to take hints from curious differences or stretched interpretations, small details, unexpected behaviors, shifting patterns, hesitations, and gaps in evidence, recognizing niches as networks of safe zones and noticing that most stable relationships as also intermittent.

Mental concepts are abstracted from their contexts, as artificial realities, like mental equations, without attached questions. For abstract science, abstract variables and mathematical statements represent nature detached from its contexts by firm definition. The contextual meaning of science has more to do with how people use science to satisfy curiosity or change the world than with what the language of abstract science has to say. Nora Bateson (2017) calls what is missing from modern science "warm data." That includes the relationships that compose and connect systems, their rich internal organization, external relationships, and their roles in their environments. For example, just having a new person in a group may raise questions about their perspectives and everyone else's in the group. So, one change changes the whole. That is because it introduces new relationships, not just an increased number. The same applies to a new animal in an ecosystem. Each change rebalances a system of relationships.

6 Discussion

Like most things, science depends on success. Using absolute control as a model for nature, the deterministic world view of the leading sciences gave us three centuries of amazing economic growth. But unfortunately, it also caused increasingly disruptive conquests of natural environments and human cultures. Now that urgent action is needed to address some of those harms, adding a new view of how natural systems develop to thrive after growth aims to help people find ways for systems to change that can sometimes address root causes, not just react to symptoms.

This report discussed how useful understanding of complex living systems can and must build on personal observation of the growth of individual new lives and their contexts. New lives seem to be what makes life lively, so it seems a possible subject of widespread new interest. Providing a general strategy for understanding new lives is also hoped to help with understanding their considerable individual differences. Confidence with any new way of working with nature would take time to go through a growth process itself, of course. In this case, there needs to be a culture change from a fascination with controlling nature to dancing with nature (Meadows 2001), *recognizing nature as family* and taking care of family.

The current progress followed from a long fascination with the subject. So, following one's fascinations is likely a good guide to success in using it. It is not feasible to persuade world leaders and cultures with this simple interpretation of the universal growth patterns of new lives. That certainly could not rest only on the observations of one author or their readers. No doubt humanity needs a new life, but many people need to see the paths for the economies to follow them and give humanity a new life.

What might add an important extra level of confidence is that this interpretation rests squarely on one of the cornerstone principles of natural science, the conservation of energy. That energy conservation implies continuity in energy using processes (Henshaw 2010b) might stimulate a wide variety of new research. That could also seem to contradict quantum theory, another cornerstone principle of physics needs to be resolved. The answer might be simple though, maybe only saying that quantum theory is a statistical theory rather than a physical process theory. That leaves both theories just as useful but independent. Hopefully, someone reading this will explain the discrepancy more fully.

Given that the world economy seems committed to continuing economic growth until it spins completely out of control, academic, financial, civil society, and government institutions urgently need to do advanced research. We must learn what is possible, no matter what smooth or highly disruptive path lies ahead. We need to find the right path. Part of what we can know for sure is that taking growth to its absolute limits will cause untold misery and environmental disaster. There is also work needed on developing analytical tools for continuing the studies using *derivative reconstruction*[18] for advanced reading of time-series (Henshaw 1995).

Big ideas may help, but the real value of this approach is its potential for helping individuals better understand the complex systems and relationships that are most familiar. One can revisit these subjects repeatedly in life and in one's imagination from many points of view to gain perspective, then imagine the rise and fall in the intensity of change over time and scan for the turning points from which to learn.

There are many directions that continuing work on this subject might take. In general, there is a great need for a better understanding of the future from a natural systems viewpoint on all levels. Too often in the past, the future has been left to wild speculation. Most likely, it will proceed by emerging and resolving growth processes. It would help if we thought more about past, current, and future developments in nature's way. Then we could ask questions like what will happen if the economy keeps escalating the life struggle for everyone worldwide. With a better understanding of the role of growth systems in our lives and the importance of making a timely *turn-forward*, we can do much better. Choosing to rely on our learning skills rather than overused old formulas would indeed be a big risk, but we do have skills, and the evidence of nature is that at a great many new lives can trust their gifts.

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8 Data Sources

8.1 Climate

1. Atmospheric CO2 PPM 1501-2019 Fig 2
   http://scrippsco2.ucsd.edu/data/atmospheric_co2/icecore_merged_products
   Atmospheric CO_2 record from splined ice core data before 1958, and yearly average measurements from of Mauna Loa and Antarctica after and including 1958.
   (Keeling & Keeling 2017; Macfarling 2006).

[18] Henshaw 1990s research archived as "The Physics of Happening" - https://synapse9.com/drwork.htm

8.2 Economic

2. GDP (PPP) 1971 – 2016* Fig 2
Archived IEA PPP data extended with recent World Bank data, see Fig 13 for illustration
WB: https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD?end=2016&start=1990

3. World economic energy use 1965-2017 – Fig 2
BP: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html

4. Modern CO2 Emissions – 1971-2016, Fig 2
Archived IEA CO2 data extended with WRI CO2 emissions: https://www.wri.org/resources/data-sets/cait-historical-emissions-data-countries-us-states-unfccc

5. Historical Co2 Emissions 1751-2013 Fig 2
US DOE DOE CDIAC data: https://cdiac.ess-dive.lbl.gov/ftp/ndp030/global.1751_2014

6. World Meat Production – 1961-2016 Fig 2
Rosner - OurWorldInData: https://ourworldindata.org/meat-and-seafood-production-consumption

7. World Food Production – 1961-2016 Fig 2
FAO: http://www.fao.org/faostat/en/#data/QI

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