Chapter 9 Embracing Disturbance for Periodic Transformation

Sometimes brick walls need to be torn down and turned into foundations.

After any man has been the boss for ten years he should fire himself,
no matter how good he is at his job.

It is the very nature of life to strive to continue in being. Since this continuance can be secured only by constant renewals, life is a self-renewing process.[290]

Practice resurrection.[291]

Have you changed your marketing strategy in the past year?
Are you willing to alter your practices in the face of unforeseen challenges?
Have you changed management structure in last five years?
Have you changed who's in charge of various enterprises lately?
Do you like to shake things up every now and then?

Where did life come from? No one knows, but all indications are that the astounding diversity of life on our planet arose through a series of transformations as organisms adapted and innovated to respond to the living and nonliving forces around them. Punctuated equilibrium researchers[292] have amassed an amazing amount of evidence showing that all living systems arose through emergent transformation.

It's easy to see how adaptation and innovation are crucial to survival and resilience. Less obvious is that an innovation at one scale is a vast transformation at a lower scale. Transformation at a lower scale is often required for any system to be resilient. At any given scale, however, transformation can be required for resilience. Our task here is to explore the quality of resilient systems which enable them to transform themselves: "the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable."[293]

In learning the crucial factors conditioning resilience, you have probably noticed how integral transformation is to resilient systems. The change and adaptation needed to meet disturbances from weather to disease to new predators will often have emergent and transformative qualities. In fact, within every factor of resilience lies transformation as a subtle or predominant force. Transformation is key to developing new relationships when exercising modular connectivity. Transformation is the result

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[290] Dewey, J. 1922. Democracy and Education: An Introduction to the Philosophy of Education. New York: Macmillan.
[291] Berry, W., 1973. Manifesto: The Mad Farmer Liberation Front. The Country of Marriage, Harcourt Brace Jovanovich.
[292] Gould, S.J. and N. Eldredge, 1977. The Tempo and Mode of Evolution Reconsidered, Paleobiology, 3: 115-151.
[293] Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. Ecology and Society 9(2): 5. http://www.ecologyandsociety.org/vol9/iss2/art5/

of the unique organizations that emerges from locally self-organized systems as individuals determine what the greater whole will look like. To become ecologically integrated, working with nature, requires a monumental transformation in our conception of agriculture, a massive transformation of practices and ideas. When practicing conservative innovation, systems can create radical innovations which transform their entire systems. When building infrastructure, redundancy and backups, the system is building enough reserves to weather most disturbances and provides the foundation for transformation in the face of others.

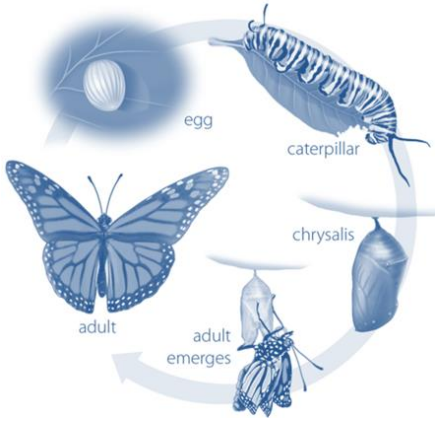
This chapter will illustrate the transformation process in both Nature and man's social ecological systems and how we can harness this piece of the resilience puzzle.

In all resilient systems, death is renewal

So often we perceive change as a kind of death or end, something to be mourned and prevented for as long as possible. What does this mean for resilience as we delay our transformations? We can take lessons from natural systems in the butterfly, the mushroom and fungi, as well as seeing what happens when a thicket is left to mature for too long without interruption from fire or flood.

In this case the thicket that has never been thinned by a disturbance develops into a thick, dense stand of small trees all combating for light, stunted in their growth. Many smaller trees perish in the struggle to reach light and find nutrients. One day in the heat of summer as all the moisture has been wicked up by these hungry trees, a fire erupts in a neighboring prairie. Soon this fire reaches the edge of the thicket, quickly bursting into a massive forest fire as the small trees are quick to ignite. What trees remain are surrounded by extreme decimation, many seeds latent in the ground have been destroyed due to the extreme heat from such dense growth. This extreme disturbance triggered by a lack of transformation results in the exposed soil eroding in the next rainfall, potentially leaving only stone and clay behind. It will take a long time to recover these areas, if ever, into lush growth and tall healthy trees.

If, on the other hand, the forest had regularly been subjected to forest fires the ticket would have been thinned earlier, more species would inhabit the areas between juvenile trees meaning a larger seed bank, the heat from each fire would be less extreme causing less damage. The longer we allow our systems to similarly clog up without managed transformation, ours will similarly collapse under the intensity of the change, unmanageable excess of resources that erupt will be wasted in the rush to find solutions.



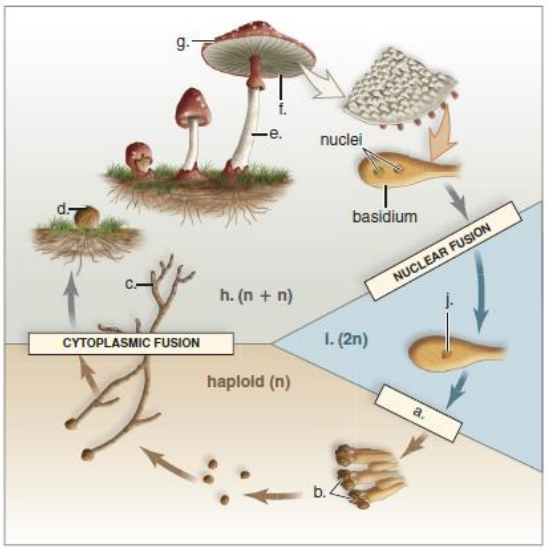
The butterfly effect in resilience.[294] One of Nature's most spectacular transformations (butterfly metamorphosis) illuminates transformation throughout living systems. Around 280 million years, some insects began to hatch from their eggs not as minuscule adults, but as wormlike critters with plump bodies and many tiny legs. After forming a chrysalis or cocoon, these larvae release enzymes which dissolve nearly all of its

[294] Not to be confused with the butterfly effect in chaos theory where a small change (symbolized by the flap of a butterfly's wings) can lead to self-organization of a powerful force (such as a typhoon).

tissues. However, some organized groups of cells survive. These clusters of cells called imaginal discs, first form when an insect embryo develops in its egg. The imaginal discs remain dormant until the larva has been destroyed, then they rapidly proliferate and grow into adult legs, wings and eyes, using dissolved larval cells as fuel and building blocks.[295]

Similarly all resilient systems carry the equivalents of imaginal discs (such as seeds or new inventions or new social organization) which enable the system to transform as it uses the resources generated in previous stages.

A mushroom analogy for resilience. The fungal structure we call a mushroom is the very transitory fruiting body of an organism which can live for centuries and occupy acres of soil. The mushroom only appears when the organism (as mycelia underground, in decaying logs, or in plastic bags) has colonized all the available territory. Only then does it produce the fruiting body of the sexual phase which produces innovative offspring which can colonize new territories.[296]



All resilient systems follow this path. Most of life is spent in the growth and maturation phases. But when needed, the alpha phase is begun to create the transformation and innovation which leads to more fit, evolved and productive systems.

Other ecosystems show how species can embrace disturbance to increase their own resilience. Some chaparral species don't re-sprout from the base after a fire, but reproduce only when fire stimulates germination of seed. The regular clearing away of old growth leads to innovative chaparral plants. By losing the re-sprouting ability and acquiring the post-fire seeding strategy, plants greatly increase their fitness in ecosystems with predictable fire recurrence, and thus access new ecological conditions causing rapid and sometimes spectacular adaptive radiations.[297] In a similar fashion our ability to build redundant, backed up systems means we can be as responsive to disturbance as these species. By accepting and integrating disturbance and planning for it, we can not only overcome disturbance but also then thrive in the aftermath.

Stability can undermine ecological resilience. A stable, mature forest in which fires are suppressed will eventually become a raging inferno which scours the landscape. The result is often massive erosion and destruction of seeds and roots. The stability of the forest results in reduced capacity of the system to

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[295] Jabr, F., 2012. How does a caterpillar turn into a butterfly? Scientific American, http://www.scientificamerican.com/article/caterpillar-butterfly-metamorphosis-explainer/

[296] Some mushrooms and fungi have lost the innovation-inducing sexual phase. They are known as fungi imperfecti or Basidiomycetes. Not to be confused with the mushroom theory of management where employees are kept in the dark and fed unsavory material. http://www.urbandictionary.com/define.php?term=mushroom+management

[297] Pausas, J.G. and Keeley, J.E., 2014. Evolutionary ecology of resprouting and seeding in fire-prone ecosystems. New Phytologist, 204: 55–65

regenerate. An unstable ecosystem, with small fires and other disturbances occurring every year, maintains a variety of systems from meadow, to savanna, to forest. Disturbance is required to maintain the diversity needed for resilience.

What we can take from this example is the realization that regular, systematic changes in any system will encourage new growth, mitigate losses and bring in new talent and ideas. As the title suggests, death and change are opportunities for renewal providing us with unique opportunities for growth *every time*. Just as the forest will never reorganize in exactly the same way it was before, neither should our systems. It behooves us to engender in our organizations and businesses with a willingness to change and accept new practices and ideas to fit our changing world and culture.

Approaches to disturbance before ecological resilience

Before resilience theory emerged, many ecologists saw dissolution or breakdown as the final stage of an ecological system. Ecological resilience does not. Before the concepts of balance of nature and climax communities were demonstrated to be inadequate in ecology, some eminent ecologists such as Howard Odum viewed the mature climax community, e.g. an oak-hickory forest in the American Midwest, as a steady-state system which is far more sustainable than a growth-oriented ecosystem.[298] Many modern agroecologists seem to also see the most sustainable system as a well-developed, stable, mature system which recovers from disturbance and adapts to change.[299]

The conventional wisdom in many sustainability circles that "stability and balance are good and growth is problematic" should be leavened with the reality of ecosystems. In fact, trying to maintain stability within a climax community may actually erode resilience. By keeping one particular system stable, the resilience of the larger system may crash. U.S. agricultural commodity policy--promoting stability while decreasing diversity, redundancy and flexibility—is widely believed to undermine ecological resilience of our agricultural system.

Approaches to adversity in psychological resilience

Similarly, in psychology, the resilience concept emerged as a competitor to a deficit model of child development. The latter approach views child development as a linear process; deviations from this process, resulting in deficits, are, through empirical studies related to certain adversities. This model provides a simple mandate when addressing those subject to a high risk of adversity, such as children in poverty: decrease the risk of adversity; when it strikes, try to rectify it.

Those few who faced significant adversity and did not show deficits were rarely studied; no one had asked if anything contributed to their resilience. They were thought to be anomalies. Studies beginning in the 1970s turned their attention to these supposed outliers. Significant relationships were established between high-risk children who were resilient — showed few or no deficits as adults — and family functioning, school environment, and community services. Studying resilience in individuals identifies protective factors in addition to risk factors.

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[298] Odum, H., 1974. Energy, Ecology, & Economics, http://www.sustainabletucson.org/2007/01/energy-ecology-economics-by-howard-t-odum-intro-by-bob-cook/

[299] Gliessman, S., 2004. Agroecology and Agroecosystems. In Agroecosystems Analysis, http://www.canunite.org/sites/default/files/agroecology%20and%20agroecosystems2004.pdf

Stressing returning to normal undermines resilience. A significant limitation with the engineering approach to resilience is the idea of "restoring conditions" or "returning to normal." Children in poverty who overcome adversities do not stay the same, but they can still be seen as resilient. Cities subject to disastrous events that are notably different afterwards can still be seen as resilient. Crises can even generate increased resilience to future adversity, though not necessarily.

One slogan of resilience thinking is "Embracing Change." One part of this is accepting that change in response to adversity is itself normal. Fighting against it, as well, can actually cause a decrease in resilience

Sustainability is about preservation of some thing or some function, implying the desirability of what is preserved. Sustainability may be promoted in ways that don't involve basic change: risk aversion, crisis recovery, and increased efficiency. When we realize disruptive events of a certain magnitude cannot be avoided, however, then sustainability over time cannot be accomplished without transformation.

Destruction of societies by managing to minimize disruption. Many researchers have[300] illustrated how societies which focus on stability can undermine resilience. Agriculture replaces hunting and gathering making societies more resilient to changes in wild resource base. Human population rise is accompanied by irrigation and other technological changes which makes the system more resilient to drought.

These shifts in the agricultural system developed into more reliance on irrigated agriculture, setting into motion a loop of soil degradation and increased agricultural intensity. This process can then lock the system into a degraded state (soil degradation) with high dependence on irrigated agriculture. Hundreds of societies have disappeared around the world—all due to a single-minded focus on sustaining food supply by decreasing effects of disruptions.

Innovation, self-organizing, creative destruction and transformation

Conservative innovation was previously discussed in the context of adaptation to disturbance. Innovation can also *create* a disturbance which transforms the system. Technological innovations often are such powerful innovations that they transform nearly every aspect of our lives as humans and the lives of other creatures around us. The automobile replaced the horse and buggy, the smart phone has largely replaced land line phone, the calculator, alarm clock, the point and shoot camera, video player and recorder, audio recorder, photo album, watch, and even flashlight. Creation of new industries results in destruction of old industries.

Creative destruction is a process through which something new brings about the demise of whatever existed before it. The term is used in a variety of areas including economics, corporate governance, product development, technology and marketing. In product development, for example, creative destruction is roughly synonymous with disruptive technology.[301]

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[300] See, for example: Anderies, J. (2006). Robustness, institutions, and large-scale change in social-ecological systems: the Hohokam of the Phoenix Basin. Journal of Institutional Economics, 2(02):133–155; Lowdermilk, 1953. Conquest of the Land Through Seven Thousand Years. United States Department of Agriculture.

[301] Joseph Schumpeter, an Austrian-American economist, developed the concept of creative destruction in his 1942 work, Capitalism, Socialism, and Democracy.

Creative destruction allows an innovation to induce a release and dissolution (omega) phase for some subsystems. When moderated by the other aspects of resilience the larger system becomes more adapted.

The dark side of creative destruction occurs when the conservative forces pushing the systems toward survival and reproduction are subverted. Unpredictable self-organization, the foundation of all innovation, in human societies is often divorced from the conservatism which insures that innovations contribute to the survival and reproduction of the society. Societies in the mature or K phase often have so many assets that they support innovations which undermine their foundations. Such innovations don't survive long in any ecosystems whose assets are continually under attack by competing adaptive systems. But if the system has accumulated assets which enable it to sustain itself in the short run, it can destroy creative destruction, the foundations for long term resilience.

Complex adaptive, self-organized systems also generate new questions: if certain parts or subsystems can fail, which parts do we want to continue to operate? And in the event of which sort of crisis? The simpler view of ecosystems before ecological resilience arose obviated both questions, because the resilient system maintains all of its subsystems and interactions between them, and disturbances were assumed to be external.

Resilient systems thrive on disturbance by using it for creative destruction. In resilient systems, in contrast to the standard course of human societies, dissolution of the old is a precursor to a more powerful system.

System identity and cycles

Ecological resilience research itself transforms our concept of system identity and cycles. Ecosystems do not tend toward single, stable identities, but rather have the potential to exhibit multiple identities, and can rapidly shift between them. Further, all ecosystems move through cycles of change. No ecosystem is static; for instance, ecological communities do not tend toward a stable distribution of species, but are always changing.

Management of ecosystem requires transformative shifts in identities. Agricultural systems must be managed to embrace change, transformation and reformation if they are to be resilient. Throughout history when agricultural systems were forced to conform to the standards and expectations of the past, chaos and shortage ensued[302]. As we discussed earlier, as cultures became reliant on irrigation and kept using it despite droughts and shortages, systems inevitably collapsed. Our own system is overdue for the kinds of innovations not seen since the introduction of the tractor and heavy equipment. Innovations are required that are diverse and unique to each bioregion, sensitive to the ecosystem they affect. One of the most publicized systems in need of transformation is the extensive use of water from the Colorado River and the Central Valley to irrigate New Mexico, Arizona and California. Unless we embrace the change that is called for in these states to mitigate water consumption and planting crops suited to the environment, we are inevitably headed for a system collapse which will affect millions of acres of farmland as well as millions of households who also rely on the waters of these rivers.

[302] As an example, let's look at the fall of the Roman Empire. It has been cited consistently as a comparison that is similar to our own global situation today: http://www.edwardgoldsmith.org/28/the-fall-of-the-roman-empire/

Ecologists who use the complex adaptive systems approach understand management is itself part of the system in question. One doesn't just study ecosystems, but social-ecological systems, which includes the actions of the managers of the ecosystems, the users, the advocacy groups that seek preservation, and anyone who has some interest in the ecosystem. Management, then, must also foster diversity, modularity, connectivity and redundancy. In addition, it must foster innovation and novelty, experiment, innovate, and encourage endogenous self-organization and novelty.

One example of a current project that embraces new concept and new tactics is one from Colorado. There is the Crystal River basin where in the early 1900s, and again starting in the 1950s, miners pried coal from these mountains, easing 100-ton loads down the switchbacks. Now the mineshafts are closed, but the tangle of roads, along with 100 acres of waste-rock piles, remain major erosion problems. On this site a unique merger is occurring between the Forest Service, local cattlemen and environmental groups. This marks a new age of cooperation for the greater good, "The real issue here is taking care of environment, doing it in a unique manner, and doing it with unusual partners."[303] With a 3-year plan to halt, or significantly slow down the erosion of the landscape. Already in the Coal Basin after using a three-year "cow stomp" to integrate biochar, compost and rotational grazing, results are becoming evident in new grasses, and decreased erosion in the 1-acre test plots of the 50-acre site.

Through mindful and inclusive management we can work together to solve larger problems with innovative solutions. It is up to the individual as well as organizations and governments to embrace this network and employ those ideas that bolster resilience of a landscape, as the Cow Stomp project seeks to achieve through unique, overlapping solutions to a common problem.

Management flips system between states. Management of rangeland and savanna systems[304] illustrates how management determines ecosystem state. Consider a system with two states: one with a balance between grass and shrubs with periodic fires and one with little or no grass, dominated by shrubs.

A flip can be induced by overgrazing or fire suppression or by controlling grazing and prescribed burns. Increased grazing and fire suppression can reduce the resilience of the desirable basin (the one with plentiful grass and few shrubs) to a drought.

By embracing disturbance, managers increase resilience of desirable systems. The system is exposed to discrete, low-level events that cause disruptions without pushing the system beyond a critical threshold. Such frequent, small-scale disturbances can increase system resilience and adaptability in the long term by promoting natural selection and novel configurations during the phase of renewal.

Disturbance regimes, defined as the repeated exposure to certain shocks over time, push the processes of evolution and adaptation in ecosystems and build ecosystems' capacity to recover from future disturbance. As long as the disturbance does not push the ecosystem too close to or beyond a critical

[303] Commission Chairman John Martin in an interview with Post Independent - http://www.postindependent.com/news/8432996-113/project-county-support-crystal

[304] Anderies, J., Janssen, M., and Walker, B. (2002). Grazing management, resilience, and the dynamics of a fire-driven rangeland system. Ecosystems, 5(1):23–44; Janssen, M., Bodin, Ö., Anderies, J., Elmqvist, T., Ernstson, H., McAllister, R., Olsson, P., and Ryan, P. (2006). Toward a network perspective of the study of resilience in social-ecological systems. Ecology and Society, 11(1):15; Walker, B., Ludwig, D., Holling, C., and Peterman, R. (1981). Stability of semi-arid savanna grazing systems. Journal of Ecology, 69(2):473–498.

threshold, the system can recover and may even be stronger upon reorganization. Disturbance initiates the release of resources that have become sequestered or bound up so that other components can take advantage of them while forming novel configurations; disturbance loosens rigidity.

However, for exposure to disturbance to achieve the desired effect of building resilience, and not the consequence of pushing the system beyond a threshold, the system must be robust, with a strong foundation of ecosystem services and governance. Managed (or unmanaged) properly, disturbance contributes to agroecosystems' resilience in two ways. First, it facilitates diversity as described above. Disturbance regimes affect the landscape irregularly, creating a mosaic of plant and animal communities in various stages of succession. Second, it sets into motion the phase of renewal and reorganization. Resources are then redistributed and reorganized into novel configurations that are more adapted to the changing conditions.

One analogy for how the careful introduction of disturbance can build resilience is from the technique of breeding horizontal resistance in crops. In the first round of the breeding process, a crop is exposed to a pathogen for which breeder's desire resistance. Individual plants that show full resistance are discarded, and plants that are highly susceptible die. Only plants that show partial resistance are bred for the next generation, and the population exhibits a range of resistance to that particular pathogen. With horizontal resistance, some damage and loss is accepted, but overall crop resistance is preserved by the genetic variability of the overall population. In breeding for vertical resistance, on the other hand, only plants with full resistance are selected and back-bred until the population is genetically uniform. No amount of loss or damage is accepted. Resistance, in this case, is either on or off, with no variability. Defense mechanisms function as long as the pathogen does not evolve, but once it does, it can lead to total crop loss. The difference between building horizontal and vertical resistance in crops parallels the long-term benefits gained from carefully introducing disturbance into the agroecosystems.

Governance of social ecological systems

Resilient societies have instituted regular and orderly disturbance by changing those who are in power. At least every eight years the U.S. President is replaced. This embrace of disruption is hardly the norm in the world's societies. Robert Mugabe's continuous rule in Zimbabwe since 1980 has eliminated productive businesses and farms and stimulated perhaps "the most rapid disintegration yet of a modern nation-state."[305] There is a remarkably high correlation between length of time in office of a country's leader and stagnation or decline in living standards in a country.[306] No matter how benevolent a dictator, he is limited by his own experience and networks. In ecological resilience this is an example of rigidity or poverty trap: the governance of a system insures that the system does not move into more adapted state.[307] The system does not change and may appear resilient in the short run, but undermines any long-term resilience of the system.

[305] http://www.latimes.com/opinion/la-op-kirchick30sep30-story.html#page=1
[306] http://en.wikipedia.org/wiki/List_of_longest-ruling_non-royal_national_leaders_since_1900
[307] Carpentter, S. and W. Brock, 2008. Adaptive capacity and traps. Ecology and Society, http://www.ecologyandsociety.org/vol13/iss2/art40/

Governance of systems may maintain a system in a poverty trap not only through the perpetuation of one particular leader. In fact, more pernicious influences on resilience are rigid cultural mindsets[308] and other controllers of governance structures (such as well-heeled lobbyists).[309]

Following are a number of illustrations of innovations which could lead to transformations to ecological resilience, but have thus far been stymied by such mindsets and gatekeepers.

Transforming Practices. There are many new and innovative ideas circulating in the world of business related to ecological resilience. Depending on what field you specialize in, from production to distribution, there are new models coming out nearly annually that are alternatives to standard management structures and operational guidelines.
These changes can be implemented intentionally, though more often than not it is due to extra-ordinary circumstances that force us to reorganize and restructure our business models.

Take Randy Hardin, our case study from Central Arkansas as a prime example. His farm was highly diversified and fed into a larger business that housed a pumpkin patch, corn maze, restaurant and educational opportunities for children all over the property including replicas of American Indian and colonial homes on site. Business was going great, he employed a tremendous staff generating wealth in the local economy and his business model was built on providing enjoyment and education to all ages. As luck would have it, a highway was constructed right through the center of his property, effectively cutting off the vegetable fields that fed into his restaurant and creating too much liability to have children around with the new highway looming nearby. Rather than packing up and taking a job in the city, he transformed his model choosing to reopen a new store in a nearby town that specialized in locally grown food and culinary products as well as a successful BBQ and ready-made meals for the ageing populace around him. It was his willingness to transform the model to something new, choosing not to maintain the old business in the face of game changing disturbance.

Another example is a model termed Innovative democracy[310], a term made coined by the manufacturing company W.L. Gore and Associates which makes Gore-Tex and a number of other products for uses from space travel to sports arenas. Their management model has no managers, bosses, or subordinates. Rather, everyone is an associate working in small teams. In this way Gore is a network of individual units all working separately though contributing to the greater whole. The underling philosophies within Gore celebrate innovation, self-motivation and transparency in leadership and decision making. This concept came about when Bill Gore left a previous company he felt stifled in his work. Moreover he felt like the benefits of what is now Gore-Tex weren't being fully realized within his previous corporate environment. He chose then to leave with the right to Gore-Tex and start his own company with totally transformed ideas about how to manage people. His model, though time consuming due to the time it takes to make decisions in such a democratic fashion, lends itself to highly motivated, committed people working on multiple projects simultaneously. Moreover these individuals get to choose what they work on lending the ability for people to use their strengths and propel projects forward faster.

[308] Diamond, J. 2005. Collapse: How Societies Choose to Fail or Succeed. Viking.
[309] Gunderson, L., et al. Escaping a rigidity trap: governance and adaptive capacity to climate change in the Everglades social ecological system. Idaho Law Review, 51:127-156.
[310] http://www.managementexchange.com/story/innovation-democracy-wl-gores-original-management-model

In agriculture another way to look at new management schemes of profit-sharing based on total transparency for farm costs and profits. The cost of seed, fertilizer, labor and all other expenses that are normally kept from the laborer. When this information is on the table, many laborers feel more integrated into the whole and therefore are more enthused and engaged in the entire production process. Some farmers have even taken the approach of using this transparency to develop harvest time incentives. One farmer used this model because he didn't have the money to pay a living wage until harvest time and because of his transparency on the matter laborers agreed to wait for full payout until harvest. The result was that laborers would come out on their days off, pruning, paying careful attention to the plants because they had a unique buy in. At harvest they had the best crop on record generating more profit than was expected, providing the farmer and the workers with a bonus.[311]

It's important to look around at different models for inspiration as to how to change your own system for the better. Through our willingness to acknowledge our systems' shortcomings, we find opportunities to change not only our practices but our models and the implicit theories of management.

Willingness to transform. The heart of conservative innovation is the ability to recognize good ideas and move forward with them! If you're not able to recognize the power of a truly great idea, transformation will be stifled. Moreover if you're resistant to embracing an inevitable change, like the transition to agriculture that generates healthy soil rather than destroying life through the application of pesticides with reckless abandon, your business will eventually be outdone by competing producers.

It comes down to a willingness to be wrong just long enough to find out what's "right" and acting on that information. Pride and prejudice are degenerative forces when it comes to making real and substantial changes for the better. Throughout history, cultures have shifted their ideals and practices to encompass the winds of change, bending to make space for new and improved ideas. We will look now at a few examples of how human cultures of the past have made these transitions to help illustrate not only that drastic change is possible, it is inevitable.

Transforming History – Landmark examples of transformation to a new age

Throughout history we can find remarkable examples of new systems that changed the way we live dramatically. Innovations that have led us to where we are now in our cultural practices. Here we will take a look at just a few examples of transformations that have taken place to inspire you, illustrate possibilities and lend insights for where humanity may, or may not go.

From Forest to Field – The Transition to Agriculture

The most profound transformation of ecological systems occurred with the transition from hunting and gathering to agriculture. Beginning with domestication of plants and animals in many different locations around the world, the agricultural revolution transformed small, mobile small groups into villages, towns and cities. Innovations in individual species have made them unrecognizably different. The few tough, small kernels on the ear of the wild progenitor of maize has become today's sweet corn that makes a whole meal on a hot summer's day. The transition resulted in radical alternations of the local ecosystems.

[311] https://attra.ncat.org/attra-pub/viewhtml.php?id=330

Though it took eons to create the vast array of high yielding herbs and vegetables we have today, it was a change in mindset, and culture that allowed people to settle down and transform the ways of their ancestors. Agriculture matured differently on each continent as Europeans noted when they came to the Americas. The American Indians grew their produce in clumps, grouping plants together in guild planting. When Europeans came to the continent for the first time, they had a hard time distinguishing between an overgrown field and the agricultural plots of the Indians.

Another practice alien to the Europeans was the Aztec use of chinampas. In this innovation, swampy areas were turned into fertile farmland by piling mud from drainage ditches onto mats secured by posts. The woven mats covered with rich soil both enabled them to grow in more areas, while the water underneath the woven mats supplied much of the irrigation needed for their crops. This was much unlike the models of the Spanish who grew their crops on dry land.[312]

Even further South, tribes used biochar to build up fertile islands in the Amazonian swamps and jungles. Even today, these areas remain with vastly elevated organic matter compared to surrounding lands.[313]

All of these regions generated self-organized, totally unique approaches to make the transition from hunting and gathering. Unfortunately these innovations were ignored by the European settlers since they fell outside the scope of European farming practices.

European settlement of America and global transformation. Some contend that the biggest transformation in the planet's history happened in the early 1600s as a result of European settlement.

Two global signatures appear in about 1610. Pollen from imported New World crops begins to appear in Europe, and a massive dip in carbon dioxide levels can be seen in Antarctic ice cores dating to that time. Both of these events are a direct result of increased trade and transport of animals and plants across the Atlantic Ocean — a barrier which had previously kept the New and Old Worlds separated for millions of years. Today nearly all the crops grown in some parts of the Old World (maize, sweet potatoes, Irish potatoes, cassava, beans) originated in the New World and helped transform societies worldwide.

In the case of the global dip in carbon dioxide, this appears to be the result of the deaths of millions of indigenous people in the aftermath of European colonization. As many as 50 million Native Americans died in the aftermath of European expansion into the New World, mostly as a result of infectious diseases such as smallpox. As their numbers dwindled, the resultant loss in agriculture allowed for forests to re-grow throughout the Americas. These expanded forests scrubbed the atmosphere of carbon dioxide.[314]

The destruction of the previous system enabled the rise of a new system.

The Industrial Revolution

Before the industrial revolution people spent either much of, or their whole lives in small villages, producing for their region on a small scale. A stable system, it was fast disrupted by the innovations that ensued with changes in working conditions and capabilities. What happened over the 150 years

[312] http://www.aztec-indians.com/aztec-farming.html
[313] http://www.biochar.org/joomla/index.php?option=com_content&task=view&id=114&Itemid=7
[314] Lewis, S.L., and M. A. Maslin, 2015. Defining the Anthropocene. Nature, 519:171–180.

commonly associated with the industrial revolution are paramount to the changes that can and are happening today with the inclusion of new technologies and strategies.

The battery, lightbulb, large scale manufacturing, locomotive and personal vehicle are just a small selection of the inventions that were realized over that period. We've discussed the effects of creative destruction by specific technological innovations. However, a broader shift is even more transformative. The industrial revolution caused great leaps and bounds in productivity but it also saw many social, environmental and economic issues arise. This mix of results is one reason for bearing in mind the element of conservation in our innovations. In our rush to transform our culture (for example into a more inclusive and environmentally conscious one) we must consider what effects our decisions will and do have on those around us, from other humans to plants, animals and our atmosphere.

As we continue in our industrialized world we have reached a climax, entered into the conservation period of our adaptive cycle. Now is the time to develop an ecological approach to technology, integrating the earth's tried and true ecological processes into our vision for productivity and efficiency.

Transformation today

In today's world, innovations are emerging are an exponential rate. With such innovation occurring in so many sectors and with so many minds working on wicked problems like energy production, poverty and climate change, there should be plenty of potential solutions to test and evaluate.

Are these innovations being stifled by powerful interests or impersonal market forces? Or are they occurring all around us and we don't see them because we are blinded by our non-resilient view of the world?

Stephen Hawking suggests the emergence of the silent revolution, one that is emerging out of the millions of non for profit and humanitarian agencies across the globe all working independently on these monumental issues of our day and age. Each one working on issues that are local as well as global finding solutions that work in a range of settings and climates. Though their successes are often shunned or disregarded by mass media their effects are relevant nonetheless. The Pachamama Alliance[315] offering support to indigenous tribes in the Amazon rainforest and beyond, Homeboy Industries[316] in Los Angeles, CA helping Latino gangs in Los Angeles and El Salvador. These are just two of the innumerable government, religious and independent organizations transforming local systems around the world.

Just a few statistics to help illustrate the changes:

> Amount of global investments in renewable energy in 2004: **$40 Billion**
> Amount of global investments in renewable energy in 2013: **$214 Billion**[317]
>
> Number of protests worldwide in 2006: **59**
> Number of protests worldwide in 2012: **159**[318]

[315] The Pachamama Alliance http://www.pachamama.org/
[316] Homeboy Industries http://homeboyindustries.org/
[317] Originally cited from YES magazine, issue #__
[318] As defined in a study by the Initiative for Policy Dialogue and the Friedrich-Ebert-Stiftung New York Office

Number of cell phone users in 1990[319]: **12.4 Million**
Number of cell phone users in 2011: **Over 6 Billion**

Total world capacity for production of solar power in 2004: **3.7 Gigawatts**
Total world capacity for production of solar power in 2013: **139 Gigawatts**[320]

Approximate change in Earths freshwater wildlife population 1970-2010: **-76%**
Approximate change in Earths terrestrial Wildlife population 1970-2010: **-39%**
Approximate change in Earths human population, 1970-2010: **+185%**[321]

These highlights offer a few different perspectives on the fast changes that are occurring on this planet and how humanity has changed and transformed the planet. Sometimes for the better, sometimes for the worse. As our damage becomes greater, so our solutions must adapt. Today there are inventors looking to develop sea based energy, harnessing the wave energy just off our coast line. Similarly, young inventor Boyan Slat[322] age 19 has devised a technique wherein he and his colleagues suggest they could clean up the ocean in roughly 5 years' time and make a profit doing it by building a grid of solar and ocean powered buffers that would collect plastics and separate them from lifeforms like plankton.

These are large scale solution to fit large scale problems, much larger in fact than even the largest single mono-crop, pesticide rich farms dominating many of the landscapes across the U.S. Midwest. There are large scale problems present in agriculture that likewise are in desperate need of these large scale solutions. Whether its pesticide run-off into estuaries, erosion causing loss of top soil, depletion of water in the western United States and around the world, or the decimation of natural biota in the soil, we need to be open to creative solutions that mitigate and eventually eliminate the damages reaped by these systems.

Within this need to transform, however, how are we balancing the knowledge of the past with our need and desire to innovate and change? Are we respecting and valuing the time tested models that built soils, cleansed water ways and grew magnificent oxygen-generating forest for centuries and millennia?

Embracing Tradition in the Transition. Author Hassan Fathy, mentioned in an earlier chapter talks extensively in his book Architecture for the Poor[323] about how to ensure that we embrace tradition as we innovate and develop modern technology and building styles. Though his beliefs could be perceives as stunting growth or stifling progress it is worth noting the immeasurable value of tradition and culture.

Much commentary has been made about the lack of concern for traditional culture within, particularly, American society. More and more as countries become more "developed" it is often at the expense of local traditions. Why is this? In our pursuit of the newest design theme and the most modern cities we have systematically removed the unique, totally original manifestations of art and architecture that have marked cultures, some for thousands of years. In Hassan's book he talks about the beauty of original

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[319] Bridget Borgobello 2013 - http://www.gizmag.com/mobile-pnone-40-year-anniversary-photos/25677/
[320] International Renewable Energy Agency, 2014. Rethinking Energy. http://www.irena.org/rethinking/Rethinking_FullReport_web.pdf#page=33.
[321] World Wildlife Fund, 2014. Living Planet Report. http://www.worldwildlife.org/pages/living-planet-report-2014
[322] http://vr-zone.com/articles/19-year-old-inventor-finds-way-to-clean-up-the-worlds-oceans-in-under-5-years-time/19381.html
[323] http://www.abebooks.com/9780226239163/Architecture-Poor-Experiment-Rural-Egypt-0226239160/plp

Egyptian designs, the unique domes, drawings, pillars and statues that in times past pervaded Egypt. He suggests that with this loss of traditional design local people lose something that is somewhat undefinable and that once lost is hard, if not impossible, to reaffirm. It is something like pride that is reflected in local crafts, specialty foods, regional tastes and styles.

We risk losing something that is invaluable, largely intangible and wholly unique to every locality. Whether it is cheese from Wisconsin, wild herbs from the Ozarks or Chinese provinces suited to the micro-climates, New York pizza, or the mud brick buildings so well suited to arid climates in Egypt, these particular signatures mean more than one might suggest. These foods, designs and crafts encompass generations of development, selection and taste that is irreplaceable.

This uniqueness and originality are possible if we choose to transform our systems through the lens and practices of resilience. It is only through locally self-organized systems that we stand to engender the same kind of constructive selection that develops into regional options.

Once there was an unmistakable flavor and view to the rural towns of the world and as we rush to "develop" and "grow" in the shadow of modern design and commercial interest, we steadily lose a piece of ourselves at the same time. The shadow cast by progress can shade out even the most resilient designs unless we understand the virtues and values of our cultures, our traditions.

What is your area's local specialty? How can you grow to support it? If there is no recognizable flavor or taste in your region, can you create one? What would that look like? How can you harness this time in our society that is asking for something local and original? We live in a unique time where the people of the world are poised for change, awaiting with a desire for something that feels and tastes like a home they often don't remember.

Using the Omega Phase of the Adaptive Cycle to harness Transformation constructively

Earlier in this book we looked at the adaptive cycle, the movement from conserved resources, to disturbance, to reorganization of resources, to growth, eventually returning to a conservation of resources. Many who understand the adaptive cycle would suggest we are in the conservation phase, at risk of a societal disturbance that is akin to the ecological impact of a rampant forest fire. The resources we have accumulated are astonishing, and we continue to accumulate through mining, production and accumulation of finite materials.

The encouraging aspect is our ability to harness where we are to manage our social, economic and environmental disturbances; if we are willing to adapt.

In agricultural systems we have many opportunities to see the coming change and adapt with both innovative and time tested methods. We cover many practices in the Working with Nature chapter of this book, here we strive primarily to further inspire you to action with the knowledge that you are empowered to create change on your scale. As more farmers, ranchers, mycologists and gardener's transition to more ecologically integrated practices, the seemingly small changes amount to something greater.

Predicting the future. Emergence and transformation are by nature unpredictable. Our minds can see present trends and make projections based on them, but we cannot predict something which is

unpredictable. However, we can be sure that society will evolve in one of an archetypal triad of directions—evolution, decline, or progression.

Progression assumes that economic interdependence deepens, dominant values spread, and developing regions converge toward rich-country patterns of production and consumption. Structural continuity is assumed. Core institutions are able to absorb disturbances and adapt to changing conditions. This view was widespread as the Soviet Union disintegrated. "The triumph of the West, of the Western idea, is evident first of all in the total exhaustion of viable systematic alternatives to Western liberalism."[324] Such gradualism makes the risky wager that stepwise responses will not be overwhelmed by any external disturbance or internal transformation. Progression is a near cousin of the discredited climax community and balance of nature concepts. The many conflicting impulses created by competing complex adaptive systems which composed the climax community have an inherent capacity to transform by as they embrace disturbance. In the progressive world-view, where progress is associated with economic growth and the good life with material consumption, it would take massive political will to counter the momentum of dangerous trends. Where would it come from? It's nowhere in sight. Perhaps it will come from a realization that this world in not a desirable vision. Do we really want the world to resemble a well-engineered mall, where the environment continues to deliver services and few people starve, but not a place where people and nature thrive?

If the world does not experience enough technological transformations to be able to achieve the "well-engineered mall," we are left with the bleak future of unattended crises and a deluge of instability swamping society's adaptive capacity, leading to a general global crisis and the erosion of civilized norms. Again, many different scenarios could unfold—enough to stimulate the creative juices today of an army of apocalyptic screenwriters and novelists. In one version, powerful international forces are able to impose social order and environmental controls, leaving elites in protected enclaves and an impoverished majority outside. In various breakdown scenarios, authoritarian interventions fail, chaos spirals out of control, and institutions collapse.

By contrast, the ecological resilience approach seeks to build at a local level the foundations of resilience we have discussed in this book: modular connectivity, local self-organizing, building assets, redundancy, complementary diversity, conservative innovation, and ecological integration. When these foundations are in place, the system can embrace disturbance and create transformation.

Managing the future: interactive adaptation and emergence. The interactive adaptation of all living organisms—often overwhelming in human social interaction--and the unpredictability of emergence, insures we cannot predict the transformations of the future. And higher the scale, the less likely we are to be able to predict how systems will adapt to each other and what new systems will emerge.
So let's come down to a level where you have a better chance of managing the future of a system: your farm or business or the land you work on.

The Back-ups/Redundancy chapter discussed how resilient systems must have a means of reproducing themselves. Systems which don't reproduce themselves, by definition, die. The transformation which is also a foundation of resilient systems conflicts, however, with our human urge to sustain the present

[324] Fukuyama, F. 1989. The End of History? The National Interest, (Summer 1989): 3-18; Fukuyama, F., 2006. .The End of History and the Last Man. New York: Free Press, 2006.

system. We build a farm or a business and we want to see it continue. Often, however, we are less likely to welcome the change which is necessary for it to continue.

This is especially true on farms. A new manager always brings in new ideas. The son or daughter has different ideas and lots of energy to implement them while their father does not want to let go of the reins. When no offspring want to farm, the farmer faces an even less certain transition. We've discussed means turning this dilemma into a resilient system in the redundancy chapter.

Facilitating the foundations of resilience by transformation. Passing on the farm is just one example of facilitating resilience through transformation. All systems enter an omega phase eventually, transforming to something new. Our task is to insure that we build up the foundations of resilience so something we don't expect doesn't destroy the system as a whole. Perhaps it's extreme weather destroying factories or power lines causing disruption in the supply of oil, or electricity. Maybe it's a market fallout of a certain type of equipment or crop that you rely on.

Escaping poverty traps. A great number of vicious cycles exist in which transformation is especially desired. Intensive irrigated agriculture leading to population increase which leads to more intense irrigated agriculture until all resources are outstripped and system collapsed is an example of positive feedback leading to what is termed a poverty trap. Government control of economy leading to a worse economy leading to more need for government control is another.

In resilient societies, innovators will bring in a disturbance instead of letting the vicious cycle rule.

Anderies[325] and Lowdermilk (ibid.) have illustrated how societies which focus on sustainability can undermine resilience. Agriculture replaces hunting and gathering making societies more resilient to changes in wild resource base. Human population rises is accompanied by irrigation and other technological changes which makes the system more resilient to drought.

These shifts in the agricultural system induce more reliance on irrigated agriculture, setting into motion a positive feedback loop of soil degradation and increased agricultural intensity. This process can then lock the system into a degraded state (soil degradation) with high reliance on irrigated agriculture. Hundreds of societies have disappeared around the world—all due to a single-minded focus on sustaining food supply by decreasing effects of disruptions.

Management to maintain, not transform, decreases resilience. Some types of adaptation are undertaken by governments on behalf of society, sometimes in anticipation of change but often in response to individual events. Such responses are short-sighted, and can even contribute to a worsening of the threat: droughts and water shortages in Melbourne, Victoria have, for instance, spurred the building of an energy-intensive desalination plant and creation of a pipeline to divert water from upstate.[326] Increased energy usage, along with a new dependency on a pipeline, certainly don't work to increase resilience

Forces resisting transformation. Transformation may mean that a forest burns, a business fails, or an innovation or social policy isn't successful. An attempt at transformation, by risking these events, may

[325] Anderies, J. (2006). Robustness, institutions, and large-scale change in social-ecological systems: the Hohokam of the Phoenix Basin. Journal of Institutional Economics, 2(02):133–155.
[326] Barnett, J. and O'Neill, S. (2010). Maladaptation. Global Environmental Change, 20(2):211–213.

promote resilience over a larger scale. Their failure or destruction seems a reasonable cost to bear in promoting a sustainable forest, a market economy, and better social policy, respectively. But when we consider people, alone or within families and communities, immediate ethical obligations may overrule the longer-term, or higher-level, view.

Faced with famine, an epidemic of acutely fatal infectious disease, or a natural disaster, the humanitarian response is geared towards preventing death or permanent disability. Yet to prevent this, one might need to overexploit resources to provide food and shelter, or to use antibiotics in a way that might increase the chance of resistant infections in the future. Until resilience has been built up enough, such difficult choices between present urgency and long-term sustainability still need to be made.

Low level transformation can forestall catastrophe. Resilient systems are often exposed to discrete, low-level events that cause disruptions without pushing the system beyond a critical threshold. Such frequent, small-scale disturbances can increase system resilience and adaptability in the long term by promoting natural selection and novel configurations during the phase of renewal; described as "creative destruction." An example is selection of crop varieties by exposing populations to pests and disease followed by selection of plants that fared well and exhibit signs of resistance

Disturbance regimes, defined as the repeated exposure to certain shocks over time, push the processes of evolution and adaptation in ecosystems and build ecosystems' capacity to recover from future disturbance.[327] As long as the disturbance does not push the ecosystem too close to or beyond a critical threshold, the system can recover and may even be stronger upon reorganization. Disturbance initiates the release of resources that have become sequestered or bound up so that other components can take advantage of them while forming novel configurations; disturbance loosens rigidity.

However, for exposure to disturbance to achieve the desired effect of building resilience, and not the consequence of pushing the system beyond a threshold, the system must be robust, with a strong foundation of ecosystem services and governance. Managed (or unmanaged) properly, disturbance contributes to agroecosystem resilience in two ways. First, it facilitates heterogeneity as described above. Disturbance regimes affect the landscape irregularly, creating a mosaic of plant and animal communities in various stages of succession. Second, it sets into motion the phase of renewal and reorganization. Resources are then redistributed and reorganized into novel configurations that are more adapted to the changing conditions.

One analogy for how the careful introduction of disturbance can build resilience is from the technique of breeding horizontal resistance in crops. In the first round of the breeding process, a crop is exposed to a pathogen for which breeders desire resistance. Individual plants that show full resistance are discarded, and plants that are highly susceptible die. Only plants that show partial resistance are bred for the next generation, and the population exhibits a range of resistance to that particular pathogen. With horizontal resistance, some damage and loss is accepted, but overall crop resistance is preserved by the genetic variability of the overall population. In breeding for vertical resistance, on the other hand, only plants with full resistance are selected and back-bred until the population is genetically uniform. No

[327] Gunderson, L. and Holling, C. (2002). Panarchy: understanding transformations in human and natural systems. Island Press; Berkes, F., Colding, J., and Folke, C. (2003). Navigating social-ecological systems: building resilience for complexity and change. Cambridge Univ Press.
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amount of loss or damage is accepted. Resistance, in this case, is either on or off, with no variability. Defense mechanisms function as long as the pathogen does not evolve, but once it does, it can lead to total crop loss. The difference between building horizontal and vertical resistance in crops parallels the long-term benefits gained from carefully introducing disturbance into the agroecosystem.

How does you system rate on the periodic transformation quality of resilience? Contemplate these questions:

Have you changed management structure in the last five years?

Have you changed who's in charge of various enterprises lately?

Do you like to shake things up now and then?

Are you hesitant to make changes in your farm?

Conclusions. Before the concepts of balance of nature and climax communities were discredited in ecology, some eminent ecologists such as Howard Odum viewed the mature climax community, e.g. an oak-hickory forest in the American Midwest, as a steady-state system which is far more sustainable than a growth-oriented ecosystem.[328] Many modern agroecologists seem to also see the most sustainable system as a well-developed, stable, mature system which recovers from disturbance and adapts to change.[329]

This maintaining equilibrium approach to ecosystems often leads to management failures. Disturbance can cause a system to dissolve or breakdown. Many see this as the final stage of an ecological system. Ecological resilience does not. Instead it is just once phase in the adaptive cycle. And it is a required phase all systems go through in order to evolve. The mammals could only take over when the age of the dinosaurs was over. Transformation or reformation is the stage which follows dissolution in a resilient system.

The conventional wisdom in many sustainability circles that stability and balance are good and growth is problematic should be leavened with the reality of ecosystems. In fact, trying to maintain stability and a climax community may actually erode resilience. By keeping one particular system stable, the resilience of the larger system may crash. U.S. agricultural commodity policy--promoting stability while decreasing diversity, redundancy and flexibility—is widely believed to undermine ecological resilience of our agricultural system.

Agricultural systems must be managed to embrace change, transformation and reformation if they are to be resilient.

Ecosystems are complex adaptive systems changing over time with changing environmental conditions. If management aims to keep a given system by enhancing its resilience, the system might become mal-adapted but still persist for a long time. Management must consider resilience as dynamic and changing in order to go beyond mere persistence.

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[328] Odum, H., 1974. Energy, Ecology, & Economics, http://www.sustainabletucson.org/2007/01/energy-ecology-economics-by-howard-t-odum-intro-by-bob-cook/

[329] Gliessman, S., 2004. Agroecology and Agroecosystems. In Agroecosystems Analysis, http://www.canunite.org/sites/default/files/agroecology%20and%20agroecosystems2004.pdf

Resilience is high during the pioneer stage α and growth or r phases. So establishing highly resilient ecosystems is facilitated by maintaining the system to these stages and circumventing the natural cycle.