Resilient Communities: An Ecological Perspective

by Tom Wessels

Tom Wessel's view of interdependent local ecologies lays out a conceptual framework for human communities and corporations. His rich examples of biodiversity provide great metaphors for how competition and negative conditions can be transformed by natural cooperation and can lead to self-organized, self-managed natural communities that are sustained by emergent systems and can co-evolve.

Many times while walking from Knoll Farm's "upper pasture" down to the barn, I have been stopped by the sheer beauty of the view that forces my eyes to rise to the crest of the Green Mountains. Within the many square miles encompassed by that view are species of organisms too numerous to count. Each of those organisms has their own specific way of living and yet somehow, through all their interactions, resilient ecosystems result. How does this happen? The very foundation for how those ecosystems thrive lies in the principle of self-organization.

Having come to light with the development of complex systems science in the 1970s, self-organization is a relatively young concept to science, but one, as we will see, which was clearly understood long before western science identified it.

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Self-organization, the observation that as a system grows, it gets not only bigger, but also more complex, is the hallmark of all biological, ecological, and healthy human systems. The increasing complexity of a self-organized system results from the parts becoming ever more specialized and at the same time more and more tightly integrated. As each part does what it needs to do to sustain itself, it creates conditions that sustain the whole. As a result, self-organized systems become increasingly resilient, stable, and energy efficient.

All of us are perfect examples of self-organization. We each started life as a single, microscopic cell. As we developed to adulthood, each of our single cells multiplied itself into more than 30 trillion cells. However, not only did the number of cells geometrically increase in number, they also differentiated into 254 different cell types, including skin, muscle, bone, and nerve cells. Yet the specialization didn't stop there. Some nerve cells connect to muscle cells, others to sensory cells, and yet others connect motor neurons to sensory neurons. As each highly specialized cell functions to support itself, it creates conditions that serve the whole body. As a result the internal environment of our bodies is stable and resilient.

Self-organization also occurs in ecosystems through evolutionary time. In nature, the fundamental currency is energy. Since energy is finite, any individual or species that wastes energy has a reduced chance of survival, while populations that are energy efficient can increase their numbers as a finite amount of energy can support more individuals. Natural selection continually pushes species to become ever more energy efficient through a process called *coevolution*. As we will see, cooperative interactions between species are far more energy efficient and integrative than are harmful or competitive ones.

Whenever two species first begin to interact, the nature of their relationship is often very negative for both parties. A dramatic example of this is seen in the accidental introduction of the chestnut blight fungus into North America in 1904. The fungus was present in Chinese chestnut trees planted at the Bronx Zoo and Botanical Garden. The Chinese chestnuts looked fine and healthy because they had coevolved with their fungus for tens of thousands, possibly millions, of years. However, the American chestnut had no such relationship with the fungus.

At the time the fungus entered the new world, American chestnut was the most common forest tree east of the Mississippi River. In the heart of the species' range, in the forests of Tennessee and Kentucky, one out of every two forest trees were American chestnut. Within thirty years of the introduction of the fungus; however, the American chestnut was almost completely wiped out. This was obviously a negative outcome for the chestnut; it was not good for the fungus either. If an organism *is* a parasite, the worst thing it can do is to kill off its host. That is an incredibly energy-wasteful outcome.

If two species survive their initial introduction, natural selection will force them to interact in less energy-wasteful, harmful ways. Over long periods of time through coevolution, relationships that begin disastrously, like that between the American chestnut and the chestnut fungus, can eventually develop into a mutualism where both species not only benefit but also need one another to survive.

My favorite example of mutualism involves the bull's horn acacia tree and its resident acacia ant. Both species exist in Mexico and Central America. The acacia has evolved three features to service its ants. These include huge, pliable, swollen thorns that no longer serve to ward off herbivores, but instead are first hollowed out by the ants and then used as cavities within which the ants can live; open sap wells on the leaf stems where ants get their water and carbohydrates, and Beltian bodies that are packed with protein and lipids, which the ants harvest from the Acacia's leaf margins. If acacia ants are removed from their host tree they will die within twenty-four hours since they can only survive on acacia sap and Beltian bodies.

In return, the acacia ants give their host tree the most advanced plant defense system in the world. Acacia ants have very venomous bites that will drive off all herbivores. Additionally, if vines attempt to grow up an acacia tree, the ants will chop them down. Or if a neighboring tree attempts to encroach on the acacia's space, the ants will climb that tree and defoliate it. Acacia trees lacking ants will perish within a month.

The most intriguing thing about this relationship is that acacia ants are derived from leaf-cutter ants. When these tropical ants first came upon the ancestral acacia trees, they probably defoliated and killed them. However, that was a very energy-wasteful thing to do, so natural selection forced the ants and the acacia to adjust their ecologies and the eventual result is witnessed in the tight mutualism they exhibit today.

Competition between species is another interaction that coevolves. During competition, individuals lose energy, making these struggles inherently inefficient. If species can specialize to reduce the nature of their competition, then all will benefit through energy gains. In the forest adjacent to my home, I frequently encounter Black-capped Chickadees and White-breasted Nuthatches. Each bird species feeds on the same insects that live on the bark of trees, but due to specialization in the way they feed, they avoid competition. The chickadees are specialized to forage on branches while the nuthatches have evolved to walk down the steep trunks of trees and only forage there. In this way competition forces innovation, allowing species to coexist without wasteful energy losses.

> Just as with an economy, self-organization should also be fostered within and between organizations. Within organizations, self-organization is accomplished by having a clear sense of what each individual is good at and enjoys doing and having him or her serve in those capacities.

In Vermont, where I live, midsummer meadows host a huge array of pollinators. Multiple species of bees, bumblebees, wasps, hornets, moths, butterflies, flies, beetles, and ants each pollinate flowers in their own specialized way. If any one species of pollinator should go extinct, the meadow will be fine since the other pollinators will fill the gap of service. Coevolution, by forcing species to become ever more specialized, allows all these many pollinators to coexist creating a high level of redundancy with respect to pollination. It is exactly this redundancy—that occurs in all functional roles within an ecosystem from numerous species of photosynthetic plants to untold numbers of decomposers—that gives ecosystems their resiliency. Due to this redundancy, the extinction of any one species does not threaten the integrity of the whole ecosystem. Coevolution fosters specialization that gives rise to redundancy of function that creates resilient and stable ecosystems.

The principle of self-organization is apparent not only in the human body but also in successful nonliving human systems, such as our economy. Two centuries before western science would recognize this principle, Adam Smith articulated how self-organization occurs through "the invisible hand" of the marketplace. In his 1776 classic, *The Wealth of Nations*, the kind of economic system Smith wrote about was a village economy with specialized merchants—butchers, bakers, blacksmiths, brewers. Being specialized, the merchants were not in competition with each other and were tightly integrated together. Each did what they did for reasons of self-interest and at the same time provided services that supported the whole without anyone directing it. That was Smith's "invisible hand."

For more than a century our economic system has consistently moved away from the type of self-organization Smith described. Corporations have grown into huge, transnational giants that are no longer specialists integrated with others in their sector, but generalists that work to monopolize many sectors through competitive exclusion, mergers, and acquisitions. As a result the global economy has lost redundancy and resiliency.

A critical reason for the collapse of the financial sector during the fall of 2008 was not related solely to risky investments, but was also due to the fact that the financial sector lacked self-organization. At that time, 40 percent of the investment capital in the United States was held in just ten gargantuan banks. These firms were not specialists and were all invested in the same kinds of instruments. As soon as one of those banks started to falter, the whole sector, and the global economy as well, would have toppled in a chain reaction unless governments stepped in to shore up the system. If in 2008 America had thousands of smaller, more specialized banks rather than just ten huge ones then, like the meadow, the financial system would have been just fine. As Janine Benyus


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writes in *Biomimicry*, "The more our world functions like the natural world, the more likely we are to endure." I would add the more likely we are to thrive.

Just as with an economy, self-organization should also be fostered within and between organizations. Within organizations, self-organization is accomplished by having a clear sense of what each individual is good at and enjoys doing and having him or her serve in those capacities. Ideally, this would determine each individual's specialized role. The critical thing is that all of these individuals need to be integrated so that each one has a sense of their essential purpose in the larger system. Specialization on its own is of little value.

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For people like me who love trees, going to an arboretum can be a wonderful experience. There is so much diversity! Yet the forest out my back door with only a dozen tree species has a much higher level of self-organization because everything in that forest has coevolved together and is all tightly integrated. This integration is often hidden from view since so much of it occurs below ground. In my forest, the white ash, which is specialized to grow in rich, moist soils stands next to the yellow birch a tree that has also specialized to grow in moist soils, but underground both are connected by the mycelium of numerous mycorrhizal fungi that allows nutrients and possibly energy to flow between these two different species of trees. By comparison, the arboretum is just a mixture, since it lacks the integration fostered by self-organization. Diversity of any kind brings forth its benefits to the degree that those diverse entities interrelate in ways that are mutually supportive.

Of course, organizations need to be conscious not only of the nature of their internal self-organization but also how well they are self-organized both within their sector and even with other sectors. This is probably a more difficult task for any leader of an organization and yet it is critical in movements for social change. It is in fact one of those things that defines grassroots—a tightly knit web—in contrast to the isolating approach taken by multinational corporations. It is critical for each organization in a partnership or movement to be clear about its specific role and strengths. Leaders of organizations should always be looking for opportunities to partner with other organizations in ways that not only benefit the sector they are working in but also mutually benefit each organization.

At first, creating these partnerships can take a lot of time since organizational cultures may be different resulting in differing approaches to how they work. But just as in coevolution, as organizations learn more about each other's work and how it is approached, they will find ways to more effectively interrelate. Even though there may be a heavy investment of time at the beginning, as the organizations learn to partner, beneficial adjustments will occur in more and more timely fashions. If we are ever really going to be effective in the organizational work we do or in larger social change movements, we all need to make efforts to self-organize within and between the sectors where we work. Just as these interrelationships bring benefits to organisms in ecosystems, organizations will benefit from their attempts to partner with each other.

Life has cloaked this planet for at least 3.5 billion years and during that time it has not only sustained itself, it has thrived. This enormous amount of time is a little easier to comprehend using an analogy of a stack of paper. Imagine that the thickness of a standard sheet of paper equals a century. Two sheets would represent the tenure of industrial culture. Two hundred sheets, or a two-inch thick stack of paper, would represent the time it is believed that humans have lived in the Americas. How tall would the stack need to be to represent the tenure of life on Earth? It would be a stack of paper over three miles in height, each sheet representing hundred years. Self-organization is the foundation for that long tenure. It is a model to which we need to pay close attention and one which we should consciously weave into the work of our organizations.