by Rob Newman

Ripples in the Stream:

Social Transition and Self-Organization

As human society struggles to adjust to a growing variety of ongoing changes, understanding how human society adapts to challenges has become a vital avenue of research. New technologies, political situations and an ever-growing list of environmental problems: many people claim their lives have become too chaotic, too complex.

In this paper I provide a brief discussion of the evolution of our understanding of chaos, and discuss a few examples of complexity that can be found within the structure of human society. Strong parallels can be found between social organization and complex structure found in nature; when we consider natural systems, we see that ecosystems evolve and adapt to changes according to the rules of complexity. Ecosystems are said to *self-organize*, a behavior we can also observe in many social systems. Self-organization is the process by which a complex system adapts to change, building order out of the chaos created by disruption. By recognizing complex behavior in human social systems, we can also learn to recognize effective self-organization and design social systems that self-organize more effectively.

The Origins of Chaos

The concept of chaos is surprisingly old. The term chaos was first used by the ancient Greeks to refer to the primordial disorder present before the creation of the universe. The term became associated with disorder in the physical world, describing such varied phenomenon as rugged canyon lands and unsolved mysteries of the natural world. The early Western philosophers attempted to banish intellectual chaos by developing a total understanding of the universe. Many thinkers felt this was an attainable goal; Aristotle, for example, speculated that order was to be found in all things.[1]

Isaac Newton and his contemporaries believed that if one could determine all of the governing rules and the initial conditions of the universe, everything would be predictable. At the peak of this reductionist paradigm the universe was seen as a giant clockwork machine composed of discrete pieces put together in clever but predictable ways.

As exploration in the sciences continued, shadows began to creep over the clockwork universe. Ironically, one of the greatest challenges emerged directly from the physics of Newton. In the late nineteenth century, Henri Poincaré began modeling the orbits of multiple body systems such as the solar system. As it was not possible to find an exact solution to the equations involved, he used an approximation that ignored the effects of very small objects within the system. This method appeared to work at first, but when he decided to add the effects of slightly smaller objects to his equations he discovered that they radically altered the final result. Poincaré was so disturbed by these results that he gave up his research, claiming the implications of his study were simply too bizarre to contemplate.[2]

This unpredictable behaviour reappeared in the study of weather. In the Newtonian model of physics, the weather should be just as predictable as planetary motion, as long as one knows the initial conditions and the rules governing the system. In the early 1960's, George Lorentz began to develop computer models in order to improve forecasting. Lorentz could never know the exact weather conditions at every point on earth, so he made approximations similar to those made by Poincaré. In theory, local fluctuations shouldn't have affected the overall results. Lorentz checked the accuracy of his model by varying the initial conditions, and found that even the smallest variations produced a totally different forecast. Though the equations of atmospheric dynamics are known, they have extreme sensitivity to initial conditions. As one cannot have exact knowledge of current conditions, weather prediction becomes impossible. Like many systems, our climate is complex; the apparent order of the equations hides a deeper layer of chaos.

The discovery of systems that are extremely sensitive to initial conditions revolutionized science in a way comparable to the theory of relativity and quantum mechanics. Together these three discoveries totally dismantled the idea of a clockwork universe. These discoveries also had profound implications for social scientists. After all, modernist social theory drew from the rationalist, behaviorist science of Newton, Darwin, and their peers. But are human systems truly chaotic and complex or is their complexity metaphoric rather than concrete?

Do We Live in a Complex System?

There is ample evidence to support the hypothesis that human social systems are complex in nature. Though most people are familiar with effects such as positive reinforcement, which refers to the unpredictable propagation of small-scale effects to the large scale, more compelling evidence of the existence of complexity within human social systems can be found in the lesser known phenomenon of scaling. Scaling is best understood by examining the example of scaling relations in earthquakes: for each magnitude nine earthquake there are ten magnitude eight earthquakes, one hundred magnitude seven earthquakes, one thousand magnitude six earthquakes, and so on. Earthquake distribution over time is thus said to follow a scaling law where likelihood and magnitude are related by powers of ten. This phenomenon is called scaling because a chart of earthquake magnitudes over time would look the same over a wide range of time scales.[3]

One of the most important things about scaling relations is that they put unusually extreme occurrences into relation with more common ones, a property useful in the study of social systems and economic systems in particular. As an example, financial analysts conventionally try to explain away large stock market movements on a case-by-case basis, and develop a theory that is valid the rest of the time. Mandelbrot showed that financial markets obey a scaling law, and that large movements are an intrinsic part of the structure of the market and cannot and need not be explained away.

Researcher Per Bak feels scaling relations are such a fundamental part of complex systems that we can often recognize self-organized complexity by the presence of scaling relations. His general idea is that nature and society are poised in a complex, organized state where anything can happen. Bak began his exploration of scaling laws by examining many systems, including the lengths of rivers versus the area they drain and the frequency of droughts and floods. He first connected these phenomena to complex systems when he proved mathematically that systems that scale have to be open, which is a property of complex systems by definition.[4] To understand this rather obscure point, we need only consider the Earth's ecosystems. Though the Earth sits alone in space, it is "open" as sunlight enters the system, driving its development. Complex systems must be open as the energy driving their self-organization must come from somewhere if the second law of thermodynamics is to be obeyed.

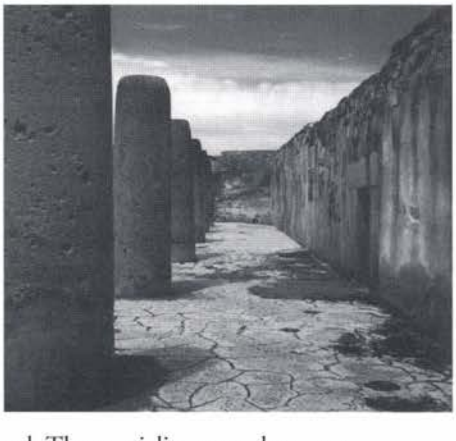
Bak determined that self-organized behaviour leads to scaling as the system "tunes" itself to a state where a small input can cause any size of "catastrophe," a phenomenon similar to positive reinforcement.[5] However Bak is not the first researcher to note the prevalence of scaling laws within human and natural systems. In the mid-twentieth century, George Zipf showed that the population of cities within a country follows a power law distribution such that about 15 percent of the population lives in the biggest city.[6] The remaining population is spread between small number of mid-size cities and a great number of smaller cities. Known as Zipf's law, this surprising result is direct evidence that human systems scale, and are thus complex. The length of financial recessions also scales, suggesting that large recessions are part of the natural economic cycle of a society.

One might ask why scaling appears in all of these various complex systems. Mandelbrot comments that the answer remains a mystery, though he feels economic systems might scale because inputs into the economy such as resource distribution and long term weather patterns also scale.[7] This, of course, simply bumps the question up a level. The source of scaling in complex systems remains an intriguing mystery.

Self-Organization and Maladaptation

As a complex, self-organizing system, human society has an amazing ability to adjust to change. This fact partly explains why the predictions of material shortages and famines made in landmark works of ecology such as Paul Ehrlich's *The Population Bomb* and Donella Meadow's *Limits to Growth* failed to be fully realized; society partially adapted to the environmental threats at hand. Some economists have gone as far as to use the existence of self-organization as an excuse to ignore ecological problems. Economists such as the late Julian Simon go as far as to argue that intelligence is an "ultimate resource" that can substitute for any natural material.

Contrary to thinkers such as Simon, complex systems are also very capable of self-organizing in destructive ways that ultimately lead to the failure of the system. Systems engage in several types of damaging or maladaptive organizational behavior. A very common form of maladaptive behavior is displacement. In a simple social system an acceptable response to many problems is to displace the problem "away" until it is no longer of local concern. As an example, we often displace wastes to other areas or leave them for future generations. However in a complex system these wastes tend to come back to us in the form of long-term environmental damage, often in quite unexpected manners.



When maladaptive societies face rapid change they also tend to overspecialize; as the flow of information and ideas within society grows, "experts" must constantly absorb an ever-increasing flow of knowledge. At some point the new information flows faster than one person can comprehend. The specialist must then narrow their specialty, leading to a society filled with individuals who are experts on tiny slivers of knowledge yet who are incapable of making connections with each other.

Hall of Columns, by Christina Lessels

Thinking Like An Ecosystem

As we search for ways to cope with social transitions, we should look to nature, as it represents a complex, self-organizing system that has functioned well for billions of years. Ecosystems have evolved structures that are able to ride out wild swings in climate, meteor strikes, and volcanic disruptions. The first and most important technique natural systems use to survive in a complex environment is heterarchical structure. A heterarchy is a system in which elements are connected with each other in multiple ways, creating a wide variety of paths from point to point. If one path is disrupted, another can take its place. Unlike the hierarchies found in human society, no one element of a heterarchy is in absolute control. All elements share in the management of the system. In a hierarchy, if one link is severed due to change, the entire structure can become inoperable. In a hierarchy, reorganization is slow and ponderous. A heterarchy is resilient, and can adapt quickly even if some of the elements of the system are damaged.

Natural systems also exhibit diversity. Though change might prove fatal to some elements of natural systems, other elements survive. A species with a diverse diet will not starve if one of its food sources disappears. Western society does not currently employ diversity as a management strategy; we are becoming more and more dependent on economics and technology, two areas that are very vulnerable to complex changes. The rise of monoculture crops is a good example of our ability to alter our environment so as to limit diversity. We cannot rely on technological or economic limitations to prevent large-scale social and ecological damage. We must diversify, setting our limits through the expression of many values including but not limited to technical and financial concerns.

Complexity and the Individual

How can we avoid maladaptive self-organization? As individuals, how can we better manage our lives as we struggle to live within a complex society? Complexity theory suggests a few simple initiatives that individuals can pursue in order to manage rapid change.

Accepting Complexity: We must first accept that we live in a complex world, move forward, and view change as an opportunity for building better social structures rather than as a threat. We must learn to deal with complexity in much the same way physicists learned to deal with complexity thirty years ago; by studying and developing tools for understanding complexity's effects on society.

Rediscovering Generalism and Diversity: We once lived much more general lives, performing a variety of tasks in order to produce the goods and services needed to survive. We have often faced change by adjusting and innovating as needed. By producing some of our own goods and entertainment we become less reliant on large social structures and thus less vulnerable to change. In order to become more diverse, we must move away from a lifestyle entirely controlled by economic forces. Though we must cope with the change within our lives, we can also learn to enjoy community and nature. We can help mitigate the negative effects of consumerism by participating in barter and volunteer communities, and by shifting our consumption into inexhaustible goods, such as the products of human intellect. Human thought does not follow the laws of physics, as thought grows more valuable as it is consumed by a larger group of people. We need to encourage the trading of information within the global village if we are to build strong communities.

Learning from Nature: By studying other natural systems, human societies can learn how to cope with social chaos and complexity. On the individual level we have much to gain by building an awareness of nature. Many of us enjoy exploring this bond with the natural world, even if we only take a walk through the woods or plant a tree. Time spent among natural systems reminds us that there is a larger structure surrounding us, and helps us to reflect on what creates a high quality of life. As Janine Benyus reports in *Biomimicry*, a growing number of people are actively studying natural systems as a source of inspiration.

The complex, interconnected problems facing human society might seem daunting, but our ability to self-organize gives us hope for the future. With the proper tools such as those long used by natural systems we can build a lifestyle that works with change instead of being a constant battle against chaos. From a more whimsical perspective, self-organized behavior in human systems makes the world a more interesting place. Ordered systems are boring and unchanging, and chaotic systems have no links between the past and present. Complexity makes our lives more difficult, but it also makes them more interesting.

Notes

1 John Briggs, David Peat, *Turbulent Mirror: An Illustrated Guide to the Science of Chaos Theory*, (New York: Harper and Row, 1989) 21.

2 Ibid 29.

3 Benoit Mandelbrot, *Fractals and Scaling in Finance*, (New York: Springer, 1997) 24.

4 Per Bak, *How Nature Works: The Science of Self-Organized Criticality*, (New York: Copernicus, 1996) 37.

5 Ibid 48.

6 Ibid 57.

7 Mandelbrot 231.