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.

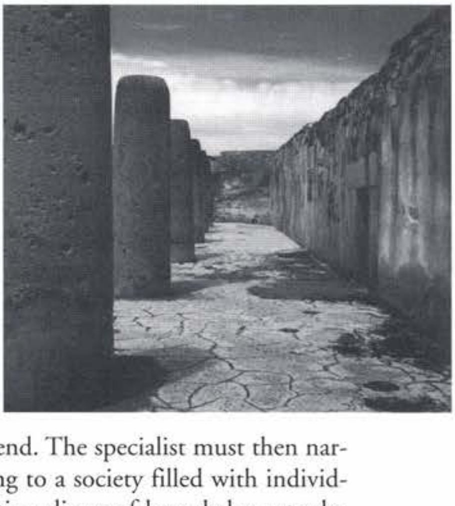
Bak determined that self-organized behaviour leads to scaling as the system "tunes" itself to a state where a small input can cause any size of "catastrophe," a phenomenon similar to positive reinforcement.[5] However Bak is not the first researcher to note the prevalence of scaling laws within human 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