The New Science of Complexity vs. Old Science

by

CODYNAMICS[SM]
THE NEW WAY TO THINK AND WORK TOGETHER

Ant colonies, bird flocks, rain forests, businesses, organizations, communities, the stock market and the global economy all have something in common. They are ***complex adaptive systems***. *Complex* means composed of many parts which are joined (literally "twisted") together. *Adaptive* refers to the fact that all living systems *dynamically adapt* to their constantly changing environments as they strive to survive and thrive. And *systems* means everything is interconnected and interdependent.

"Complexity" represents the middle area between static order at one end and chaos at the other. Thus complexity is sometimes called *the edge of chaos*. If we think of static order as ice and chaos as water vapor, complexity would be liquid water.

Using powerful computers, scientists from a wide range of fields – including a number of Nobel Prize winners – have developed **computer models** that simulate on the screen the evolution and changes that occur as complex adaptive systems move, adapt, survive and thrive or – if their strategies are wrong – die. These models have included customers making choices in retail stores, investors trading in the stock market, baggage handling by airlines, product distribution by major companies, and many other practical business applications.

These applications were not even possible until recently, when computers were able to run complex mathematical programs or algorithms to simulate this real-world activity. From these models and the analyses by the scientists who create them have come a growing number of **insights any organization can use** in the real world - without requiring any special computer programs or science.

Unlike nonadaptive complex systems, such as the weather, **complex adaptive systems** have the ability to internalize information, to learn, and to modify their behavior (evolve) as they adapt to changes in their environments. In other words, they have brains. Examples of complex adaptive systems include:

- The patterns of birds in flight
- The interactions of varied life forms in an ecosystem
- The behavior of consumers in a retail environment
- The rise and fall of species in evolution
- The interactions of people and groups in a community
- And other complex social, biological and ecological phenomena.

The findings of Complexity science can be used for more natural, more productive, more enjoyable and far more innovative results managing people, organizations and communities. This website is maintained by Lawrimore Communications Inc. to share this exciting knowledge and promote its use for a better world.

Already leading-edge organizations ranging from global manufacturers and service organizations to hospitals and advertising agencies are finding that the key principles of Complexity science allow them to **cope more effectively with rapid change and make full use of human creativity.** Many people believe this will become **the dominant form of organization in the 21st Century.** Let us explain old viewpoints and new science in a little more detail before getting into how Complexity science can be used to develop an organization or community to higher levels, especially in its most practical form, Codynamics.

Old Science And Our Views Of Reality

From the late-17th Century until the early 20th, the Laws of Motion and other linear, mechanical principles discovered by Isaac Newton dominated the understandings of science and filtered down into every aspect of the Western world. This view of reality over time penetrated our education system, our culture, our language, our organizations and our management practices so completely that it became taken for granted. Most people are not even conscious that they are using what is called the mechanical view of reality when they think and talk. This view of reality assumes:

- Things happen because something causes them to happen (cause and effect).
- We can understand what happened by reducing things to their components or parts and examining those parts (reductionism).
- The universe is orderly, follows natural laws, and works like an incredibly complicated machine.
- The best way to manage people is to organize them into a clear structure and control them with clear directions.
- The best results occur when work is streamlined to be as efficient as possible, with a minimum of wasted effort, producing the most output in the least amount of time (the "lean machine").

In the early 20th Century, the certainty of Newton's mechanics was undermined by quantum mechanics and the Uncertainty Principle developed by Werner Heisenberg. Albert Einstein found that time is relative, space is curved, matter and energy are interchangeable, and many other new challenges to the old Newtonian view of reality. So scientists began abandoning the Newtonian worldview, while ordinary people held on to it.

Still for many years physics was considered the ultimate science and mathematics the ultimate expression of reality. Scientists still practiced *reductionism*, reducing things into their parts and examining the parts to understand what made them tick. They reduced matter to quarks and gluons, and they reduced life to DNA and the genetic code. Reductionism still works when you are looking at inanimate objects or the genetic sources of life structure.

From around the 1950s on, leading biologists were taking a different tack. You can't just reduce living organisms to machines, they believed. Living organisms are very complicated. Even a single cell has more complexity than a typical manufacturing plant. You can only understand living things as **complex systems**. Viennese biologist Ludwig von Bertalanffy believed that all living systems have certain characteristics in common, and his book "General System Theory" paved the way for much of the work being done in Complexity today. To understand the common characteristics of living systems, click here.

The Shared Work of Nobel Prizewinners

The new science of Complexity evolved out of general systems theory and a field of study known as *chaos theory*. James Gleick's "Chaos: Making A New Science" became a national bestseller after its publication in 1987. The New York Times reporter popularized such insights as the Butterfly Effect, whereby a butterfly flapping its wings in India causes a series of air movements that eventually result in a thunderstorm over Chicago. In the late 1980s a number of leading scientists were discovering different aspects of order in chaos, using computer models which draw diagrams on monitors, playing out mathematical algorithms at a speed impossible by hand. All of this was very interesting, resulting in some fascinating images and insights. But no one was quite sure how to use it other than improving weather forecasting.

Then in the 1990s a group of brilliant scientists (including several Nobel winners) affiliated with the **Santa Fe Institute** in New Mexico said, in effect, "There's not much point in studying chaos. It's too chaotic. Let's study Complexity, where with the help of computers we can actually figure something out." And indeed they have discovered many things about "the real world" with practical applications for business, management, community and economic development. They have discovered some profound properties of life forms, order and structure using advanced computer modeling, which suggest powerful new ways by which **organizations can emerge, evolve and thrive in the increasingly complex technological-economic environment**. Or for that matter in your community--wherever your organization operates.

Many are drawn to Complexity science because it provides a **more accurate view of reality**. Others are attracted because they have found through painful experience that traditional strategic planning is unsatisfactory because it does not provide an effective way to manage people and tasks in an environment of constant change (complexity) on a day to day basis. Codynamics is the most practical, useful application of Complexity science available.

A very readable introduction to complexity science is available in Roger Lewin's "Complexity: Life At The Edge of Chaos" (Chicago, 1992, 1999). The gaseous molecules bouncing around in the room where you are right now are moving *chaotically*, very randomly, with very little order. By contrast, **"the science of Complexity has to do with structure and order,"** Lewin writes (pg. 10), especially in living systems such as social organizations, the development of the embryo, patterns of evolution, ecosystems, business and nonprofit organizations, and their interactions with the technological-economic environment.

"We're looking for **the fundamental rules that underlie all these systems,** not just the details of any one of them," explains Chris Langton of the Santa Fe Institute (pg. 11). "You can only understand complex systems using computers, because they are highly nonlinear and are beyond standard mathematical analysis." A linear equation such as x=2y can be graphed as a straight line. A nonlinear equation produces a curve. Put several of them together and you have complexity that only a computer can graph, yet still there is underlying structure and order, as in real life.

"For three centuries science has successfully uncovered many of the workings of the universe, armed with the mathematics of Newton and Leibniz," Lewin continues (11). "It was essentially a clockwork world, one characterized by repetition and predictability. The launching of a spacecraft to rendezvous with the Moon after several days of travel depends on that (linear) predictability.... **Most of nature, however, is nonlinear** and is not easily predicted. Weather is the classic example...."

Complex Nonlinear Systems

In **complex nonlinear systems** (including the organization or community of which you are a part):

1. "Small inputs can lead to dramatically large consequences," such as the Butterfly Effect noted above. The recent attacks on New York and Washington have also vividly shown how a relatively small "input," the actions of two dozen terrorists, have dramatically altered the lives of an entire nation, and much of the world, and further precipitated an economic recession as well as a new war.

2. "Very slight differences in initial conditions produce very different outcomes." The next time the butterfly flaps its wings, nothing of consequence happens. If the hijackers had all been overpowered by the passengers and crew, and all the jets had all crashed in rural areas, as the fourth one did, the outcomes would have been tragic but quite different

3. In complex dynamical systems, such as organizations or ecosystems, "**global properties flow from aggregate behavior of individuals.** For an ecosystem, the interaction of species within the community might confer a degree of stability on it; for instance, a resistance to the ravages of a hurricane, or invasion by an alien species. Stability in this context would be an emergent property" (13). Likewise people interacting in an organization create a whole that is greater than the sum of its parts, and the properties of the organization emerge from their combined behavior. The interactions of "companies, consumers and financial markets produces the modern capitalist economy, 'as if guided by an invisible hand,' as the Scottish economist Adam Smith once put it."

4. The scientists at Santa Fe Institute are especially interested in types of nonlinear systems known as **complex adaptive systems,** as found in living organisms and organizations. What makes a complex adaptive system different from a nonadaptive complex system such as the weather is "a **compression of information with which it can predict the environment**" (15). In other words, **learning**! In the words of Institute member Murray Gell-Mann, a genius Nobel prizewinner in physics who speaks 13 languages, "Complex adaptive systems are pattern seekers. They interact with the environment, 'learn' from the experience, and adapt as a result."

5. "Most complex systems exhibit what mathematicians call attractors, states to which the system eventually settles, depending on the properties of the system" (Lewin, 20). "Imagine floating in a rough and dangerous sea, one swirling around rocks and inlets. Whirlpools become established, depending on the topography of the seabed and the flow of water. Eventually, you will be drawn into one of these vortexes. There you stay until some major perturbation, or change in the flow of water, pushes you out, only to be sucked into another" (20-21). Thus the existing structure of your organization is one attractor state, but changes in the turbulent environment may cause it to change into another type of structure altogether. If your organization resists too long, it may become obsolete or extinct. If your organization learns how to learn, it can adapt to the forces of change and go with the flow.

New Truth So Important For Leaders And Organizations

Now here is a profound truth so important for 21st Century leaders and organizations: Most organizations today were established on **linear, mechanical principles**, the organization as a machine, producing goods and services. Science abandoned the mechanical view of the universe almost 100 years ago. Most of us are still operating on a worldview that is left over from the machine age and is 100 years out of date! This is the Information Age, and **nonlinear, complex adaptive systems are the best way to understand systems involving people.**

"Managers are finding that **many of their long-established business models are inadequate** to help them understand what is going on, or how to deal with it" (Lewin, 197). "Where managers once operated with a machine model of their world, which was predicated on linear thinking, control and predictability, they now find themselves struggling with something more organic and nonlinear, where limited control and a restricted ability to predict are the norm."

The world is simply too complex and fast-changing for linear models to work! But what is really exciting about Complexity science is it provides a whole new way to "go with the flow" by taking advantages of the discoveries of "rules" governing complex adaptive systems. Here are some of those rules and an explanation of what they mean for business and other organizations:

1. "The source of emergence is the interaction among agents who mutually affect each other" (Lewin, pg. 202). Manager-leaders should focus on developing relationships where people mutually affect each other, especially **learning by teams**, for innovation and new adaptive structures to emerge. The best way to facilitate this is through **authentic dialogue**, the open exchange of thoughts and ideas which allow a team to function as a super-human. This type of dialogue, common in older cultures such as American Indians in colonial days, is "natural" but must be learned afresh by people who are all too used to classrooms, committees, "meetings" and "discussions" where there is usually a hidden or explicit agenda.

2. "Small changes can lead to large effects" (pg. 203). Managers should lead change through many small experiments, which adapt to the wide range of possibilities, and find out which ones work best, then diffuse this change throughout the organization. Let different teams try different adaptive experiments.

3. "Emergence (of order) is certain, but there is no certainty as to what it will be. Create conditions for constructive emergence (of order) rather than trying to plan a strategic goal in detail. Evolve solutions, don't design them" (203). Detailed strategic planning simply does not work in today's fast-changing world. Vision and goals are desirable, but let the strategies emerge naturally. Don't try to figure it all out in advance.

4. "Greater diversity of agents in a system leads to richer emergent patterns. Seek a diversity of people, their cultures, their expertise, their ages, their personalities, their gender, so that when people interact in teams, for example, creativity has the potential of being enhanced.... Specifically, whatever enriches the interactions (that is relationships) among agents (that is, people) in the system will lead to greater creativity and adaptability" (203).