

*Chaos theory shows us a world far more complex and unpredictable than Newton's physics can explain. Can we apply the theory to organizations?*

## ***Shifting Paradigms:*** **From Newton to Chaos**

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*Chaos often breeds life,  
When order breeds havoc.*

—Henry Brooks Adams

Chaos theory and its spin-off, complexity theory, argue that relationships in complex systems, like organizations, are nonlinear, made up of interconnections and branching choices that produce unintended consequences and render the universe unpredictable. Can this theory, now widely discussed in the scientific community, provide a new, more accurate lens for viewing organizations? Or is it something useful for physicists, with no application to management?

Various commentators have suggested that this new paradigm can be useful in dealing with current and future change in organizations. Using this lens, however, presents an unprecedented challenge for change agents in all types of organizations. The new realities differ dramatically from the past.

### **THE TRADITIONAL WORLD OF NEWTON**

Newtonian science, the underpinning of civilization from the 1700s to the present, is rooted in physics and mathematics—rule-bound disciplines that require data “up front” in order to operate. The core of the paradigm,

the laws of motion, suggests that the world is a well-behaved machine. It offers the promise of a law-abiding and predictable universe, a belief strengthened by the notion that relationships between cause and effect are simple, clear, and linear. The “if X..., then Y” view of the world prevailed for two centuries, delighting scientists whose ultimate goal was to predict and control.

When we entered the industrial era, the lens of Newtonian science led us to look at organizational success in terms of maintaining a stable system. If nature or crisis upset this state, the leader's role was to reestablish equilibrium. Not to do so constituted failure. With stability as the sign of success, the paradigm implied that order should be imposed from above (leading to top-down, command-and-control leadership) and structures should be designed to support the decision makers (leading to bureaucracies and hierarchies). The reigning organizational model, scientific management, was wholly consistent with ensuring regularity, predictability, and efficiency.

When the future is viewed as predictable, organizations do well to send their top leaders off on a retreat where they can envision a future state and develop a long-range plan for realizing that vision. The leaders have various planning models at their disposal, some of which have been used effectively for years; however, it may well be that their success has

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been more serendipitous than purposeful, a function of relatively quiescent times. But as the speed of change increases and as the complexities of life and of the workplace expand, the assumptions underlying models such as these, as well as traditional views of organizations and their leadership, will no longer tolerate violation. They rely too heavily on a belief in linearity and predictability.

### **THE NEW, NONLINEAR WORLD OF WORK**

The shift from an industrial to information age has altered the nature of the workplace, the worker, and the work. Industrial era workers were located primarily in urban factories where they engaged in routine work, often on an assembly line. They worked a specific shift, punched a time clock, and performed tasks under close supervision. A "good" worker was one who was reliable and passive, capable of modest manual dexterity.

In contrast, thanks to modern technology, information era workers can be located anywhere and can conduct much of their work anytime. A telecommuter can be with his or her children after school and make up the work in the evening after the children are in bed. The prized worker is one who learns quickly and continuously, who works collaboratively, and who is comfortable in an environment of experimentation and risk. The new knowledge workers perform their work largely without supervision, and those who are engaged in collaborative efforts do so as members of self-managed teams.

It would seem obvious that these two worlds cannot operate effectively under the same set of guiding principles.

### **Characteristics of the 21st Century**

As we enter the new millennium, the differences with the past are exacerbated by the context in which organizations operate. Organizations must now contend with six primary characteristics:

**1 Technology.** The infomedia industries (computers, communications, and consumer electronics) are capitalized at \$3 trillion. It is not surprising, therefore, that whereas there were only 50,000 computers 20 years ago, that many are now installed daily. In 1994, 2.2 million people were on the World Wide Web. One year later, there were 6.6 million. Almost 20 million people own cellular phones and/or carry pagers. The new technologies increase efficiency, productivity, speed of production, and consumer power.

**2 Globalization.** Today everyone is interconnected in the flow of information, money, or goods. Between 1987 and 1992, the market value of U.S. investment abroad rose 35 percent to \$776 billion. In 1994 alone, Americans bought \$663 billion overseas. Foreign investment in the U.S. more than doubled between 1987 and 1992 to \$692 billion. It is clear that our interdependencies are increasing.

**3 Competition.** Globalization and technology have led businesses to compete fiercely for market share. American icons such as the Eastman Kodak Company are finding their market share eroding on their home front. Japanese-owned Fuji, with newly built plants on American soil, has continually grabbed business from Kodak in both color film and photographic paper. The once proud auto industry has suffered as well. In 1950, America had 76 percent of the world's motor vehicle production. In 1995, our share had fallen to 25 percent.

**4 Change.** Today's changes are discontinuous and happening at a geometric rate. Organizations must be sufficiently agile to be instantly reconfigurable to meet new demands. The disequilibrium created is unprecedented in our history.

**5 Speed.** In 1946, the first computer, ENIAC, was capable of calculating 5,000 basic arithmetic operations per second, which was thought to be astounding. Today's 486 microprocessor, already being eclipsed by the Pen-

tium chip, is capable of handling 54 million instructions per second. This incredible increase in technological speed is matched in business (product life cycles are measured in months not years) and in people's lives (most of us feel we are running as fast as we can merely to stay in place).

**6 Complexity and Paradox.** All of these factors contribute to the complex nature of our current existence, a situation reflected in the eruption of paradoxes that confront us. (See Exhibit 1 for examples of current organizational paradoxes.) Charles Handy predicts that paradoxes will be ubiquitous in the new millennium and will present a significant challenge to managers. As Gareth Morgan notes:

The management of organizations, of society, and of personal life ultimately involves the management of contradiction....The choice that individuals and societies ultimately have before them is thus really a choice about the kind of contradiction that is to shape the pattern of daily life.

The conflicting choices or conditions that are the essence of paradox make most people uncomfortable, enveloping them in the ambiguity that attends the perceived need to choose between seeming bipolar opposites. It is human nature to prefer, to seek out, and even to expect certainty. Paradoxes threaten that world order. A common way to handle this unpleasant state is to "fix" on one polarity and to see the world as "either/or" rather than to reconcile the two polarities with "both/and" thinking.

Nowhere is this more prevalent than in managers' choice of order to the exclusion of disorder. While this option served them well in the 20th century industrial era, continuation of that practice will be a disservice in the 21st century. Tom Peters captured the essence of the situation a decade ago when he observed that we'd spent the past 40 years teaching people to create order out of chaos, but would have to spend the next 10 years

## EXHIBIT 1

### PARADOXES FOR LEADERS AND ORGANIZATIONS IN THE 21ST CENTURY

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Long-term and short-term	Independence and interdependence
Plan and experiment	People and productivity
Revenue growth and cost containment	Empowerment and accountability
Lower costs and increase quality	People skills and technical skills
Centralize and decentralize	Conflict and consensus
Product and process	Compete and cooperate
Creativity and efficiency	Stability and change
Core competency and diversification	Incremental and quantum
Specialist and generalist	Predictability and unpredictability
Entrepreneur and team player	Simplicity and complexity
Lead and follow	Intention and chance
Manager and leader	Regularity and irregularity
Take charge and everyone's a leader	Order and disorder

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teaching people to create chaos out of order. In fact, we have spent so much time teaching our organizations to be systematized and orderly that now they can't respond to the fast-changing environment.

### CHAOS: THE NEW PARADIGM

Tom Peters did not use the term "chaos" gratuitously. He was on the cutting edge of a new order. The Newtonian vision of an orderly universe no longer exists.

The new world is full of unintended consequences and counterintuitive outcomes. In such a world, the map to the future cannot be drawn in advance. We cannot know enough to set forth a meaningful vision or to plan productively. In fact, engaging in such activities in the belief that we can predict the future and, to a degree, control it, is probably both illusory and dangerous, in that it allows a false and potentially debilitating sense of security.

The focus of chaos is the web of feedback loops present in every system. In some systems, the feedback loops are linear; in others, nonlinear. Business organizations, because they are made up of people and, hence, are highly complex, are nonlinear feedback sys-

tems. Feedback loops can be negative, producing stable equilibrium, or positive, producing unstable equilibrium. At their border, these two contradictory forces, operating simultaneously, pull the system in opposite directions. Scientists have discovered that, at this border area, where chaos lies, feedback autonomously flips between positive and negative, generating patterns that are neither stable nor unstable, but rather a paradoxical combination of both.

### Chaos as Order

For the non-scientist, the term "chaos" conjures up images of a birthday party for 20 four-year-olds, or an airport terminal when runways have closed down in a blizzard, or a shopping mall on Christmas Eve. These images lead us to see chaos as synonymous with confusion, disarray, and pandemonium.

Scientists have learned that chaos is none of these. Rather, chaos describes a complex, unpredictable, and orderly disorder in which patterns of behavior unfold in *irregular but similar* forms. Consider, for example the regular irregularity of snowflakes: an always-recognizable six-sided figure, but each snowflake unique.

Similarly, every human is different, but we know one when we see one. Ralph Stacey calls this "bounded equilibrium" and Dee Hock, futurist and founder of Visa, calls it "chaordic," a combination of chaos plus order. As Hock puts it, "In chaordic systems, order emerges. Structure evolves. Life is a recognizable pattern within infinite diversity."

### **Chaos as a Self-Organizing Entity**

Hock's words "emerges" and "evolves" are highly significant and at the core of chaos theory. In fact, they are what make chaos theory so intriguing: While irregular and unpredictable, the patterns that emerge from chaos have a "hidden" recognizable form. Chaos is actually constrained by the rules that govern it. If we can identify the rules, we can forecast the conditions under which the chaotic behavior will occur.

Waldrop describes research conducted by Craig Reynolds in 1987 in a nuclear physics lab in Los Alamos, New Mexico. Reynolds simulated bird-flocking behavior, having bird-like objects called "boids" fly together in a flock following only three rules: (1) fly in the direction of other objects, (2) try to match velocity with neighboring boids, and (3) avoid bumping into things. He found that the boids, forced to break apart to avoid an obstacle, soon regrouped into a new formation even though nothing about their programming told them to display this collective behavior. This demonstrates the essence of chaos theory; namely, that simple agents obeying simple rules can interact to create elaborate and unexpected behaviors.

Geographical economic development provides a real life example of this paradox of rules and randomness. How did Silicon Valley come into being? Its existence can be attributed largely to the intersection of distinguished research centers at Stanford and the University of California at Berkeley and the availability of skilled labor. While Silicon Valley is unique, other high-tech economic areas have emerged in Austin, Texas, the Triangle Research Center of North Carolina, and Route 128 outside Boston. Their emergence

shares a commonality with Silicon Valley; namely, that they, too, arose in areas providing excellent educational institutions and skilled labor. Thus, while these centers differ from one another, clear patterns can be detected: The availability of advanced technology attracts electronics manufacturers which, in turn, attracts component suppliers and support companies.

The "rules" or common features in these patterns of geographical economic development would seem to suggest that they can be deliberately created, yet when governments attempt to artificially create these geographic concentrations, they often fail. One reason for this is that chaos is self-organizing. No individual was in charge of creating a high-tech industry. Silicon Valley "emerged." It is a prime example of how spontaneous self-organizing systems produce extraordinary outcomes out of chaos.

The global marketplace is another self-organizing system. No one is in charge of the market, yet considerable coherence emerges from millions of independent, but connected, decisions. The Internet is yet another example. No one is in charge of this mammoth entity, which is still in the process of evolving.

Margaret Wheatley explains the self-organizing concept in simple terms: "Life seeks order in a disorderly way...mess upon mess until something workable emerges." Whereas a Newtonian view of the world imposes structure on an organization from above, the biological model, represented by chaos theory, views the organization as a living, self-organizing system; complex and self-adaptive. It suggests that if you set a group of people in motion, each one following the right set of three or four simple rules, then, like the "boids" in Reynolds' study, they will spontaneously self-organize into something complex and unexpected.

### **Self-Organization and Emergent Change in Companies**

Visa is an example of a self-organizing company. It has grown 10,000% since 1970 and is a trillion dollar business serving over half a

billion people. It consists of 20,000 financial institutions operating in more than 200 countries and territories and has a staff of about 3,000 in 21 offices on four continents.

Despite its size and growth, you don't know where it's located, how it's operated, or who owns it. That's because Visa is decentralized, non-hierarchical, evolving, self-organizing, and self-regulating. Founded by Dee Hock, it is a chaordic system conceived as an organization solely on the basis of purpose and principle. Its structure evolved from them. Hock is a prime proponent of chaordic organizations and argues that the way organizations should develop is to imagine the world as it ought to be and behave accordingly.

Chaos theory is potentially threatening to organizations, particularly to those that are large and traditional, owing to the risk involved in the concept of self-organization. The concept has a prime audience, however, in the newer, smaller entrepreneurial companies whose workforces are made up of 20- and 30-year-olds who have little investment in traditional ways of doing things.

One such organization is Sony's PlayStation, a unit that had virtually no sales just three years ago. This year, PlayStation will generate worldwide revenues of more than \$5 billion on gross retail sales of \$9 billion. Almost everyone on the management team at PlayStation is in their 30s. Their entire day is spent managing the paradoxes of chaos and order as they juggle creativity and experimentation along with control and efficiency. In an industry that must push the envelope to survive, they live in a constant stream of tensions: balancing work with play, creativity with competition, complacency with outrageousness. The tempo in the industry is so rapid that people are assigned to new teams in readiness for a new project before they even know what that project will be. Teams are kept in constant motion, which is the essence of managing in chaos.

Motorola provides an example of a large American business that did not deliberately set out to apply the chaordic model to its organizational change (as Visa did), yet engaged in emergent change. The illustration

is instructive regarding the problems change agents will face in managing the transition from the Newtonian to the Chaotic model of change in well-established organizations.

In 1983, Motorola's CEO, Bob Galvin, recognized that, despite experiencing 15 percent growth, the company faced a serious threat from foreign competition. At the biennial meeting of the company's top officers, rather than issue a directive, Galvin threw out a seemingly spontaneous challenge: renew the organization.

The officers, accustomed to specific, well-defined statements of need, goals, and plans, waited for Galvin to flesh out his ideas. When he didn't, they were baffled. Largely because they were unsure of what Galvin was proposing, they were unable to respond in their usual manner of efficiently carrying out their leader's wishes. They dealt with their confusion and anxiety by denying the need for change.

Throughout that year and into the next, managers struggled without a road map. Galvin's follow-up memo to the biennial meeting did not spell out specific actions to be taken or results to be achieved. Even a document produced late in 1984 by a Policy Committee (which included Galvin) raised more questions than it gave answers. Through it all, Galvin refused to provide a silver bullet solution.

Finally, when senior managers were asked to identify projects in their own business units and to report back on their plans and their results, progress was made. At long last, managers stopped agonizing over what Galvin wanted and began to act, to experiment, to accelerate the development and work of teams and projects. Suddenly, product development took less time and money than before. Galvin's challenge...indistinct and radical, providing neither vision nor means nor ends...produced emergent change.

## **BUILDING A CHAORDIC ORGANIZATION**

Few companies have the temerity to embrace the emergent paradigm to the degree that Visa and Motorola have. Rather than immerse

the entire organization in the messiness attending a full acceptance of chaos theory, they are proceeding cautiously, building a *readiness* to engage in the new order, designing and erecting one or more dimensions of a culture of chaos.

### **1 Knowledge and Information Sharing.**

Knowledge is one of the primary preconditions for emergent change. Companies that want to prepare themselves to become chaotic organizations must rely on the collective intelligence of their people to create a desired future. Knowledge and information sharing go hand-in-glove. The traditional practice of hoarding knowledge in order to enhance one's personal power is not only unacceptable in the new order, it will backfire. In the chaotic organization, power accrues to those who become a source of knowledge by sharing what they know. The concept of collective intelligence presupposes system-wide sharing of information so internal barriers, such as those that prevent cross-functional learning, must be eradicated. Hewlett-Packard deals with this issue by having an award called "Not Invented Here." It is an honor bestowed on a division that implements the most ideas from other divisions in the company.

One company that understands the importance of the knowledge element of emergent change is Buckman Laboratories International, a specialty chemicals company in Memphis, Tennessee. Buckman, the CEO of this privately held company, developed a global knowledge transfer network, called K'Netix, which makes a steady flow of information accessible to everyone in the company worldwide. Answers to problems or questions can come from anyone anywhere in the world, including Buckman himself. To ensure knowledge reciprocity and sharing of information, the company offers incentives and rewards to its best knowledge sharers.

**2 Innovation and Creativity.** Along with knowledge and information, emergent change requires innovation and creativity. These characteristics require an organiza-

tional culture in which rules are meant to be broken and assumptions are continually being tested. They call for an environment that supports experimentation, risk-taking, and failure, and views trial-and-error as a viable process.

Companies are beginning to acknowledge that many of their successes attributed to brilliant foresight were, in fact, the result of trying lots of different things and keeping what worked. 3M, for example, began as a mining company and its evolution into the tape business was totally serendipitous. The derivation of 3M's Post-it Notes is a classic tale of accidental success. Similarly, Johnson & Johnson did not deliberately set out to enter the baby-powder market. As the story goes, a director of research sent a packet of talc to a physician who complained that patients were developing a skin irritation from the company's plaster. The director began sending talc with various products and soon customers began to buy the talc separately. Today, 44 percent of the company's revenues come from baby powder.

### **3 Teamwork and Project Orientation.**

Knowledge growth, information sharing, creativity, and innovation thrive best in small groups where people can interact freely. A few people with new ideas and creative thoughts is not sufficient for institutional learning unless they are encouraged to interact with others.

Therefore, to prepare the organization for emergent change, companies need to delay and decentralize, to organize work around tasks performed in teams and project task forces, and then ensure that these teams and project groupings are flexible enough to form, change, and dissolve, as needed. High-tech companies are always shifting jobs to areas that have higher potential payoffs. Their work groups need to be sufficiently agile to continually reorganize. Intel, for example, uses temporary teams drawn from a range of disciplines, constantly forming around specific business issues or projects. It's a task-oriented company where the organization is more like a

web of teams and projects than a clearly defined vertical hierarchy.

Another example is 3M, a company synonymous with innovation. One way that the company achieves its goal of having 15 percent of its revenue come from new products is by providing its managers with the latitude to move from one business unit or laboratory to another without bureaucratic obstruction. Project groups, operating with little constraint from the formal organization, come together to accomplish a task and disband when their work is completed. There's lots of self-organization and self-design without the need for formal coordination. Similarly, 3M researchers who cannot get funding for their ideas within their own center or lab are encouraged to search out other centers and labs.

The flexibility of work arrangements, the emphasis on ideas rather than structures, and the clear signal that it is better to share ideas rather than reinvent them, frees people to focus on their imagination and creativity, thus making 3M one of the most successful companies in the world and one that is close to being a chaordic organization.

**4 Diversity.** The secret to productive and creative project groupings is diversity. Homogeneous groups tend to produce homogeneous ideas. Executives talking with other executives rarely produces a diversity of opinion. To achieve a high level of creative thought, it is necessary to bring together diverse groups of people: people with different levels of expertise (including representatives of non-business disciplines), employees at all levels of the organization (representing a variety of ages, experiences, and backgrounds), people outside of the organization (customers, suppliers), and, above all, people representing a broad spectrum of ideas.

At Skandia, the Swedish financial services company, CEO Leif Edvinsson wanted to reach the future faster, so he created Skandia Future Centers with five elite Future Teams. These are based on a model he calls "3G": a mix of three generations ranging from their 20s to 60s as well as a variety of functional

roles, organizational experiences, and cultural backgrounds. Edvinsson believes discussions among diverse groups advance learning faster than traditional groups.

For original thinking, the diverse mix should include the company's mavericks. Every company has them, but they often must struggle against company orthodoxy. Having their ideas dismissed out of hand leaves them so frustrated that they either stop participating or leave the company altogether. Arie De Geuss, reporting on a study of companies that survived one hundred years or more, found that one of the four traits they held in common was a tolerance of new ideas. Clearly, companies that crossed a century's worth of changes could not control their world; therefore, they learned to tolerate ideas and activities at the margin.

Honoring the contributions of everyone, including mavericks, requires a high tolerance for conflict. Levi-Strauss and Company is an example of an organization that believes people need to be allowed to challenge ideas, no matter where they originate. To foster dissension, the company hangs whiteboards in the halls and encourages people to anonymously contribute their criticisms of what is wrong with the company's plans. Managers hang bulletin boards at meetings for people who prefer to post anonymous comments rather than make them publicly.

At 3M, new recruits actually take a course with their supervisors on risk-taking in which they are explicitly taught to be willing to defy their supervisors. They are told stories of victories won despite the boss's opposition. Chaordic organizations are, by definition, conflictual, but the very tension that produces conflict also produces genuinely creative, fruitful ideas.

**5 Strong Core Values.** To enable individuals and small groups to pursue the learning and innovation that leads to self-organizing behavior, they must be allowed autonomy. But autonomy cannot be allowed to dissolve into anarchy. There must be some grounding entity that unites the independent participants and their efforts.

Traditionally, that entity was managerial control. In chaordic organizations, it is core val-



ues or, as was noted earlier, what Dee Hock refers to as purpose and principle. Collins and Porras, in their study of visionary companies, describe values as a bonding glue that keep a fluid organization from evolving beyond recognition. Values allow for coordination without control and for experimentation and adaptation without lawlessness. A value system creates a sense of purpose; the organization knows what it is about and can invest focused attention despite seemingly random behavior.

Boeing's ideology, for example, revolves around its commitment to push the envelope of technology and to take risks and accept challenges to do this. 3M's values center on innovation and the desire to solve real human problems with truly original ideas. At Sony, the focus is on being a pioneer in doing the impossible and experiencing the joy that comes from advancing and applying technology. Despite the complexity and chaotic nature of the environment and the messy state of the emergent change, it is the company's core ideology or values that can provide its direction and purpose.

## THE ROLE OF THE MANAGER

Precisely how chaos and complexity theories will shape the work world isn't clear, nor are there many examples of emergent change to guide those responsible for managing on the edge of chaos. Nevertheless, five essential ingredients of the 21st century manager's role are apparent.

**1 Manage the Transition.** The most important role managers have *at this time* is to lead people through the transition from the industrial era to the information era, from the world of Newton to the world of Chaos. William Bridges defines transition as "the *psychological* process people go through to come to terms with the new situation" [italics added].

That process begins with letting go of the past and coming to terms with what is being lost. Today's workers are being asked to trade their comfortable, safe, stable, and predictable work world for one that is unstable, unpre-

dictable, and highly ambiguous. Traditional workers are accustomed to carrying out decisions made by higher authorities, being told the end result and how to get there, and relying on tried-and-true knowledge and skills that have served them well in the past.

With the new order, however, they are being called upon to identify and solve problems, make decisions, experiment, generate perpetual novelty, and continually learn new skills and behaviors.

Their world has turned topsy-turvy. Managers need to help people understand the reasons behind these dramatic changes and generate a sense of urgency about the need to move forward in a different manner. To do this, they must be specific regarding the attitudinal and behavioral changes that are necessary, communicate consistently and often, expect and accept people's negative reactions, and reward their positive efforts.

**2 Build Resilience.** As the speed, volume, and complexity of change accelerate, workers' mental and physical stamina are worn down. Reeling from multiple downsizings, organizational restructurings, mergers and acquisitions, and programmatic initiatives over the past two decades, many of them feel incapable of gearing up for yet another assault on their energies. Feeling out of control, they have reached what Alvin Toffler termed "future shock." But much as they long for "the good 'ol days," they are destined to be disappointed. Chaos theory and emergent change tell us that ability to adapt and to absorb *even more change* is what lies ahead. Therefore, an important role for managers is to help people increase their resilience; that is, their capacity to bounce back no matter how intense the speed or complexity of the changes.

Daryl Conner argues that major change occurs when people have significant disruption in their expectations. When people can anticipate and prepare for the change, they respond better, in part, because they feel more in control. Negative reactions and dysfunctional responses come from being surprised, feeling unprepared and out of control.

Reaction to change is largely a function of perception and managers can build resilience by helping people adjust their expectations. Managers need to help workers understand the new realities; namely, that there is no going back, that change is the order of the day, and that we may never feel "in control" again. They need to explain the nature of chaos and emergent change, emphasizing the lack of predictability and stability along with the principle of "order in disorder."

But at the same time, managers need to ensure that people have the skills they need so they can feel equipped to meet the challenges ahead. Never before has training been so important to the workforce and to organizations. Motorola, with one of the best training programs in the country, pushes employees to continually redefine themselves and how they do their jobs, requiring each employee to attend a minimum of 40 hours of training annually. Motorola University, begun in 1987, delivered 123,000 hours of training by 1991 with 6,800 people participating in courses. One estimate is that 300 to 400 companies now have their own versions of corporate universities or learning centers.

**3 Destabilize the System.** In the industrial era, we viewed a successful organization as one that operates as close to equilibrium as possible. But a model that places stability at its core serves to restrict managers to strategies of repetition and imitation. As such, it is dysfunctional for a world that has become increasingly complex and competitive and in which organizations literally live or die on the basis of their ability to innovate.

Therefore, managers need to assume the important role of creating an environment that elicits, supports, and nurtures creativity by deliberately upsetting the status quo, escalating some changes while damping others, and seeking a chaotic state or a state of bounded instability.

One way to destabilize the system is to keep it in a state of tension. Tension is a necessary ingredient of creativity, but it will take particular skill on the part of managers to keep the tension level at a point where it gen-

erates dynamic imagination without exceeding people's ability to handle the stress engendered.

Another way to destabilize the system is to deliberately seek disconfirmation of our beliefs. A secret of success in the new order, according to Intel's CEO, Andrew Grove, is to continually try to prove yourself wrong, to challenge your thinking, to find flaws in your own mental models, to continually experiment and test every possible alternative.

To voluntarily annihilate one's ideas, however, is not as ego-satisfying as having them confirmed, so managers need to maintain constant vigil to ensure that the process of disconfirmation becomes a natural, acceptable mode of problem solving. They can do this by modeling an openness to the testing of their own ideas, by rewarding those who raise tough questions, and by playing devil's advocate when consensus is achieved too readily and without debate.

**4 Manage Order and Disorder, the Present and the Future.** The self-organizing principle of chaos theory might lead one to conclude that managers are superfluous. On the contrary, they have a critical role in providing the balance between the need for order and the imperative to change. They are responsible for seeing to it that the organization engages in enough innovation to keep it competitive yet enough stability to prevent its dissolving into total disarray.

This paradox, which is really a constellation of paradoxes consisting of regularity and irregularity, simplicity and complexity, predictability and unpredictability, and stability and instability, calls for tremendous agility on the part of managers. In the old order, with its either/or thinking, managers merely pursued one end of each continuum, but today, with both/and thinking required, they will have to juggle both ends.

One approach to the conundrum is to apply order, regularity, predictability, and stability to the daily business and disorder, irregularity, unpredictability, and instability to future change. Ken Blanchard suggests having people in the organization on two

teams: a Present Team, focused on today, and a Future Team, focused on tomorrow.

Further, Blanchard argues that people are naturally suited to one or the other. He points to Michael Eisner, CEO of Disney, as a natural visionary, and the late Frank Wells, Disney's former President and COO, as a natural implementor. Where Eisner preferred to innovate, Wells preferred to redesign systems to support the new directions Eisner charted. By allowing managers to function in a capacity suited to their preferred mode of operation, Blanchard's model might well provide a means for easing the anxiety and tension that the paradox creates for many workers. Both the organization and the workers get their needs met.

**5 Create and Maintain a Learning Organization.** Learning is the *sine qua non* of an information/knowledge age and central to the self-organizing activities from which new systems emerge. Thus, a major role of managers in chaordic organizations will be to create the means by which everyone can be involved in continuous learning.

This should not be difficult since there is always potential for learning in the everyday problems and opportunities workers confront. Learning and doing are synchronous so workers can learn in real time, but only if learning is made an explicit organizational value and only if there is time put aside for reflection on what worked, what didn't, and why. When learning is an accidental byproduct of activity rather than a central core process, it is neither sustainable nor does it get integrated into the business.

To create and maintain a genuine learning organization, managers need to establish an environment supportive of and conducive to learning. If experimentation, risk-taking, and trial-and-error modes of problem solving are to compete with the overused rational, analytic modes, then the culture must tolerate failure, refrain from placing blame, and reinforce nontraditional thinking. If truly innovative ideas are a primary goal, then the culture must tolerate conflict, people "pushing back," public testing of one another's assumptions, and

healthy debate around diverse ideas. If the organization wants to capitalize on its collective human capital, then the culture must tolerate a messy structure in which project groups form, reconstitute themselves, or disband as needed.

These five roles, critical for managers to enact if their companies are to enter the 21st century as chaordic organizations capable of engaging in emergent change, call for leaders who, themselves, understand and accept the assumptions of chaos and complexity theories. These invaluable agents of future change seek neither stability nor predictability, developing a comfort level that tolerates disequilibrium. They know that messiness and ambiguity are part of the process of self-organization and self-emergence and that, rather than attempt to manage it through command-and-control, their role is to support it through allocation of resources and the design of an appropriate culture. They recognize the futility of attempting to draw a map of the future in advance, appreciating the fact that, when the waters are uncharted, their destination can only be discovered through the actual process in real time; that the map can only get drawn as they go along.

To be a successful manager in the 21st century and to enact the five roles enumerated above calls for a new mental model of manager, one suited to a world of chaos. Those who retain their Newtonian world view will find themselves leading their organizations into oblivion.

## IS CHAOS THE NEXT ORGANIZATIONAL PARADIGM?

Let's return to the question posed at the beginning of this article. Can chaos theory provide us with useful methods and metaphors for understanding the world of work? Does it lend itself to the self-organization of people in companies? Is there utility to chaos and complexity theory which could add to, or even supplant, the Newtonian order? Or is chaos theory the current darling of scientists with no application to organizations or management?


So far, complexity theory has been applied successfully to operational problems. At both GM and Deere & Co., complexity-based computer systems were used to develop programs for manufacturing. These models solved operational problems better than previously used linear techniques, saving the companies time and money.

To date, chaos and complexity theories have not been applied to human systems, although self-directed teams represent a small version of self-organization. The recent shift to team- and project-based processes in many organizations demonstrates the fact that groups of workers will, if given the chance, find ways to accomplish a task.

Top consulting firms, including Coopers and Lybrand, McKinsey, and Ernst & Young, sent people to the Sante Fe Institute (SFI), the heart of exploration into chaos theory, to find

ways to use chaos and complexity theories in their consulting practice. While direct application has not yet occurred, Ernst & Young was so taken with the possibilities of this new paradigm that the firm ran a three-day symposium, "Embracing Complexity," and mailed 15,000 copies of Kaufman's *At Home in the Universe* to its clients.

The next steps in the application of chaos theory, and its off-shoot complexity theory, involve developing lifelike simulations followed by testing the theory in real time on actual human problems. Chaos theory may not be a viable model for understanding organizations as yet, but it is an intriguing way to think about the world.

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