Corporate DNA

Organizational learning, corporate co-evolution

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Introduction

Over the last 30 years, the Law of Life—learn and adapt or die—has become the Law of Markets. When Digital Equipment Corp. didn't adapt to the personal computer because its CEO, Ken Olsen, couldn't learn that this was the future, the company began to die. When General Motors couldn't learn about either customers' changing tastes or how to create a more cooperative style with its unions, the company's market share began falling from nearly 50 percent of American cars to just above 30 percent. As long as Xerox was unable to learn how the Japanese could sell copying machines for less than it took Xerox to make them, the company continued in a downward spiral. Having learned that management technology—quality improvement—the company bounced back. Because this Law of Markets has become unmistakable, it's no surprise that the idea of the learning organization, which Peter Senge introduced less than a decade ago in The Fifth Discipline (1990), has become so popular. Today, Amazon.com lists more than 100 titles under "the learning organization," and the idea has been reincarnated in the trendy new management technology, knowledge management.

What is surprising is that no one has gone back to the Law of Life for guidelines on how to design organizations that learn. Life has been able to learn and adapt to shifts in the environment for 3.5 billion years. Those shifts have been as extreme as the transformation of the atmosphere from a methane to an oxygen base and five major extinctions, where at least half of all species disappeared. What, then, can managers learn about designing organizations that take advantage of life's record?

The best way to answer that question is to explore a series of other questions about the purpose and processes by which organizations learn:

- What does this organic way of thinking suggest about the term "organizational learning"? What is learning's purpose in nature? Is it similar in organizations?
- What does organic organizational learning look like, compared with the learning that occurs in more traditional, more mechanical organizations?
- To what extent does the choice of a mechanical or organic model determine an organization's style of learning?
- What examples do we have of corporations already built on this model?

AN ORGANIC DEFINITION OF ORGANIZATIONAL LEARNING

In order to define organizational learning organically, it is important to state three assumptions that indicate why such learning is important and why it's becoming more so:

- First, *time is how we experience change*. Life is an ongoing, irreversible flow of shifting conditions to which we must adapt. Because the rate of this change is accelerating, it's becoming more and more difficult to predict what those shifts will be, except in the short term. For example, current studies expect that, by 2025, as many as 80 technologies now in the lab, representing breakthroughs in virtually every field—from computing with light to the use of fuel cells for transportation—will be fully competitive (Halal, Kull, and Leffman, 1997). How those technologies will combine with existing technologies and each other is impossible to know. As a result, the most sustainable strategies are likely to be those in which organizations develop the capacity to learn quickly about new market developments, and then encourage products and services that take advantage of them to emerge from their interaction with customers.

- Second, as Gregory Bateson pointed out a quarter century ago, evolution and learning are similar processes, in which a stream of events, mutations, and ideas, respectively, are chosen from by a selective process so that some of those events survive (Bateson, 1979). Evolution is the process by which living things develop emergent adaptations to change over many generations. Learning is the process by which they develop emergent adaptations within a single generation. Organizations, however, blur this distinction. While it took dinosaurs hundreds of thousands of generations to evolve into birds, Mercedes-Benz Credit Corporation was able to evolve from a mechanical hierarchy to a much more organic form in only five years, in a single organizational generation. As a result, we can define organizational learning as the process by which organizations evolve emergent adaptations.

Third, *all organizations are complex adaptive systems* (CAS). CAS are complex, composed of many autonomous agents whose interaction creates behavior on the scale of the whole that would be impossible at their individual level. One such behavior is the need to adapt as its surroundings shift over time. The important distinction that will be noted in this article is whether management wants to direct/control the behavior of the organization as a CAS, with a mechanical model of organization, or to free it to find its own direction through selforganization. For this reason, mechanical and organic models lead to radically different styles of organizational learning.

TWO STYLES OF LEARNING

Most readers of this article will be familiar with the way traditional organizations learn in their markets. Essentially, their leaders act as chief learning officers who use the organization to pursue a vision, operating it by command and control, much the way you operate your car. For example, in the late 1940s and early 1950s, Tom Watson, Jr. urged his father, IBM CEO Tom Watson, Sr., to push the company into the emerging market for digital computers. That required a powerful vision, because, at the time, even the most knowledgeable experts couldn't imagine a market for more than 100 computers worldwide.

Then, after Watson, Jr. became IBM's CEO in 1956, he risked the company in a $5 billion effort—that would be valued at about $200 billion in 1998—to recreate the computer industry. At the time, major computer makers produced a line of computers with increasing computing power. However, each computer in the line was developed separately and so required its own software. As a result, it was impossible to upgrade. If your business was ready for a more powerful computer, you had to buy an entire new system. Watson, Jr. set out to create a family of computers, all using the same software, so that customers could upgrade their machines as their computing needs grew. Under his direction, IBM succeeded in creating its "360" family of computers in the early 1960s, and was catapulted into a dominant position in the industry, with a 70 percent market share. Tom Watson, Jr.'s vision of emerging trends in the computer industry, and his ability to direct IBM to realize that vision in the market, demonstrate exactly how powerful the mechanical model of organizational learning can be (Carroll, 1994).

Organic organizational learning, on the other hand, is less an issue of any one person's learning. It involves people throughout the organization building on each other so that the most significant learning occurs at the level of the organization itself, as we can see from 3M's Integrated Solutions program. In 1995, managers at the company began noticing a pattern of complaints from some of their largest customers. Because 3M sells its products through some 40 semi-autonomous product divisions, each with its own sales department, these customers were receiving calls from three, four, even five 3M salespeople, each from a different division. The team of managers charged with solving this problem developed Integrated Solutions, demonstrating how 3M's processes of corporate learning not only meet its customers' current needs, but actually increase its ability to meet new

needs as they emerge.

With Integrated Solutions, if a 3M customer buys from four product divisions, the company trains a team of four salespeople, one from each division, and has them ask if they can map the customer's workflows. In return, they promise recommendations for reducing costs and increasing productivity. If the customer agrees, the sales team maps its workflows and, later, examines them with members of their divisions' marketing and R&D departments, looking for three things:

- *Existing 3M products* that the customer can use. While no one salesperson can know all 50,000 3M products, the team of eight or ten working on the customer workflows might know most of them.
- *New products* that 3M can develop to solve customer problems.
- *Process improvements* that 3Mers had learned in working with their other customers.

When the recommendations are ready, 3M brings in the customer, usually one of its senior managers, for a full report. According to Dominic Tallarico, a member of the management team that heads Integrated Solutions, these reports are often eye-openers for customers, suggesting opportunities they'd never even imagined. In his words:

> *We had one customer that manufactured buses. By the time we made our report, we were able to offer them material and process science solutions that gave them the opportunity to do things they didn't think would be possible. The company now wants 3M in on the design and specification stage of its development process.*

In another case, a team making recommendations to the vice-president of an airline suggested a productivity increase of as much as 300 percent to a process the airline thought was already highly efficient. Tallarico noted:

> *When he saw the improvements we were suggesting, the vice-president got so excited that he offered us one of the company's planes for a year, so we'd have a model to work from.*

With Integrated Solutions, 3M does more than learn about immediate customer needs. The program blurs the company's boundaries from its customers. As its customers implement its recommendations, 3M managers can watch for new needs that customers develop as a result. When those needs develop, it will be prepared to find ways to meet them,*even before its competitors know those needs exist.* By contributing to its customers' success, 3M can encourage a mutual dependency that will enable both the company and its customers to operate more successfully. In the process, it will also continue to learn about its customers and their markets in the most intimate possible way.

This organic learning process is co-evolutionary. That is, 3M is optimizing its ability to behave like a living thing, evolving in ways that enable it to cultivate mutually beneficial relationships with other living things in its environment. In one striking example of co-evolution in nature, certain acacia trees have evolved hollow thorns and small food packets at the base of their leaves. A species of ant lives in the thorns and eats the food packets. In return, the ants protect the trees from small mammals that would damage them. What makes this arrangement appear co-evolutionary, rather than merely accidental, is a curious fact: Researchers have found this arrangement in the Americas, Europe and Africa, but not in Australia, where there are no small mammals to threaten the acacias (Grant, 1984).

Just as this arrangement between acacias and ants increases the ability of both to survive, Integrated Solutions increases the ability of both 3M and its customers to prosper in their markets. This market coevolution is the purpose of organic organizational learning. To develop such an organic learning process, managers can model an organization on living things, rather than machines—that is, they can apply the dynamic principles by which living things learn and adapt, freeing the organization to function as a self-organizing CAS.

MODELS OF ORGANIZATION

One warning: It's tempting to think of organizational models as either metaphors that enable managers to translate whatever they find attractive in a model to their organization, or literal renderings that translate every detail of the model into their organization. This article uses the idea differently. On one hand, a literal rendering ends up seeming ridiculous because organizations are significantly different from both machines and living things. With a mechanical model, for example, managers may think of workers as replaceable parts. But it's impossible to control a human being as fully as we control machine parts. On the other hand, organizational models operate much more specifically than metaphors. With them, managers apply the design principles of a model to help answer a critical question.

That question is: "How can managers integrate the very different interests, skills, and desires of 100 or 100,000 people to pursue a common goal?" Traditionally, managers used a mechanical model. By thinking of their organizations as if they were machines and applying the design principles of machines to those organizations, managers could consider their workers as replaceable, pre-programmed human parts. Such employee/parts would need to know only how to do their jobs, just as the spark plugs in your car only "know" how to ignite gasoline in the engine. Managers must then be responsible for connecting workers in cause-andeffect chains to perform complex tasks, as an engineer must put the parts of an engine together in a design, if your car is to run. In such an organization, the formal structure should also be mechanical, composed of many mechanically distinct subunits with impermeable boundaries. This structure functions as a prison, keeping workers focused on their tasks and those of their units, avoiding distraction by limiting connection. If you've ever worked in a bureaucracy, you'll recognize how extensively these principles are translated into such organizations' operations.

Finally, machines are tools of human purpose. As we saw in the story of Tom Watson, Jr. at IBM, organizations built on a mechanical model need someone to exercise purpose—a visionary leader whose job is to operate the corporate machine. Such a leader will use their vision to navigate the organization through shifting market conditions, just as your vision enables you to drive your car through shifting road conditions. In the end, the visionary leader acts as chief learning officer, testing their vision in the market and making necessary adjustments through a command-and-control management style.

As long as such organizations have capable visionary leaders, they can remain highly successful. This style of organizational learning, however, has two problems. First, a leader's vision sometimes fails. When Henry Ford's vision of the auto industry failed in the 1920s, his insistence on producing just one model, at a time when General Motors recognized the public's desire for more product differentiation, severely damaged Ford Motor Co., which had dominated the industry for some 20 years. Similarly, Ken Olsen's refusal to recognize the growing demand for personal computers in the late 1970s and early 1980s would eventually kill off Digital Equipment Corp., which had been one of the leading computer companies from that market's beginnings. Second, when a visionary leader leaves the company without a visionary successor, it can easily lose its way, as IBM did after Watson, Jr. left in 1970. In both these cases, deprived of their chief learning officers, mechanically modeled organizations lose their ability to remain connected to their markets, stop evolving, and face extinction.

AN ORGANIC MODEL

The alternative to a mechanical model is an organic one. What happens if managers put their people together as if they were members of a living thing, rather than parts of a machine? What organic design principles are critical for ensuring that our organizations are able to learn and adapt as living things must?

CORPORATE DNA

For our purposes, the key organic design principle is DNA. Functionally, DNA is a flexible database of procedures and structures, all aligned to an organism's identity, with which the information of the whole is encoded in all the parts. In Bateson's words, it provides "storage of available alternative pathways of adaptation" (Bateson, 1979). Notice how each part of this description contributes to DNA's value as the vehicle for evolution:

- As a *database of procedures and structures*, DNA enables living things to replicate in a way that maintains their integrity.
- Because the database is *flexible*, DNA enables living things to experiment with new procedures and structures, a capability that becomes especially important when their environment shifts.
- With procedures and structures *aligned to identity*, DNA ensures that surviving experiments will enhance its ability to survive. This alignment is maintained by two mechanisms—an internal one that filters out most mutations, and natural selection, which operates externally. Because the information of the whole is encoded in all nucleated cells, living things can develop from a single fertilized cell with one set of directions.

When we apply DNA to our organization, not as a specific structure (a literal translation) but as a set of operating principles, the

resulting corporate DNA has enormous power to help our organizations learn and adapt. *Corporate DNA would then be a flexible database of all an organization's procedures and structures, aligned to its corporate identity, and made available to everyone in it*. Consider how these qualities enable organizations built on an organic model to learn:

- As a *database of procedures and structures*, corporate DNA documents the best ways that any organization has currently found to perform any task. Some organizations document it in hard copy, as with the Ritz-Carlton's Skills Mastery Manuals (a binder of each department's procedures); some in electronic form, as much of Mercedes-Benz Credit Corporation's is; others in a mix, as at Federal Express. What is most important is that it can act as the repository of alternative approaches to evolution that Bateson suggested.

- Corporate DNA's *flexibility* enables people to experiment with it continually. When combined with its universal availability, corporate DNA drives the process of organizational learning. For example, people at the Ritz-Carlton's Philadelphia hotel were working to reduce cycle time for room cleaning. When they got stuck in this effort, one person working in housecleaning told a friend at the front desk about the impasse. The friend at the front desk wondered what would happen if housecleaning used the same software the front desk used to track customer preferences. After checking housekeeping's Skills Mastery Manual, this person suggested what would become the breakthrough procedure for speeding room cleaning. As opposed to a more mechanical organization, where procedures belong only to the people who use them, the universal availability and flexibility of the Ritz-Carlton's corporate DNA invited everyone to take ownership for all the organization's procedures and improving them.

- Finally, because all procedures and structures are *aligned to corporate identity*, such improvement efforts have an internal guidance that allows managers to encourage their people to work in a selforganizing manner. Rather than need the external direction that management provides in a bureaucracy, people can operate autonomously. At 3M, for example, almost all procedures and structures are aligned with its corporate identity, Innovation. Its practice of having R&D people visit customer premises; its 15 Percent Rule, by which most people have 15 percent of their time to explore their own ideas; its "bootlegging" policy, through which people can beg and borrow the resources they need to pilot new ideas—all these, and many more, provide the incentives that keep 3M people focused on finding new ways to use its technologies to meet developing customer needs, without managers having to tell them what to do.

In short, corporate DNA provides the flexible documentation of alternative paths of evolution/learning on which anyone can build, so long as their contribution moves the organization in the direction of its identity. The result is ongoing, accelerated organizational learning. At St. Luke's Stroke Center in St. Louis, MO, use of a critical path for stroke patients, treated as part of its corporate DNA, enabled healthcare providers to reduce the average length of stay for stroke patients from 7.5 days in 1993 to 5.5 days in 1997. The critical path maps all the procedures through which stroke patients must go, from the time they're admitted until they're released. Because the path was considered both flexible and universally available, team members—including physicians, nurses, rehabilitation therapists, and dieticians—were all invited to suggested ways to improve care and reduce length of stay. The more than 25 percent reduction over less than four years occurred, not as the result of individual learning, but through the combined contributions of many team members. The organization was learning, rather than merely one or two of its individuals.

In addition to the way it enhances organic organizational learning, corporate DNA can produce other benefits for organizations that treat their procedural and structural information this way. For one thing, it speeds customer service. Unlike bureaucracies, where customers often have to speak with a series of people before finding the one employee who can answer a specific question, universal availability of procedural information means that even when employees can't answer a customer's question, they can quickly and easily find out who can. And that, in turn, makes it easier to learn about those customers' emerging needs. For another, having information universally available creates a sense of common ownership. As with the front desk clerk at the Philadelphia Ritz-Carlton, a job isn't limited to its procedures, which in a bureaucracy are owned by the person who performs them. Rather, every employee's responsibility is to the company as a whole, and with corporate DNA available, those employees have the information they need to make contributions anywhere in the organization.

CORPORATE NERVOUS SYSTEM

A second critical organic design principle is the nervous system's ability to gather information, integrate it into a picture of the world outside, and then coordinate the activities responding to the events it senses. (The nervous system also works with the endocrine system to communicate what's happening within the body. For the sake of simplicity, we'll consider endocrine functions as part of the nervous system.) The nervous system has two components: the *peripheral nervous system*, the network of nerve cells that connects almost every cell in the body, communicates sense impressions from all parts of the body to the *central nervous system*, the brain and spinal chord, and then carries messages back to the body. We'll return to the central nervous system when we look at how an organic corporation governs itself. Right now, let's turn to what happens when an organization applies the principle of communication available to all its parts performed by the peripheral nervous system.

When organizations apply the principle embodied in this system, they come up with a corporate equivalent of the peripheral nervous system. I've elsewhere called it a "corporate nervous system." Such a corporate nervous system enables everyone in the organization to learn what's happening inside or outside so that they can react by drawing on its corporate DNA. Not only that: It also allows people to learn how effective their actions have been so that they can modify them to be more effective next time. In this way, every person in the organization becomes its eyes and ears, the sense organs by which it gathers information about its markets.

Some examples of corporate nervous systems are extremely well known. Wal-Mart, for example, transformed retailing by using barcode scanners to create a company-wide information network. Because its people could learn what was being purchased at the point of sale, Wal-Mart was not only able to manage inventory on a moment-to-moment basis. It was also able to identify hot new items earlier than any of its competitors. With the information from its corporate nervous system, Wal-Mart began buying directly from its suppliers and stocking its stores through regional distribution centers. In addition, because it could amass this information much more rapidly than its suppliers, Wal-Mart was able to develop strategic alliances with suppliers, such as Procter & Gamble, which now has employees dedicated to working with Wal-Mart in its Bentonville, Arkansas headquarters. According to George Stalk and Thomas Hout (1990), this use of barcode information enabled Wal-Mart to grow three times faster and earn a return on capital twice that of its competitors.

Federal Express uses its corporate nervous system, including a barcode-scanning network, for very different purposes. Because every package is repeatedly scanned on its voyage to the person who will receive it, FedEx's computer system enables customers to learn exactly where their packages are at any moment. You don't even have to call a FedEx service rep to find out: You can check for yourself on the company's website. In this way, Federal Express has extended its corporate nervous system out to its customers. In addition, there is a company-wide television network so that people can learn what they need to know. If jets in Nome, Alaska, are having trouble taking off, people who will have to process them in Memphis, Tennessee, can find out so that they can rearrange their work schedule to avoid disruption.

3M's Integrated Solutions demonstrates a less technological, but still highly sophisticated use of corporate nervous system. On one hand, the work process mapping brings in extensive amounts of information about customers. On the other, when the sales/marketing/R&D team sits down to look for business opportunities in that mapping, those team members can draw on information from another area of 3M's corporate nervous system—the network of technical information by which 3Mers can learn about new technologies that are being developed within the company. It was, for instance, through this extended network that Art Fry learned about the adhesive he would use to invent Post-it Notes. These two elements of 3M's corporate nervous system ensure that its people working in Integrated Solutions have enormous amounts of information to enhance the quality of learning they do to meet their customers' needs.

It is important to note here that, in living things as well as organizations, learning occurs in the interaction between the nervous system and DNA. For organizations, the corporate nervous system brings in information about its customers in its markets, and corporate DNA gives their people the information on their options for responding. The clearer the information from the corporate nervous system, the more employees know about how to respond. The more effective the procedures and structures in corporate DNA, the more effectively they can respond.

NESTED NETWORKS

While it is essential to have these types of information available, living things also must be structured in such a way that enables them to respond in an emergent fashion—that is, they must be able to respond appropriately to the specific circumstances around them, no matter how different they are from what happened yesterday or the day before. To do so, living things are structured as nested networks. Molecules are nested in organelles, such as mitochondria or the nucleus; organelles, in cells; cells, in organs; organs, in organ systems; and organ systems, in the body as a whole. The boundaries of all these structures are semi-permeable so that all of them can be connected, either by the nervous system, the circulatory system, or both.

With this structure and their distributed information systems, living things can attack complex tasks very differently from the way machines do. Machine parts must be programmed and then arranged to perform complex tasks in a cause-and-effect manner. Living things, on the other hand, bring together units from each nested level to perform such tasks. As I write these words, hemoglobin molecules in my bloodstream are bringing oxygen, picked up in the alveoli of my lungs, to my brain cells so that they can choose the words and send messages to muscles in my arms and fingers, to type the words, and to muscles in my

eyes to scan the words and ensure that they are put together and spelled (mostly) correctly. In this one activity, my body uses structures at the level of molecules, cells, organs, and organ systems, combining activities in my nervous, circulatory, respiratory, and muscle systems. Our bodies are the ultimate in teamwork.

3M structures itself exactly this way. To oversimplify only a little, individuals are networked in functional departments (sales, marketing, R&D); departments, in product divisions; divisions, in market groups; market groups, in sectors; and sectors, in the company as a whole. And like living things, the boundaries of each of these units are semipermeable so that information can flow in and out. The key structure is the product divisions, which are semi-autonomous to the point of each having somewhat different cultures. To ensure a strong sense of interconnection, people in any functional department are cross-trained in other areas of their divisions. Salespeople, for example, learn about key divisional technologies, and those in R&D are expected to visit customer premises to learn how they use the division's products. Look at how this structure enhances organizational learning in Integrated Solutions:

- Individual salespeople from different divisions, sometimes representing different market groups, work together to map a customer's workflows.
- Salespeople work with others in their divisions representing marketing and R&D to identify customer needs.
- Each of those people draws on their personal network of connections within 3M, so that 10 people sitting together can be connected to most of the people in the company.

With the ability to draw on the knowledge of people company wide, regardless of the formal structures to which they belong, 3Mers can learn in a way that is truly organizational, rather than individual.

Moreover, this organic structure makes teamwork an expected standard of behavior. Because of the mechanical separation of subunits in more traditional organizations, cross-functional teamwork often creates problems. At one Baldrige National Quality Award winner, senior management demanded that such cross-functional teams start looking at a variety of problems. When the quality managers in charge of this effort reported back, they told the senior managers that these teams had made some advances but that, to make them most effective, the company would have to change its reward system. As long as rewards were solely tied to team members' units, they would represent the interests of their bosses, not the team. However, because those senior managers' relied on the reward system to maintain their power, they never made the changes that would have produced more effective cross-functional teamwork.

3M's nested network structure, however, facilitates teamwork by suggesting a reward structure based on organic teamwork, rather than mechanical separation.

CORPORATE CENTRAL NERVOUS SYSTEM

Where machines need an external intelligence to control and direct them, living things are self-governing. That self-government is provided by the central nervous system, which performs four key functions:

- To integrate impressions from the peripheral system into a unified picture. The world you see when you open your eyes combines thousands and thousands of nerve messages from the outside world with even more messages from your brain on how to interpret it all (Maturana and Varela, 1992).
- To make high-level decisions for the whole body. Parts of your brain are responsible for helping you decide everything from your body as a whole, from what to eat for breakfast to whether you will marry someone you're seeing or how to spend your lottery winnings.
- To coordinate the activities of the various parts of the body. As I write these words, the motor area of my brain is sending messages to the muscles in my hands and fingers, and to my eyes, so that their activities can be coordinated and I can string together on the page the words I've chosen.
- To monitor the body's subsystems so that the whole can remain healthy. Various centers in the brain monitor everything from temperature (the hypothalamus) to carbon dioxide levels in the blood (the vasomotor center) so that it can send chemical messages to keep the whole system healthy enough for all parts to do their jobs.

Two differences between mechanical government and organic selfgovernment are key. First, with machines the governing intelligence is external; with living things it is internal. Second, while the governing intelligence in both is responsible for

maintaining a picture of the outside world, making high-level decisions, and coordinating activities, the governing intelligence must *control* mechanical systems to give them direction; on the other hand, it must *monitor* organic systems so that they can self-organize and find their own ways.

As a result, an organic model suggests that senior management must act much like a corporate central nervous system. That is, while senior managers are still responsible for maintaining the corporate picture of the outside world, for coordinating activity, and for making high-level corporate decisions, they do not control the organization, as they would with a mechanical model. Rather, they monitor corporate systems to maintain the health of the organization as a whole.

At 3M, for example, as part of their responsibility for monitoring corporate systems, senior managers:

- gathered the information they needed to recognize the large customer sales problems that would lead to Integrated Solutions;
- decided to create a team-based sales program to take advantage of the opportunities those problems represented; and
- coordinated the activities needed to get it underway.

Having done all that, they could stand back and give people autonomy to run the program. They retained responsibility for monitoring the success of Integrated Solutions, but did not control it, as would probably happen in a more mechanical organization. The result is that people across the organization learn from their experiences in the program and build on each other's learning to create true organizational learning.

One other excellent example of how this process of organizational learning works at 3M is the spread of microreplication technology. Microreplication enables manufacturers to create specific product effects by covering surfaces with thousands of tiny structures. Researchers at 3M first used microreplication to create the first affordable overhead projectors in the mid-1960s. Then, without any dictate from senior management, this technology became a topic of discussion in the company's technical information network, and other researchers in a variety of product divisions began to use it. In the early 1970s, researchers used it to improve the reflective properties of traffic lights; by the late 1970s, for solar concentrators. By the mid-1980s senior managers had recognized, through their ongoing monitoring efforts, how useful the technology could be, so they created a center to speed the process of applying this technology. Today, products developed in one out of four of 3M's 40 product divisions use it, together accounting for about $1 billion in sales annually.

Yet, because the company is largely designed along organic principles, there was no need for a chief learning officer to recognize the opportunity and push its development. As Roger Appledorn, one of the 3M researchers who first applied microreplication, puts it:

> *We didn't sit down and say, 'Microreplication is the next thing to do; let's go do it.' It doesn't work this way. It evolved. It reached a critical mass. And it suddenly proliferated.*

At 3M product development can evolve like this because the company is largely based on an organic model. That is, it behaves *as if it were a living thing*: It treats internal information as flexible, universally available corporate DNA, makes current events available through a corporate nervous system, is structured in interconnected nested networks, and is governed by senior managers acting as a corporate central nervous system. By thus taking advantage of these organic design principles, 3M can function as a true learning organization, where contributing to the corporate store of knowledge and applying that knowledge to meet customer needs in new and exciting ways becomes the most important part of every person's job. Freed of the controls of a mechanical model, 3M's people work together as the autonomous agents of a self-organizing complex adaptive system, learning and adapting because that is the basic nature of their organization.

NOTE

Much of this article's discussion—from its theory of organizational models to its analysis of corporate DNA, corporate nervous system, nested network structure, and corporate central nervous system, as well as most of the corporate illustrations—are taken from the author's book, *Corporate DNA*. A briefer discussion of the difference between organic and mechanical models can be found on the internet, in the first issue of *Thresholds* at http://www.thresholds.com.

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