

*In memory of my parents  
Idris and Rachel Morgan*

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# IMAGES OF ORGANIZATION

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## Learning and Self-Organization

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### Organizations as Brains

**I**n his book *The Natural History of the Mind*, science writer G. R. Taylor offers the following observations on some of the differences between brains and machines:

In a famous experiment, the American psychologist Karl Lashley removed increasing quantities of the brains of rats which had been taught to run in a maze. He found that, provided he did not remove the visual cortex and thus blind them, he could remove up to ninety percent of their cortex without significant deterioration in their power to thread their way through the maze. There is no man-made machine of which this is true. Try removing nine-tenths of your radio and see if it still brings in a signal! It would seem that each specific memory is distributed in some way over the brain as a whole.

Similarly, you can remove considerable amounts of the motor cortex without paralyzing any one group of muscles. All that happens is a general

deterioration of motor performance. The evolutionary advantages of such an arrangement are manifest: when pursued, it is better to run clumsily than not at all. But how this remarkable distribution of function is achieved we do not really understand. We see, at all events, that the brain relies on patterns of increasing refinement and not (as man-made machines do) on chains of cause and effect. The fact is, the brain is not comparable with anything else.

Taylor's comments raise intriguing questions. Is it possible to design "learning organizations" that have the capacity to be as flexible, resilient, and inventive as the functioning of the brain? Is it possible to distribute capacities for intelligence and control *throughout* an enterprise so that the system as a whole can self-organize and evolve along with emerging challenges?

These issues are the focus of this chapter, which pursues the basic question "What if we think about organizations as living brains?"

### Images of the Brain

As *Newsweek* reporters Sharon Begley and R. Sawhill have noted, in the 2,400 years since Hippocrates located the seat of intellect in the skull, humans have been presented with the paradox that their greatest thoughts and achievements, and even their deepest emotions, may stem from a three-pound glob of matter with the consistency of Jell-O. Through persistent research, especially over the past 100 years, scientists and philosophers of all kinds have gradually begun to probe and reveal the mysteries of this prized area of anatomy. As might be expected, numerous metaphors have been summoned to shape understanding.

Many of these images focus on the idea that the brain is an information processing system. For example, the brain has been conceived as

- A control system similar to a complex computer or telephone switchboard, transmitting information through electronic impulses
- A kind of television system with a capacity to reassemble coherent patterns and images from millions of separate pieces of data
- A sophisticated library or memory bank for data storage and retrieval
- A complex system of chemical reactions that transmit messages and initiate actions
- A mysterious "black box" linking stimuli and behavior
- A linguistic system operating through a neural code that translates information into thoughts, ideas, and actions, rather like the code

represented in an alphabet can be converted into prose through words and sentences

More recently, the brain has been compared to a holographic system, one of the marvels of laser science. Holography, invented in 1948 by Dennis Gabor, uses lensless cameras to record information in a way that stores the whole in all the parts. Interacting beams of light create an "interference pattern" that scatters the information being recorded on a photographic plate, known as a hologram, which can then be illuminated to recreate the original information. One of the interesting features of the hologram is that, if broken, any single piece can be used to reconstruct the entire image. Everything is enfolded in everything else, just as if we were able to throw a pebble into a pond and see the whole pond and all the waves, ripples, and drops of water generated by the splash in *each and every one of the drops of water thus produced*.

Holography demonstrates that it is possible to create processes where the whole can be encoded in all the parts, so that each and every part represents the whole. Neuroscientist Karl Pribram of Stanford University has suggested that the brain functions in accordance with holographic principles: that memory is distributed throughout the brain and can thus be reconstituted from any of the parts. If he is correct, this may explain why the rats in Karl Lashley's experiments were able to function reasonably well even when major portions of their brain had been removed.

Debate about the true nature and functioning of the brain continues at an intense level, and the evidence remains inconclusive. Each metaphor used to shape understanding seems to catch key insights but falls short on other accounts. For example, the information processing images capture how the human brain manages to process billions of bits of data every second, transforming them into patterns and routines that help us deal with the world around us. But the explanations tend to overcentralize the process. The holographic evidence favors a more decentralized, distributed form of intelligence. When it comes to brain functioning it seems that there is no center or point of control. The brain seems to store and process data in many parts simultaneously. Pattern and order *emerge from the process*; it is not imposed.

Holographic explanations stress the "all over the place" character of brain functioning. Different elements are involved in systems of "parallel processing," generating signals, impulses, and tendencies that make contributions to the functioning and character of the whole. But the holographic explanation can go too far in that it underplays the fact that despite this distributed character there is also a strong measure of system specialization. The brain, it seems, is *both* holographic *and* specialized!

This paradox is clearly illustrated, for example, in the results of "split brain" research. This shows how the brain's right hemisphere plays a dominant role in creative, intuitive, emotional, acoustic, and pattern recognition functions and controls the left side of the body. The left hemisphere is more involved with rational, analytic, reductive, linguistic, visual, and verbal functions while controlling the right side of the body. There is undoubtedly a high degree of specialization on the part of each hemisphere, but both are always involved in any given activity. It is just that one hemisphere seems to be more active or dominant than the other as different functions are brought into play. The complementarity is also illustrated in the evidence that although different people may bring a right- or left-brain dominance to a specific task, both hemispheres are necessary for effective action or problem solving to occur.

When it comes to understanding the brain, we have to be able to embrace this kind of paradox and develop explanations that acknowledge how logical reduction and creative expansiveness may be elements of the same process; how high degrees of specialization and distributed function can coexist; how high degrees of randomness and variety can produce a coherent pattern; how enormous redundancy and overlap can provide the basis for efficient operation; and how the most highly coordinated and intelligent system of which we are aware has no predetermined or explicit design.

Interestingly, some of the most powerful insights on these issues are emerging from the field of artificial intelligence, where experiments in the construction of brainlike machines are actually showing how we can create the capacities that G. R. Taylor refers to in the quotation presented at the beginning of this chapter.

For example, in the construction of mobile robots, called "mobots," ways are being found of reconciling principles of centralized and decentralized intelligence. Mobots with large centralized "brains" require so much supporting hardware that they get overwhelmed and immobilized by the high ratio of body to brain. And when the "body problem" is solved by putting "the brain" in a central but remote location, communication processes tend to get distorted by all kinds of random "noise" that creates a constant tendency toward system failure. The most successful innovations seem to involve systems of distributed intelligence where integration and coherence are built from the "bottom up" in a way that allows "higher" or more evolved forms of intelligence to emerge.

Consider, for example, the mobot called "Genghis," created by Rodney Brooks at MIT and described by Kevin Kelly in his book *Out of Control*. Genghis has been designated as a kind of "mechanical cockroach" that has six legs but no brain. Each leg has its own microprocessor that can act

as a sensing device that allows it to "think for itself" and determine its actions. Within the body of the machine other semi-independent "thinking" devices coordinate communications between the legs. The walking process emerges as a result of the piecemeal intelligence. The independence of the legs gives great flexibility and avoids the mammoth task of processing all the information that would be necessary to coordinate the operation of the six legs as an integrated process.

Genghis offers a metaphor for understanding how intelligent action can emerge from quasi-independent processes linked by a minimal set of key rules, making the whole system appear to have an integrated, purposeful, well-coordinated intelligence. By building around a pattern of simple "If . . . then . . ." routines, the "cockroach" walks without knowing how it does so. Rodney Brooks describes some of the key design principles as follows:

There is no central controller which directs the body where to put each foot or how high to lift a leg should there be an obstacle ahead. Instead, each leg is granted a few simple behaviors and each independently knows what to do under various circumstances. For instance, two basic behaviors can be thought of as "If I'm a leg and I'm up, put myself down," or "If I'm a leg and I'm forward, put the other five legs back a little." These processes exist independently, run at all times, and fire whenever the sensory preconditions are true. To create walking then, there just needs to be a sequencing of lifting legs (this is the only instance where any central control is evident). As soon as a leg is raised it automatically swings itself forward, and also down. But the act of swinging forward triggers all the other legs to move back a little. Since those legs happen to be touching the ground, the body moves forward.

Now return to the brain. Could it be that sophisticated forms of intelligence emerge from the "bottom up," as the result of the integration of more modest capacities and intelligences? This, indeed, is close to the view offered by cognitive philosopher Daniel Dennett of Tufts University, who suggests that what we see and experience in the brain as a highly ordered stream of consciousness is really the result of a more chaotic process where multiple possibilities—what he calls "multiple drafts"—are generated as a result of activity distributed throughout the brain. There is no master, centralized intelligence! The brain as a system engages in an incredibly diverse set of parallel activities that make complementary and competing contributions to what eventually emerges as a coherent pattern.

So, the question *What if we view organizations as brains?* raises many interesting possibilities.

Clearly, there are many possibilities!

In the following sections we will explore and develop the insights discussed above by viewing organizations in three interconnected ways: as information processing brains; as complex learning systems; and as holographic systems combining centralized and decentralized characteristics.

### Organizations as Information Processing Brains

If one thinks about it, every aspect of organizational functioning depends on information processing of one form or another. Bureaucrats make decisions by processing information with reference to appropriate rules. Strategic managers make decisions by developing policies and plans that then provide a point of reference for the information processing and decision making of others. Computers automate complex information flows, and with the development of the Internet, corporate "intranets," and other webs of electronic communication, we are finding that organizations are becoming synonymous with the decisions, policies, and data flows that shape day-to-day practice.

Organizations are information systems. They are communication systems. And they are decision-making systems. We can thus go a long way toward understanding them as information processing brains!

This approach to understanding organization, originally known as "the decision-making approach," was pioneered in the 1940s and 1950s by Nobel Prize winner Herbert Simon and colleagues like James March while at the Carnegie Institute of Technology (now Carnegie-Mellon University). Exploring the parallels between human decision making and organizational decision making, Simon is famous for arguing that organizations can never be perfectly rational because their members have limited information processing abilities. Arguing that people (a) usually have to act on the basis of incomplete information about possible courses of action and their consequences, (b) are able to explore only a limited number of alternatives relating to any given decision, and (c) are unable to attach accurate values to outcomes, Simon challenged the assumptions made in economics about the optimizing behavior of individuals. He concluded that individuals and organizations settle for a "bounded rationality" of "good enough" decisions based on simple rules of thumb and limited search and information.

In Simon's view, these limits on human rationality are institutionalized in the structure and modes of functioning of our organizations. Hence, his theory of decision making leads us to understand organizations as kinds of institutionalized brains that fragment, routinize, and bound the

decision-making process to make it manageable. As we look at organizations from this vantage point, we come to see that the various job, departmental, and other divisions within an organization do not just define a structure of work activity. They also create a structure of attention, information, interpretation, and decision making that exerts a crucial influence on an organization's daily operation.

Since Simon and his colleagues first introduced this way of thinking about organizations, numerous researchers and consultants have devoted considerable attention to understanding organization from an information processing standpoint with a view to enhance organizational rationality in practice. Paradoxically, although Simon's main contribution has been to show that organizations can never be fully rational and thus have to be content with "satisficing," the main impact of his work has been to reinforce the rational model.

For example, scientists working in the fields of operations research (OR), management decision systems (MDS), and management information systems (MIS) have been inspired to find ways of developing information processing and decision-making tools that can lead to more rational decisions. This has resulted in complex theories and systems for data management in relation to logistics, production, distribution, finance, sales, marketing, and other areas of activity and to the creation of planning, design, and implementation teams and departments that can "think" for the rest of the organization and control overall activities. In effect, this development has given many complex organizations the equivalent of a centralized brain that regulates overall activity. Large, complex organizations that rely on vast amounts of data processing to manage their customers, production, or distribution activities would now find it impossible to function without this kind of support.

Other important work in line with the rational model has been conducted by organization theorists wishing to understand organizational structure in terms of information processing models. For example, Jay Galbraith has given attention to the relationship between uncertainty, information processing, and organization design to explain the reasons for different styles of organization such as the mechanistic and organic approaches discussed in Chapter 3. Uncertain tasks require that large amounts of information be processed between decision makers during task performance. The greater the uncertainty, the more difficult it is to program and routinize activity by preplanning a response. Thus, as uncertainty increases, organizations typically find ways of controlling outputs (e.g., by setting goals and targets) rather than controlling behaviors (e.g., through rules and programs) and by relying on continuous feedback as a means of control. Hierarchy provides an effective means for

controlling situations that are fairly certain but in uncertain situations can encounter information and decision overload.

The information processing perspective has created a fresh way of thinking about organization. But there are two major criticisms, each of which opens a new line of development.

The first is that most decision-making and information processing views have had a "left-brain bias" and an overcentralized view of the nature of organizational intelligence. As Simon himself acknowledges, in his early writings he specifically sought to use logic, with its emphasis on drawing conclusions from premises, as a central metaphor for describing the decision-making process. This is why his findings reinforced the bureaucratic model. The emphasis was placed on rational, analytical, reductive approaches to information processing and problem solving. More intuitive nonlinear approaches, characteristic of a more "right-brain" orientation, were underemphasized.

A more fully developed decision-making perspective would balance and integrate left and right brain capacities. Simon himself has taken important steps in this direction, recognizing how left and right brain capacities are intertwined, rather than being polar opposites, and how much of what passes as nonlogical, intuitive judgment can be understood as the result of complex information processing skills based on pattern recognition rather than formal logic and analysis. The theory is that intuitive managers learn to recognize clusters or chunks of information and act accordingly. While their behavior often seems nonrational, in that the managers concerned are unable to give formal accounts or justifications of why a particular decision has been made, implicit analytical processes are involved.

This more intuitive, nonlogical approach to organizational decision making has also been developed by James March, Simon's former colleague, and other associates who have interested themselves in understanding the fluid and informal aspects of organizations. They have used many unconventional metaphors, such as the idea that organizations are like "garbage cans," "organized anarchies," "seesaws," and "camping grounds," to capture the unpredictable ways in which solutions go looking for problems (rather than the reverse), how rational explanations are often imposed on decisions *after* they have been made, and how one organizational pattern or design may give way to another without any explicit rational analysis. Instead of just focusing on how managers and their organizations can find ways of trying to reduce or eliminate uncertainty, as has been the case with most rational approaches to decision making and organizational design, attention has been focused on confronting and flowing with that uncertainty. The challenge has been to find ways of

opening thinking styles and decision making that take us beyond the rationality model.

The second major criticism is that too much emphasis has been placed on using the image of the limited information processing capacities of a *single individual*, as a model for understanding decision making in organizations generally. This is the implicit premise of Simon's view of "bounded rationality." The limited intelligence of individuals is used to justify the limited intelligence of organizations.

All this is now changing, as developments in information technology and forms of "networked intelligence" are giving a completely different twist to the information processing view of organization and its implications for organizational design.

Consider, for example, how computerized stock control and checkout facilities in supermarkets and other large retail stores have transformed the organizations using them. In applying a laser beam to precoded labels on the items being sold, the sales assistant records price and product and inputs data into various kinds of financial analyses, sales reports, inventory controls, reordering procedures, and numerous other automated information and decision-making activities. The system of organization embedded in the design of such information systems replaces more traditional modes of human interaction, eliminating armies of clerks, stockroom attendants, and middle managers. It also links organizations that used to have distinct identities—manufacturers, suppliers, banking and finance companies—into an integrated information web.

Organization in such circumstances increasingly rests in the information system. Indeed, microprocessing technology has created the possibility of organizing without having an organization in strictly physical terms. For example, a manufacturing organization "based" in the outskirts of New York City may coordinate the assembly of parts delivered from several Asian manufacturing plants at a location in Taiwan. The resulting product will be delivered to retailers throughout Europe and North America by independent distributors. Customer inquiries or problems with the product may be routed via a "Help Line" to customer service representatives employed in Ireland, Denmark, or New Brunswick. The accounting to support such transactions is performed in the Far East, and "Accounts Receivable" is delegated to a firm in Atlanta. The company based in New York City has a small staff of central coordinators and provides a marketing and R&D function. It is a "virtual organization." Information technology is used to dissolve the constraints of space and time, linking "knowledge workers" and factory operators in remote locations across the globe into an integrated set of activities.

We find the same pattern in "just-in-time" (JIT) systems of manufacturing, where the components to be used in producing a product are delivered by independent suppliers just minutes or hours before they are needed. This innovation has transformed the very concept of what it means to be "an organization." Under older systems of production where suppliers provided the parts or raw materials to be used in manufacturing a product, such as an automobile, the automobile manufacturer (e.g., Ford, GM, or Volkswagen) was a clearly defined organization. It had a physical boundary and a distinct workforce. But with JIT such boundaries and patterns of membership dissolve. Suppliers may locate their production activities on the premises of Ford or GM to streamline the delivery process and make the "just-in-time" period shorter and more reliable. To an outsider, it may be impossible to distinguish who is working for whom. The fundamental organization really rests in the complex information system that coordinates the activities of all the people and firms involved rather than in the discrete organizations contributing different elements to the process. JIT has transformed organizational relationships throughout the world, linking what used to be discrete organizations into integrated systems of intelligence and activity. We also see the same process occurring in financial services and throughout the service sector.

Consider, for example, how the Internet and other webs of electronic information exchange are transforming retailing and electronic commerce. Large computer software companies are collaborating with manufacturers, distributors, and credit card and finance companies to produce a pattern of direct interaction between customers and manufacturers. Besides eliminating intermediary firms, such as retailers, the development is enhancing possibilities for mass customization. For example, a person wishing to order a shirt or suit of clothes from a manufacturer can select the desired product from an electronic catalogue, submit height, weight, and other personal measurements for complete customization, pay electronically, and expect to receive delivery without further action.

We have here a system of organization. Or is it better described and understood as a system of intelligence? It reflects the shift that is occurring toward a fully fledged information economy. Organizations are rapidly evolving into global information systems that are becoming more and more like electronic brains. What once seemed to rest within the domain of science fiction—peopleless factories coordinated by peopleless offices, producing services on demand—is rapidly becoming reality.

All these developments break the old assumptions about how the structure and capacities of our organizations are limited by the "bounded rationality" described by Herbert Simon. While human intelligence is still

the driving force, networked computing is able to realize organizational possibilities that, just a few decades ago, were no more than a dream.

In this world, where rapid change and transformation are becoming the norm, organizations face new challenges. In addition to planning and executing tasks in an efficient rational way, they face the challenge of constant learning and, perhaps even more important, of learning to learn. It is to this aspect of the brain that we now turn.

### Creating Learning Organizations

How can one design complex systems that are capable of learning in a brainlike way? This question has been of special concern to a group of information theorists who have interested themselves in problems of artificial intelligence under the umbrella of what is now known as cybernetics.

#### CYBERNETICS, LEARNING, AND LEARNING TO LEARN

Cybernetics is a relatively new interdisciplinary science focusing on the study of information, communication, and control. The term was coined in the 1940s by MIT mathematician Norbert Wiener as a metaphorical application of the Greek *kubernetes*, meaning "steersman." The Greeks developed the concept of steersmanship, probably from their understanding of the processes involved in the control and navigation of watercraft, and extended its use to the process of government and statecraft. Wiener used this imagery to characterize processes of information exchange through which machines and organisms engage in self-regulating behaviors that maintain steady states.

The origins of modern cybernetics are diverse, but they are found most concretely in the research activities of Wiener and his colleagues during World War II, particularly in the attempt to develop and refine devices for the control of gunfire. The problem of firing a gun at a moving target, such as an airplane, presents a difficult problem of steersmanship involving complex statistical forecasting and computation. Along with considering the speed and position of the plane at a given time and the direction and speed of the missile to be fired, allowance must also be made for variable wind effects and the likelihood that the plane will engage in diversionary flight patterns. Cybernetics emerged from this design challenge, as scientists expert in mathematics, communications theory, engineering, and social and medical science combined their skills and insights to

create machines with the computational and adaptive capacities of a living brain.

The core insight emerging from this early work was that the ability of a system to engage in self-regulating behavior depends on processes of information exchange involving *negative feedback*. This concept is central to the process of steersmanship. If we shift a boat off course by taking the rudder too far in one direction, we can get back on course again only by moving it in the opposite direction. Systems of negative feedback engage in this kind of error detection and correction automatically so that movements beyond specified limits in one direction initiate movements in the opposite direction to maintain a desired course of action.

The concept of negative feedback explains many kinds of routine behavior in a very unconventional way. For example, when we pick up an object from a table we typically assume that our hand, guided by our eye, moves directly toward the object. Cybernetics suggests not. This action occurs through a process of error elimination, whereby deviations between hand and object are reduced *at each and every stage of the process*, so that in the end no error remains. We pick up the object by avoiding not picking it up (Exhibit 4.1).

These cybernetic principles are evident in many kinds of systems. The "governor" regulating the speed of the steam engine invented by James Watt in the nineteenth century provides an early example. Two steel balls were suspended from a central shaft attached to the engine. The shaft rotated with the speed of the engine, swinging the balls in an outward direction as speed increased, thus closing the throttle. The reverse actions occurred when speed was reduced. The machine thus acted as a form of a communication system in which an increase in speed initiated actions leading to a decrease in speed and vice versa. This is *negative feedback*: More leads to less, and less to more. Similar principles are incorporated in a house thermostat. Living organisms operate in a parallel manner. When our body heat rises, the brain and central nervous system initiate action that leads us to slow down, sweat, and breathe heavily in order to initiate changes in the opposite direction. Similarly, when we get cold, we are led to shiver, stamp our feet, and attempt to increase body temperature, keeping body functioning within the critical limits necessary for survival.

Cybernetics thus leads to a theory of communication and learning stressing four key principles:

1. Systems must have the capacity to sense, monitor, and scan significant aspects of their environment.
2. They must be able to relate this information to the operating norms that guide system behavior.

We pick up an object by avoiding not picking it up!

In a similar way, we manage to ride a bicycle by means of a system of information flows and regulatory actions that help us to avoid falling off.

Negative feedback eliminates error: It creates desired system states by avoiding noxious states.



Exhibit 4.1 Negative Feedback in Practice

3. They must be able to detect significant deviations from these norms.
4. They must be able to initiate corrective action when discrepancies are detected.

If these four conditions are satisfied, a continuous process of information exchange is created between a system and its environment, allowing the system to monitor changes and initiate appropriate responses. In this way the system can operate in an intelligent, self-regulating manner. However, the learning abilities thus defined are limited in that the system can maintain only the course of action determined by the operating norms or standards guiding it. This is fine so long as the action defined by those standards is appropriate for dealing with the changes encountered. But when this is not the case, the intelligence of the system breaks down, for



the process of negative feedback ends up trying to maintain an inappropriate pattern of behavior.

This has led modern cyberneticians to draw a distinction between the process of learning and the process of learning to learn. Simple cybernetic systems, like house thermostats, are able to learn in the sense of being able to detect and correct deviations from predetermined norms, but they are unable to question the appropriateness of what they are doing. For example, a simple thermostat is unable to determine what level of temperature is appropriate to meet the preferences of the inhabitants of a room and to make adjustments to take account of this. More complex cybernetic systems such as the human brain or advanced computers have this capacity. They are often able to detect and correct errors in operating norms and thus influence the standards that guide their detailed operations. It is this kind of self-questioning ability that underpins the activities of systems that are able to learn to learn and self-organize. The essential difference between these two types of learning is sometimes identified in terms of a distinction between "single-loop" and "double-loop" learning (Exhibit 4.2).

#### CAN ORGANIZATIONS LEARN TO LEARN?

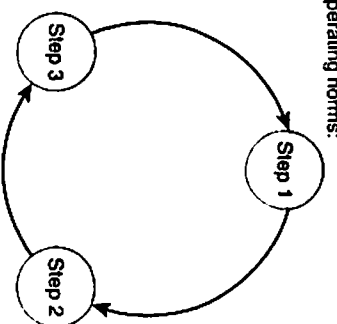
All the above ideas raise very important questions for modern organizations. Are they able to learn in an ongoing way? Is this learning single-loop or double-loop? What are the main barriers to learning? Are these barriers intrinsic to the nature of human organization? Can they be overcome?

As a result of the pioneering work conducted by Chris Argyris at Harvard University and by Donald Schön at MIT, these issues have now been brought to the forefront of management attention. Conceived as a challenge of creating "learning organizations," and popularized by the work of Peter Senge in the United States and independently through Reg Revans's concept of "action learning" in Europe, the idea of developing capacities for individual and organizational learning has established itself as a key priority in designing and managing organizations that can deal with the challenges of a turbulent world.

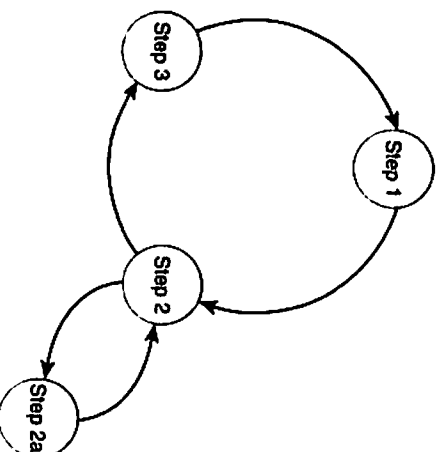
The principles of modern cybernetics provide a framework for thinking about how this can be achieved.

For example, many organizations have become proficient at single-loop learning, developing an ability to scan the environment, set objectives, and monitor the general performance of the system in relation to these objectives. This basic skill is often institutionalized in the form of information systems designed to keep the organization "on course."

*Single-loop learning rests in an ability to detect and correct error in relation to a given set of operating norms:*



*Double-loop learning depends on being able to take a "double look" at the situation by questioning the relevance of operating norms:*



- Step 1 = the process of sensing, scanning, and monitoring the environment.
- Step 2 = the comparison of this information against operating norms.
- Step 2a = the process of questioning whether operating norms are appropriate.
- Step 3 = the process of initiating appropriate action.

#### Exhibit 4.2 Single- and Double-Loop Learning

For example, budgets and other management controls often maintain single-loop learning by monitoring expenditures, sales, profits, and other indications of performance to ensure that organizational activities remain within established limits. Advances in computing have done much to foster the use of this kind of single-loop control.

However, the ability to achieve proficiency at double-loop learning often proves more elusive. Although some organizations have been successful in institutionalizing systems that review and challenge basic paradigms and operating norms, many fail to do so. This failure is especially true of bureaucratized organizations, whose fundamental organizing principles often operate in a way that actually *obstructs* the learning process.

For example, bureaucratization tends to create fragmented patterns of thought and action. Where hierarchical and horizontal divisions are particularly strong, information and knowledge rarely flow in a free manner. Different sectors of the organization thus often operate on the basis of different pictures of the total situation, pursuing subunit goals almost as ends in themselves.

The existence of such divisions tends to emphasize the distinctions between different elements of the organization and fosters the development of political systems that place yet further barriers in the way of learning. The bounded rationality inherent in organizational design thus actually *creates* boundaries! Employees are usually encouraged to occupy and keep a predefined place within the whole, and are rewarded for doing so. Situations in which policies and operating standards are challenged tend to be exceptional rather than the rule. Under these circumstances, single-loop learning systems are reinforced and may actually serve to keep an organization on the wrong course.

Barriers to double-loop learning can also be created by processes of bureaucratic accountability and other systems for rewarding or punishing employees. As Chris Argyris and Donald Schön have shown, when people feel threatened or vulnerable they often engage in "defensive routines" designed to protect themselves and their colleagues. They find ways of obscuring or burying issues and problems that will put them in a bad light and of deflecting attention elsewhere. They become skilled in all kinds of impression management that can make situations for which they are responsible look better than they actually are. They often ignore or fail to report deep-seated problems and often "hold back" or dilute other bad news, giving senior managers rosy pictures of a situation or telling them what they think they would like to hear. The sequence of events and burying of problems leading to the U.S. space shuttle *Challenger* disaster provides an excellent example. The desire to launch "on time" overrode knowledge of serious problems with the O-ring seals that triggered the shuttle explosion.

Argyris and Schön suggest that such problems are systemic and universal. They are found in many different kinds of organizations and transcend cultural boundaries. The "defensive routines" they express seem to

be learned early in life and hinge on various kinds of face-saving processes through which people seek to protect themselves and others from embarrassment or threat. In organizational contexts, formal structures, rules, job descriptions, and various conventions and beliefs offer themselves as convenient allies in the process of self-protection and are used both consciously and unconsciously for this purpose. Defensive routines can also become a central part of the culture of an organization, generating shared norms and patterns of "groupthink" that prevent people from addressing key aspects of the reality with which they are dealing.

#### GUIDELINES FOR "LEARNING ORGANIZATIONS"

Given all these potential pathologies, it is not surprising that so many organizations find difficulty in learning and evolving in a fluid way. Indeed, as Peter Senge of MIT has pointed out, most organizations seem to have severe learning disabilities; most "die" before the age of forty.

But the good news here is that awareness of a problem is often the first important step toward a solution. We can thus take the insights about cybernetics and learning and begin to define the requirements of learning organizations in practice.

In a nutshell, cybernetics suggests that learning organizations must develop capacities that allow them to do the following:

- Scan and anticipate change in the wider environment to detect significant variations.
- Develop an ability to question, challenge, and change operating norms and assumptions.
- Allow an appropriate strategic direction and pattern of organization to emerge.

Also, in achieving these aims, they must

- Evolve designs that allow them to become skilled in the art of double-loop learning, to avoid getting trapped in single-loop processes, especially those created by traditional management control systems and the defensive routines of organizational members.

The task of realizing these characteristics in practice, of course, is a difficult one and very much a "work in progress." Many organizations are

struggling to find ways of breaking free of traditional modes of operation to enhance continuous learning. However, the above guidelines provide clear indications of the direction in which to move.

### *Scanning and Anticipating Environmental Change*

Learning organizations have to develop skills and mind-sets that embrace environmental change as a norm. They have to be able to detect "early warning" signals that give clues to shifting trends and patterns. And they often have to find ways of inventing completely new ways of seeing their environment. For it is by seeing and thinking about the context of their industry and activities in new ways that they are able to envisage and create new possibilities.

As Ikujiro Nonaka and Hiro Takuchi have shown in their study of innovation in successful Japanese companies, genuine learning and the ability to develop breakthrough products and services have to go beyond the collection and processing of information. They must embrace the *creation* of insight and knowledge. Like the human brain, successful learning organizations need to be skilled in the art of representation. They need to be able to create appropriate maps of the reality with which they have to deal. But the process has to be active rather than passive. It has to embrace views of potential futures as well as of the present and the past.

The process is well illustrated in the work of Gary Hamel and C. K. Prahalad, who have shown how many of the most innovative companies worldwide possess an ability to envisage and create completely new industries or business niches. This allows them to invent and reinvent themselves, and their relationships with competitors, customers, and the broader environment, on a continuous basis. For example, Apple Computer's vision of a world where everyone has a PC helped reinvent the computer industry. CNN's vision of an international "around-the-clock" system of news reporting helped create a major transformation in broadcasting. Canon's vision of small user-friendly photocopiers using disposable parts created a major new niche in the maturing photocopier business. British Airways' drive to globalization initiated major transformations in the airline industry. The vision of a world where everyone will possess their own mobile telephone number and where telecommunications and other media services will be completely user driven is setting a new stage for the development of media, computer, and other electronic services. Similarly, the vision of electronic merchandising is changing the shape of retailing and creating personal relationships between mass, yet fully customized, manufacturers and the people who buy their products and services.

Intelligent learning systems use information about the present to ground their activities in a business reality. But they are also skilled in spotting the "fracture lines," signals, and trends that point to future possibilities. They are skilled at imagining and anticipating possible futures and acting in the present in ways that help make those futures realities. Often, the skill is not just cognitive but intuitive, emotional, and tactile as well.

As many successful companies have shown, it is impossible to truly know one's customers, potential customers, or products and services at a distance. One has to join them. One has to share their experiences. One has to understand products and services from *their* point of view. A learning organization thus has to become skilled in breaking the boundaries separating it from its environment, to engage and experience the environment as fully as possible.

The view of learning involved here goes well beyond the passive information processing characteristics of simple cybernetic machines. It embraces the kind of active intelligence characteristic of the human brain and its extension through the nervous system. And, like the products of the human brain, the actions of a learning organization actually change the environment in which it exists. We are a long way, here, from the bounded rationality of a mechanistic organization monitoring its environment, shielding itself from uncertainty and seeking to maintain a stable internal system and a fixed niche. We are involved with a much more fluid sense of intelligence that uses, embraces, and at times creates uncertainty as a resource for new patterns of development.

### *Challenging Operating Norms and Assumptions*

The kind of learning orientation described above must be rooted in key competencies within the organization concerned. As has been shown, the principles of double-loop learning give clear guidance on what's needed. To learn and change, organizational members must be skilled in understanding the assumptions, frameworks, and norms guiding current activity and be able to challenge and change them when necessary. In this way the organization can adjust internal operations to meet changing strategic and environmental requirements and avoid being locked into the past. "Double-loop" learning depends on what is sometimes described as the art of framing and reframing, which, as Donald Schön has shown, is crucial for the kind of self-reflective practice that underpins intelligent action. In concrete terms, it means that organizational members must be skilled in understanding the paradigms, metaphors, mind-sets, or mental models that underpin how the

organization operates. They must be able to develop new ones when appropriate. Most of what Peter Senge tells us about learning organizations fits here. In essence, he invites organizational members to challenge how they see and think about organizational reality, using different templates and mental models, especially those generated by "systems thinking," to create new capacities through which organizations can extend their ability to create the future.

- What business are we in, and is it the right business?
- Can we create fundamentally new products and services?
- Can we redefine the boundaries between different industries and services so that new niches emerge?
- Can we structure our organization around business processes that reflect a customer viewpoint rather than the influence of traditional departmental structures?
- Can we redesign business processes in a way that will increase the quality of production *and reduce costs*?
- Can we replace our organizational hierarchy with a network of self-managing teams?

All these questions contain a double-loop learning potential because they invite the questioner to examine the status quo and consider alternative modes of operation. They encourage us to understand key organizational attributes from the standpoint of a new frame.

This is what it takes to reinvent existing modes of operation. Many organizations get trapped by the status quo. They become myopic, accepting their current reality as *the* reality. To learn and change they must be prepared to challenge and change the basic rules of the game at both strategic and operational levels.

The practice of double-loop learning has become well established at a strategic level. Most organizations have recognized the importance of challenging key business paradigms, using brainstorming sessions and other forms of creative thinking to create new directions. As a result of the path-breaking work by Edwards Deming, Joseph Juran, and other leaders of the "quality movement," the philosophy of promoting continuous improvement (the Japanese concept of *Kaizen*) and total quality management (TQM) has done much to institutionalize the practice of challenging taken-for-granted norms and practices at an operational level (Exhibit 4.3).

The challenge, of course, is to ensure that the strategic and operational dimensions are in sync, and this is where problems often arise. Strategic development may run ahead of organizational reality because of the tendency for current operations to get caught in patterns of single-loop

The power of TQM, *Kaizen*, and other methods of generating continuous improvement rests in the fact they encourage double-loop learning:

- Employees are asked to dig beneath the surface of recurring problems and uncover the forces that are producing them.
- They are encouraged to examine existing modes of practice and find better ones.
- They are encouraged to create "languages," mind-sets, and values that make learning and change a major priority.

In challenging operating norms and assumptions in this way, the approaches create information, insights, and capacities through which a system can evolve to new levels of development.

#### Exhibit 4.3 TQM and Double-Loop Learning

learning. Indeed, the TQM movement has suffered badly from this problem. Despite an outright commitment to constant improvement, many TQM programs have got caught in old bureaucratic patterns and cultural norms, leading to failure rates in the region of 70 percent. Such is the strength of pressures toward single-loop learning. When change threatens the status quo, defensive routines "kick in," diluting or diverting the attack on established practice.

For successful double-loop learning to occur, organizations must develop cultures that support change and risk taking. They have to embrace the idea that in rapidly changing circumstances with high degrees of uncertainty, problems and errors are inevitable. They have to promote an openness that encourages dialogue and the expression of conflicting points of view. They have to recognize that legitimate error, which arises from the uncertainty and lack of control in a situation, can be used as a resource for new learning. They have to recognize that genuine learning is usually action based and thus must find ways of helping to create experiments and probes so that they learn through doing in a productive way.

All this, of course, can raise high levels of anxiety in an organization. In particular, it is difficult for managers who want to be "on top of the facts" and "in control" to ride the kind of creative chaos on which innovation thrives. Yet this is precisely the competence that double-loop learning requires. Under its reign, managers and employees at all levels have to find ways of embracing uncertainty in a manner that allows new patterns of action to emerge.

### Encouraging "Emergent" Organization

The intelligence of the human brain is not predetermined, pre-designed, or preplanned. Indeed, it is not centrally driven in any way. It is a decentralized *emergent* phenomenon. Intelligence evolves.

This aspect of the brain metaphor has enormous implications because it counters the traditional view of management as requiring strong direction, leadership, and control that, in effect, imposes goals and objectives from "above" for execution "below."

As has been shown, a "top down" approach to management, especially one focusing on control through clearly defined targets, encourages single-loop learning but discourages the double-loop thinking that is so important for an organization to evolve.

This creates interesting paradoxes for management, for how can one manage in a coherent way without setting clear goals and objectives?

The answer derived from cybernetics is that the behavior of intelligent systems requires a sense of the vision, norms, values, limits, or "reference points" that are to guide behavior. Otherwise, complete randomness will prevail. But these "reference points" must be defined in a way that creates a space in which many possible actions and behaviors can emerge *including those that can question the limits being imposed!* Targets tend to create straitjackets. Cybernetic points of reference create space in which learning and innovation can occur.

The contrast between these two approaches is beautifully illustrated in a story told by management writer William Ouchi on how American and Japanese managers view objectives (Exhibit 4.4).

In the American view, objectives should be hard-and-fast and clearly stated for all to see. In the Japanese view, objectives *emerge* from a more fundamental process of exploring and understanding the values through which a firm is or should be operating. As the Japanese bank president in Ouchi's example suggests, if his managers could absorb the basic philosophy of the bank and how it wants its staff to deal with customers and competitors, appropriate objectives and behaviors in any situation would become very apparent. They wouldn't have to be set or be imposed by a third party.

The core values of the bank are cybernetic reference points that allow self-regulating behavior to occur. They create coherence. But they also give a lot of space. In any situation a manager is free to choose whatever action or behavior seems appropriate to the situation at hand. This opens the way to sustained innovation at a local level. This, in turn, creates a potential for double-loop learning, as significant innovations can be used to modify operating norms.

William Ouchi reports on differences in the style of American and Japanese managers working in the U.S. headquarters of a Japanese bank:

The basic mechanisms of management control in a Japanese company are so subtle, implicit, and internal that they often appear to an outsider not to exist. That conclusion is a mistake. The mechanisms are thorough, highly disciplined, and demanding, yet very flexible. Their essence could not be more different from methods of managerial control in Western organizations.

In an interview with the American vice presidents, I asked how they felt about working for this Japanese bank. "They treat us well, let us in on the decision making and pay us well. We're satisfied." "You're very fortunate," I continued, "but tell me, if there were something that you could change about this Japanese bank, what would it be?" The response was quick and clearly one that was very much on their minds: "These Japanese just don't understand objectives, and it drives us nuts!"

Next I interviewed the president of this bank, an expatriate Japanese who was on temporary assignment from Tokyo headquarters to run the United States operation, and asked about the two American vice presidents. "They're hard-working, loyal, and professional. We think they're terrific," came the reply. When asked if he would like to change them in any way, the president replied, "These Americans just don't seem to be able to understand objectives."

With each side accusing the other of an inability to understand objectives, there was a clear need for further interviewing and for clarification. A second round of interviews probed further into the issue. First, the American vice presidents: "We have all the necessary reports and numbers, but we can't get specific targets from him. He won't tell us how large a dollar increase in loan volume or what percent decrease in operating costs he expects us to achieve over the next month, quarter, or even year. How can we know whether we're performing well without specific targets to shoot for?" A point well taken, for every major American company and government bureau devotes a large fraction of its time to the setting of specific, measurable performance targets. Every American business school teaches its students to take global, fuzzy corporate goals and boil them down to measurable performance targets. Management by objective (MBO), program planning and evaluation, and cost-benefit analysis are among the basic tools of control in modern American management.

When I returned to reinterview the Japanese president, he explained, "If only I could get these Americans to understand our philosophy of banking. To understand what the business means to us—how we feel we should deal with customers and our employees. What our relationship should be to the

#### Exhibit 4.4

#### American and Japanese Styles of Management: The Contrast Between Mechanistic and Cybernetic Styles of Decision Making

(Continued)

## Exhibit 4.4 (Continued)

local communities we serve. How we should deal with our competitors, and what our role should be in the world at large. If they could get that under their skin, then they could figure out for themselves what an appropriate objective would be for any situation, no matter how unusual or new, and I would never have to tell them, never have to give them a target."

SOURCE: Pages 33-34 in William Ouchi, *Theory Z* (adapted material). © 1981 by Addison-Wesley, Reading, Massachusetts.

Suppose, for example, that managers working within the framework of the bank's philosophy and values find means of meeting customer needs in a new way or of providing a new service. A system that is open to this kind of innovation from below can acknowledge, disseminate, and use the information and ideas in a way that actually influences the operating rules of the system. For example, the principles or values through which the bank seeks to serve its customers or deal with a competitor or potential competitor can evolve in a way that incorporates and builds on the successful innovation.

Many aspects of Japanese management have a cybernetic quality that promotes learning through innovation and the questioning of operating norms. It is no accident, for example, that the "quality movement" first took off in Japan. Quality circles, where people come together to share issues and problems and find ways of making improvements to the overall system in which they are working, offer a perfect illustration of double-loop learning in practice. The principles are also evident in the ritual of *ringi*, a collective decision-making process through which companies seek to test the robustness of policy initiatives and other developments. Under this process, a policy document is circulated among a group of managers or other personnel for approval. If a person disagrees with what is being proposed, he or she is free to amend the document, and it is circulated again. The process in effect explores the values, premises, and details relating to a project from multiple points of view until an agreed-on position that satisfies all critical concerns and parameters emerges. The process can be extremely time-consuming because in important decisions a very large number of people may be involved. But when the decision is made, one can be fairly certain that key assumptions will have been challenged and that most errors will have been detected and corrected.

This is what double-loop learning is all about. The *ringi* serves the dual function of allowing people to challenge core operating principles and, in

both the process and the outcome, to affirm and reaffirm the values that are to guide action. Paradoxically, it is a process that mobilizes disagreement to create consensus. It is also a process that allows innovation to be driven from all directions and for "intelligence" to evolve to higher and higher levels.

We can see here how cybernetic functioning based on double-loop learning can allow a system to get smarter and smarter. Interestingly, the process is completely paradoxical because learning has to be guided by key operating norms that, in turn, have to be constantly challenged.

Learning always seems to involve this kind of paradox because whenever we try to do something new, established modes of behavior are threatened. For example, when a corporation seeks to reinvent itself and create a new business orientation, it often encounters resistance from the "old business." The fear is that *everything* will be lost in the transition. Or when a traditional bureaucracy tries to create "empowered teams," they are often undermined as the old hierarchy tries to retain control. The existing norms of a system "rise up" and in effect say "don't change." To facilitate the double-loop process of learning to learn, people have to be skilled in managing this kind of paradox, a point to which we will return in Chapter 8. They have to be able to find ways of managing the tensions generated through the learning process in a way that allows new operating norms to emerge. Otherwise, the system will almost certainly remain trapped in the old pattern.

Cybernetics also shows us that in facilitating double-loop learning, managers have to be aware of the importance of understanding the *limits* to be placed on action. Here again we find ourselves challenging central principles of Western management theory.

Return, for example, to the whole issue of setting objectives and targets. When we try to achieve goals or targets as end states, for example, a cost reduction of 20 percent or sales growth of \$200 million, the target can dominate attention and obliterate other key aspects of the overall situation. Attention and action tend to be oriented to a fixed point in the future, and the environment tends to be manipulated in a way that will allow the organization to get there. In the process, all kinds of dysfunctions and unintended consequences arise. Managers may gain their 20 percent cut in costs but in the process do irreversible damage to the corporate culture as a result of employee layoffs. The sales department may achieve its new target of \$200 million but alienate a part of the company's future customer base because substandard product has been shipped to get the sales on time.

Corporate life is full of these kinds of horror stories. In retrospect, they always seem blatantly stupid and short-sighted. More fundamentally,

they are systemic. They are inevitable in any situation where people are encouraged to edit their understanding of reality to suit narrow purposes.

A cybernetic view of the problem shows us that while goals and targets often reflect noble *intentions*, the achievement of any goal must always be moderated by an understanding of the *limits* that need to be placed on behavior. Put more forcefully, successful system evolution has to be guided as much by the "avoidance of noxiants" as the pursuit of desired ends.

To illustrate, return to the operation of a simple cybernetic system. Look at how system behavior is guided by the *avoidance of undesirable system states*. A thermostat achieves its "goal" of a warm, comfortable room by ensuring that the room does *not* get too warm or too cold. The system avoids noxious outcomes.

We see the same cybernetic principle operating in more complex areas of social life. It is no coincidence, for example, that most of the great codes of behavior are framed in terms of "Thou shalt *not*." Whether we examine the Ten Commandments or contemporary legal systems, we find the principle of avoiding noxiants defining a space of acceptable behavior within which individuals can act, innovate, or self-organize as they please.

Interestingly, the same process is evident in the evolution of the Internet, which offers a perfect example of the problems of design in complex, open-ended systems. No one can say what form the Internet should take. No one knows its true potential or what its future should look like. It cannot be predesigned in any authoritative way.

Hence, this de facto design principle: Give would-be users advice on what they should *not* do. For example: "Don't offend other users." "Don't overload them with information." "Don't send junk mail." "Don't reveal confidential information." "Never respond to provocation."

As a result, the Internet is evolving within the space defined by key parameters. Experience and practice test the limits thus defined, giving rise to a redefinition of limits when appropriate. In this way, the Internet is self-organizing in a way that is producing an emergent design. As in the developing intelligence of the brain, resonant innovations become embedded in the evolving "architecture." Inappropriate lines of development stall or die.

Western management, with its enormous emphasis on the achievement of predetermined goals, objectives, and operational targets, overasserts desired *intentions* and underplays the importance of recognizing the *limits* that need to guide behavior. Much of the turbulence of the modern environment is created as a by-product. Independent lines of action collide as organizations jostle to achieve their targets, with a solution "here" creating a problem elsewhere. The message of cybernetics: learn from *ringi*. Be sure

to surface the noxiants associated with favored lines of action, because in surfacing the negatives, we can produce a creative redefinition of the space in which positive patterns of behavior can unfold.

Cybernetics shows us that effective management depends as much on the selection of the limits that are to be placed on behavior as on the active pursuit of desired goals. If management encourages an appropriate dialogue about the limits or constraints to be placed on action, it creates a space in which desirable futures and appropriate strategies and modes of organization can develop. The system becomes "learning driven." Detailed goals become an emergent phenomenon. They look after themselves! These ideas challenge many established management assumptions.

### *"Designs" That Facilitate Learning*

In all that has been said above, considerable emphasis has been placed on how the creation of double-loop learning and emergent forms of organization depend on an ability to transcend the constraints of the single-loop processes and defensive routines that tend to tie an organization to the past. Part of the challenge hinges on adopting an appropriate management philosophy that views and encourages the capacity of learning to learn as a key priority. It also rests in encouraging organizational principles and designs that can support this process.

This brings us to the topic of our next section: the holographic approach to organization. As we will see, the ideas generated through this image provide many interesting and practical insights into the qualities that organizations must possess if they are to have the flexible self-organizing capacities of a brain.

## **Organizations as Holographic Brains**

The metaphor of a hologram invites us to think of systems where qualities of the whole are enfolded in all the parts so that the system has an ability to self-organize and regenerate itself on a continuous basis.

Recall the image of a broken holographic plate, where any part can be used to regenerate the information contained in the whole.

Think of a holographic sculpture of a dancer in an art gallery. As you walk around the laser beam the dancer changes position as the information encoded in the beam is engaged in different ways.

Or think of how the brain is able to reorganize itself when specific parts are injured or removed. As we have seen, rats are able to thread their way