Organizing on the Edge:
Meeting the Demand for Innovation and Efficiency

Arun N. Maira and Robert J. Thomas

Lou Noto, Chairman and CEO of Mobil, is one of Arthur D. Little's key clients. After undertaking a substantial reorganization to make his company more fluid and less hierarchical, he recently described the ensuing organization as resembling „an irregular electron cloud." He went on to express a need for more focus and structure than are generally provided by electron clouds and for ways to connect the various parts of the organization more firmly.[1] But he also recognized that large companies cannot achieve this combination of fluidity, focus, and connection by using traditional ways of organizing a business. Another client, also the CEO of a Fortune 50 global company, has been leading his organization through a rapid process of learning. He has to discover how to manage in a new world in which, within the past five years, the company has deployed more than half its assets in strategic joint ventures, some in partnership with its principal competitors! The firm is rapidly becoming a networked organization, and it must learn to manage the compete-or-collaborate dilemma as it connects across former boundaries.

The winds of global change blowing through these large companies have also reached much smaller companies in formerly sheltered markets. The CEO of one of these companies, a client of ours, sensed that the world around his company was changing in fundamental ways, requiring him to reconsider his company's business model and competencies. The company needed to become much more innovative in its strategies and in its product and service offerings. At the same time, it had to maintain and even improve its operational efficiencies. While there was no immediate threat, the organization needed the capability to change quickly so that it would not be blind-sided as the environment around it changed. So how could the company be more innovative and more efficient at the same time? And how could it be even more responsive to local customer needs while being global in its perspectives? „What are the organizational competencies we need to manage these dilemmas of innovation-or-effciency, local-or-global, change-or-stability?" he asked. He had interviewed several consultants, and „their advice always seems to boil down to choosing one thing or the other, rather than having both," he said. „But what if the environment changes and we have to change our path? What we need is a new model of organizing that will give us more flexibility while improving our current performance."

The redesign of organizations to become more capable of change and innovation while improving operating efficiencies has become an urgent priority for leaders of companies all over the world. The urgency derives from a fundamental acceleration in the business environment. Many people remind us that change is the only constant. But change itself is now changing – in two ways: it is becoming both faster and less predictable, because of the increased number of connections in the world. Graham's Law says that a doubling in the number of connections in a system quadruples the number of possible outcomes. In the last two decades of this millennium, the number of connections among people and organizations has increased enormously. Here are some statistics from Daniel *Yergin* and Joseph Stanislaw's recent book, *The Commanding Heights: The Battle Between Government and the Marketplace That Is Remaking the Modern World:*

• The number of international air passengers rose from 75 million in 1970 to 409 million in 1996.

• The number of cross-border telephone calls increased from 3.2 billion in 1985 to 20.2 billion in 1996.

• International trade grew four times faster than global economic output between 1989 and 1997.

• Over the same period, foreign direct investment increased twice as fast as international trade, thus interconnecting the world even more strongly.

Above all, with the Internet permeating all organizational walls, the world is rapidly becoming an interwoven fabric rather than storerooms filled with separate bolts of cloth. This rapidly interweaving world is compelling leaders of businesses to rethink how to organize their companies so that they can be more flexible, more innovative, and more interconnected, while also being quicker and more efficient. Not surprisingly, principles of organization derived from a more stable world, where boundaries between industries and companies were clearly defined and relatively predictable, are being stretched beyond their realm of efficacy in the woven, networked world that is growing around us. The principles we were schooled in are not wrong, but many of them are inappropriate for the issues businesses need to address now. Just as the principles of Newtonian mechanics remain valid in a set of stable conditions, in other, more dynamic, conditions, we need principles of relativity and quantum mechanics. So, where do we turn for help?

As we have searched the business world for examples of a new form of organization suited to the rapidly emerging, new context, we have realized what should have been obvious at the outset. There can be very few, if any, examples of this new form, precisely because the old forms were die right forms for the world in which businesses have operated so far. And furthermore, business organizations and business schools have developed a

wealth of knowledge, concepts, and tools for these older forms, which have thus become widespread all over the world. We have to find the new principles for the 21st-century organization, as well as the tools and skills to create it. And it may be a while before we can hope to find many complete examples to „benchmark."

The Practical Value of New Theory

Five years ago we began exploring the applicability of insights from other fields, such as complexity science and evolutionary biology, to resolve the organizational dilemmas we have described earlier. We presented the emerging model for business organizations in an article, „From Process Management to Complexity Management," in the Fourth Quarter 1995 issue of *Prism.* We pointed out that processes such as strategy formation and innovation are fundamentally different from other business processes and cannot be „engineered" as can such operational processes as customer management, product development, and manufacturing. We suggested that strategy and innovation processes require the creation of organizational conditions that enable good strategies and innovations to emerge. *We* further suggested that these conditions – which we described in that article and which we will further describe here – keep an organization poised „on the edge" between the chaos of random creativity and the high order of efficiency. The conditions enable the emergence of effective innovations within an organization.

Recently several articles and books have been published describing strategy as an emergent phenomenon rather than a step-wise management process. These include „Strategy Innovation and the Quest for Value," by Gary Hamel (*Sloan Management Review*, Vol. 39, No. 2, Winter 1998) and *Competing on the Edge: Strategy as Structured Chaos*, by Shona Brown and Kathleen Eisenhardt (HBS Publishing, 1998). These authors reinforce our view that it is the condition of the organization, rather than the process of strategy, that is the source of breakthrough thinking. However, the suggestion by some of these authors mat the principles of complexity and biology apply mainly to the strategy process (and primarily in fast-changing high-technology industries) is too narrow. Companies in the cement and heavy engineering industries have applied the principles of complexity to improve innovation in their operational processes with good results. And our clients in resource-based, traditional businesses have applied our ideas to the design of their organizations to improve the strategic abilities of their companies. The truth is that what must be redesigned for the organization to stay „on the edge" is the organization itself – so that innovations in strategy, products, and processes can emerge easily and be converted efficiently to business value.

Last year, a global client of ours expressed interest in finding out more about companies that seemed to be thriving – not just surviving – in an increasingly turbulent world. Our client's initial and very healthy impulse was to commission a benchmarking study. „Find us instances of places where our competitors and other similarly situated firms are doing innovative things to get themselves out of these dilemmas," the client asked. We accepted the challenge, recognizing that benchmarking can be a good process for finding breakthrough ideas to resolve problems that seem unresolvable using prevailing principles and practices within one's own organization or industry. *Yet* we were also wary of the inherent limits of conventional benchmarking – e.g., the tendency not to venture far enough away from the obvious points of comparison – so we insisted on stretching the comparative frame to include settings some distance removed from our client's usual experience.

In fact, our client found a very fertile field for benchmarking, as we suggested, among living systems that seem to have resolved the problem of adaptation to highly interconnected and changeable conditions. Such systems, including biological species and ecological systems, must efficiently adapt to their wider environment if they are to survive and grow. They have to keep innovating their forms, slowly or in spurts, as the environment around them changes. They also symbiotically use resources from the environment around them. Neural networks and some categories of computer programs that have these same characteristics of self-adaptation within a changing environment can also be studied for clues. Finally, we can benefit from the recent surge in interest in the study of such self-adaptive systems by scientists and researchers in the field of complexity and also in the study of evolutionary biology.

In this article, we elaborate a new set of principles intended to meet the needs of organizations living „on the edge" of innovation and efficiency. These principles build from concepts found in biology, ecology, and complexity. We have found that they are validated in actual business experience. Even though complete examples of the form of business organization that is emerging may be hard to find, the practices of some companies show how these principles can be applied in business organizations. Significantly, these are also companies that are recognized in their industries for being flexible and innovative, and for having a greater ability than their peers to work in networks: companies such as ABB, Canon, Hewlett-Packard, Honda, and 3M.

In our research, we have studied three types of systems of increasing complexity:

• Systems of mind, that is, systems of pure information, such as neural networks and computer programs

• Systems of mind and matter, such as biological systems

• Systems of mind, matter, and spirit, which are human organizations only, since human beings are the only living beings known to have self-awareness and the desire and ability to consciously improve themselves

As we conducted our research, we held as a conceptual framework the following four basic elements of a business organization:

• The way it chooses its direction and its *strategies*

• The way its *organization* is designed

• The way it manages its business *processes*

• The *resources* it deploys in its businesses

And we have found, by looking at a broad array of living systems, that for each of these four fundamental elements there is an essential management principle that allows a business to have the capabilities it will need in a more interconnected and more changeable world. We will now explain what these principles are and how we derived them from our study of living systems.

Permeable Boundaries. This principle of *permeable boundaries* suggests that a system that wishes to innovate and evolve must be engaged in an ongoing exchange with its environment. This principle is derived from a fascinating but fundamentally contradictory pair of ideas in physics and biology. On the one hand, the Second Law of Thermodynamics, which governs our physical world, says that any isolated or closed physical system will proceed spontaneously to degenerate into disorder over time. On the other hand, biologists say that the living universe is evolving from disorder to order, toward forms of ever-increasing capability. So who is right? The physicists or the biologists? The answer: both!

Biologists are describing *open* systems, in which any part that is evolving is connected with its environment and exchanges information and energy with it. Ilya Prigonine, who won the Nobel Prize in 1977 for his work on the thermodynamics of non-equilibrium systems, extended this notion to the processes of self-organization and life. He showed how even purely physical systems, such as chemical solutions and streams of fluids, could self-organize into beautiful patterns if they continued to receive a flow of small inputs from their environment.

This principle of permeable boundaries applies to systems on any scale – individuals, species, complex ecosystems, and even human societies. A species produces healthier variants through the exchange of genes among its members. Shut down these permeable boundaries and the system withers through in-breeding. Societies benefit by the market mechanism that enables trading of information and resources with others. Closed economies have always tended to decay.

Current examples of permeable boundaries in business abound. Most relevant are those instances in which organizations are trying consciously to break down the barriers that separate functions, product groups, and businesses in order to stimulate sharing of best practices and innovation. In an effort to shave precious weeks and months from their time-to-market, companies such as Hewlett-Packard, Honda, Johnson and Johnson, and Sony routinely assemble cross-functional teams with clear charters but small budgets – forcing them, in effect, to find ways to uncover and share resources that might otherwise have been „owned“ by one group or another. Other firms, such as Chrysler, have gotten exceedingly good at creating symbiotic relationships with their suppliers – to such an extent that vendors literally move into Chrysler factories for the life of their contracts. European companies such as Hoechst, Philips, and Volkswagen have demonstrated great skill in using intellectual exchange with universities and technical institutes as a stimulus to their own product development and R&D efforts.

Minimal Critical Rules. The second principle is *minimal critical rules:* that is, systems that evolve to a higher order learn new and better rules, but for each rule they add they must shed an earlier rule. Chris Langton, with the Santa Fe Institute, one of the principal centers for the study of complex self-adaptive organisms, experimented with computer programs such as the Game of Life and established that very few rules are required to produce complex, highly ordered behavior. In fact, he found that if the number of rules was increased beyond the few vital ones, the system went into disorder rather than more order. Stuart Kauffman and John Holland, also of the Santa Fe Institute, have confirmed this insight and extended it to the design of systems that learn new and better rules to make themselves more effective. Holland established the notion of an economy of rules, the foundation for what we refer to as minimal critical rules. If rules are not shed, the system will become less smart and less capable of further improvement. It is as if systems develop „Catch-22“ situations when they have more rules, and the rules begin to contradict each other in an increasing number of situations.

When there are contradictions between the stated rules, people in societies and business organizations begin to ignore them and develop so-called „unwritten rules“ to operate by. A problem with unwritten rules is that they cannot easily be examined, even by members of the organization themselves, and therefore cannot easily be changed. This inaccessibility of the rules impedes needed change and improvement of the system. So it seems

desirable to have only a few important and explicitly understood rules, which are aligned with the organization's values and tacit norms.

Many executives and managers complain, often bitterly, about the excessive number of rules they create. Even when their goal is to standardize, „commonize," or otherwise simplify their core processes, they find themselves awash in rules. However, a counter-current can be found in a growing number of settings. For example, in Amoco a movement is under way to more effectively manage business processes that cross-cut the company's product-based divisions.

Stimulated by a desire to exploit the potential benefits of investments in enterprise-wide information management, Amoco came to recognize that it could realize those benefits only by replacing the complex thicket of measurements and reporting schemes required by the corporation with a small number of big, clear, consistent rules on measurements and reporting.

Flexible Architecture. The principles of *permeable boundaries* and *minimal critical rules* apply both to systems of pure information and to biological systems. Our third principle, *flexible resources,* applies to the design of matter itself in a way that enables species to evolve.

Stephen Jay Gould, the evolutionary biologist, describes this principle as „flexibility in the component parts rather than their precise adaptation for their functions." The principle manifests itself in three ways:

Latent potential, which enables innovations in function. Gould explains this with the „5-percent-of-a-wing problem." A row of feathers along a forearm cannot aid flight. So if wings were to evolve over generations, what would be the point of developing feathers before they became sufficient in size and number to aid flight? Why would the survival-of-the-fittest mechanism reward the incremental development of something that offered no apparent functional advantage? The answer is that feathers did not in fact evolve originally as a flight mechanism, and many feathered birds still do not fly. Feathers work superbly as thermoregulatory devices for conserving heat and a bird could have as many as served that purpose. However, as a species grew more feathers – for thermoregulation – they became sufficient at some point to enable a bird to take off when it flapped its forearms!

Redundancy, which enables additional or new functions. Suppose every gene an organism possesses is required for something vital to its life. To make anything truly different, it would have to adapt one of its existing genes for a novel use. But how then could the organism perform its old and still-necessary function? In other words, the organism is stuck – optimally adapted to be sure, but in a permanent rut. Therefore, all biological organisms (at all scales, from genes to organs) maintain massive redundancy – that is, a capacity for building more stuff or information than minimally needed to maintain a current adaptation. The „extra" material then becomes available for constructing evolutionary novelties.

Requisite variety, which provides possibilities for innovations through new combinations. As we discussed earlier, the number of possible „connections" influences the ability of a system to innovate through new combinations. If an organism does not have sufficient variety in its own resources, it must be part of a larger ecosystem that has the requisite variety. And it must have permeable boundaries with the larger system.

The principle of flexible resources (through latent potential, redundancy, and requisite variety) is demonstrated in several organizations recognized in their industries for their innovativeness and flexibility. For example, personnel in 3M move back and forth between dual career paths, thereby increasing the variety in their skills and improving flexibility. Honda has built flexibility into its resource-allocation processes in many ways: the way it deploys people in project teams, the approach it has taken to designing the platform of its world car (Accord), and even the machinery and equipment it uses to manufacture automobiles.

Aligned Aspiration. Obviously, human systems are more complicated than other biological systems because human beings are the only known organisms that have self-awareness and egos. For example, human beings create identities for themselves over and above their physical identities. And they work hard to preserve and enhance their identities. They create abstract visions, set goals, and consciously choose strategies through which to accomplish their goals. And so, human beings and organizations seek to understand the conditions that will lead to their own improvement and further evolution – and then to deliberately create these conditions.

The principle of building and aligning aspiration of the members of an organization is very clearly seen in companies that are adaptive and agile. People are aligned toward the broad goals of the organization, and they share values that they begin to cherish. A lot of change and improvement is brought about by cross-boundary teams that set their own challenging goals, aligned with the broader goals of the firm. These goals act as magnets for the teams, drawing them together and onward. This contrasts with the „push" approach, in which goals, often mostly financial, are imposed down the chain of command, and people do not feel drawn by the „pull" of a challenging goal.

It is important to note that aligned aspirations, magnets, and the like rarely come about as a result of top-down threats or „burning platform“ speeches. They may be precipitated by crisis, but their essential qualities of engagement, widespread commitment, and durability come about through a process of shared visioning (as opposed to vision sharing). Hence, companies such as Shell Oil, which recognize that their aspirations will not be achieved without significant shifts in culture, have committed to investing in long-term, broad-based employee involvement at all levels of the organization.

New Principles in Practice. Our four critical principles correspond to the four fundamental elements of the high-performing business (Exhibit I):

• Strategy Formation: Aligned Aspiration and Choice

• Organization Design: Permeable Boundaries

• Process Management: Minimal Critical Rules

• Resources: Flexible Architecture

We understand the essential qualities of the Fluid-Network Organization we need to create. We have the principles to guide us as we give shape to that organization. We can now proceed to actually build it. Fortunately, our tools and materials need not be new. A good architect creates the house we want by understanding our needs and translating them into the principles that must apply in the execution. For example, when we need a house that feels light and open, the architect will specify principles such as large openings to natural light, rooms that flow into each other, unobtrusive furniture, and perhaps only pastel colors. However, the basic materials involved could be identical to those used to create a house with very different qualities. The artistry is in finding and applying the few critical principles that will produce the desired qualities in the house.

Similarly, the „materials“ with which the Fluid-Network Organization is created are not particularly new. The way they are put together, however, is special and must conform with the four principles we have described. *We* described the materials, or „organization design variables“ as we call them, as well as the way they are put together, in an earlier article in *Prism* („Connecting Across Boundaries: The Fluid-Network Organization,“ *Prism,*, First Quarter 1998).

We portray the kind of organization that is created by applying these principles as „fan-shaped“ (Exhibit 2). This structure contrasts with the traditional, hierarchical, organization, which we portray as a „comb“ structure. The latter is characterized principally by vertical divisions, whether functions or business units, and a strong center at the top. Its weakness is in the lack of connections across the vertical organizations, which creates organizational „silos.“ Traditional matrix organizations seek to address this weakness by overlaying two or more comb-form sub-organizations over each other, an approach that often causes gridlock at the intersections of these sub-organizations. We characterize such matrix organizations as grid-form, which is a variant of the underlying comb-form.

Exhibit 1

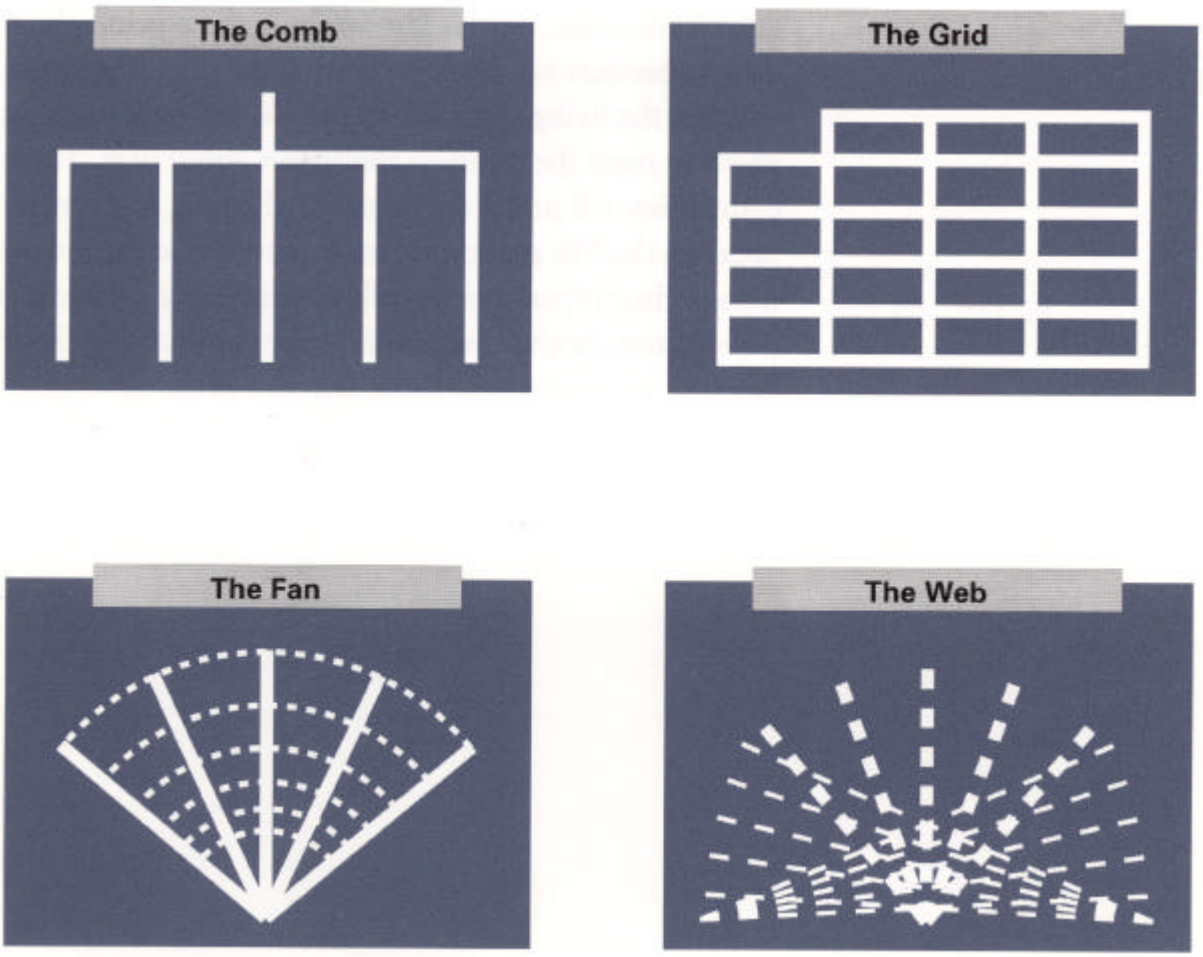
Characteristics of Fluid-Network Organizations vs. Traditional Organizations

Element	Traditional Organizations	Fluid-Network Organizations
Strategy Formation	Top-down forecasting and planning	Aligned aspiration and choice
Organization Design	Tightly bounded and focused units	Permeable boundaries
Process Management	Global standardization of procedures	Minimal critical rules
Resources	Specialized and dedicated resources	Flexible architecture

The fan organization has flexible lateral sub-organizations, created by tuning the organization design variables in accordance with the principles we have described. These provide the organization with strong, yet flexible, connections across its other dimensions. The fan organization is also distinguished from the traditional comb in the way governance is exercised. Governance, in any organization, provides the policies by which the organization operates and the final accountability for the organization’s integrity and performance. Symbolically we show this governance at the bottom of the fan, rather than at the top, to emphasize the important enabling and architectural roles of governance, which must go along with the traditional control aspects.

Exhibit 2

Four Basic Organizational Forms



We also distinguish the fan organization from a fourth form, the „web" organization. The web organization is basically an adhocracy, in which all units can connect with all other units as they need to and want to. It does not have the dedicated organizations aligned with the principal dimensions of the organization's strategy, which are the vertical structures of the comb, or the firm spines of the fan-shaped organization. The fan-shaped organization form best portrays the stable-yet-flexible, efficient-yet-innovative Fluid-Network Organization.

Some of our clients, including two of the companies we have described earlier, have begun to apply these principles to their organizations. Each is creating the organization – which is the living space for its people and processes – it needs to meet the business challenges ahead of it. These companies will surely encounter challenges, as all path-breakers do. We are confident, however, that the innovations in their organizations will help them stay ahead of their competitors, both present and future, by enabling them to be more innovative and more efficient at the same time.

[1] *„On Transformation,"* Prism, *Fourth Quarter 1997.*

Arun N. Maira is Managing Director of' Innovation Associates, an Arthur D. Little company, and a Vice President of Arthur D. Little, Inc. He has assisted companies around the globe in managing change and obtaining breakthrough performance improvement. He is the author, with Peter Scott-Morgan, of The Accelerating Organization: Embracing the Human Face of Change, *McGraw Hill, 1997.*

Robert J Thomas is an Associate Director of Innovation Associates. In addition to helping global clients design, and implement new organizational strictures, he has a special interest in developing leadership teams. He is the author of the book What Machines Can't Do, *an award-winning study of successful approaches to knowledge and technology transfer.*