p. xix My extension of the systems approach to the social domain explicitly includes the material world. This is unusual, because traditionally social scientists have not been very interested in the world of matter. Our academic disciplines have been organized in such a way that the natural sciences deal with material structures while the social sciences deal with social structures, which are understood to be, essentially, rules of behavior. In the future, this strict division will no longer be possible, because the key challenge of this new century—for social scientists, natural scientists and everyone else—will be to build ecologically sustainable communities, designed in such a way that their technologies and social institutions—their material and social structures—do not interfere with nature's inherent ability to sustain life.

The design principles of our future social institutions must be consistent with the principles of organization that nature has evolved to sustain the web of life. A unified conceptual framework for the understanding of material and social structures will be essential for this task. The purpose of this book is to provide a first sketch of such a framework.

Life Defined in Terms of DNA

p. 6 Let us now return to the question "What is life?" and ask: How does a bacterial cell work? What are its defining characteristics? When we look at a cell under an electron microscope, we notice that its metabolic processes involve special macromolecules—very large molecules consisting of long chains of hundreds of atoms. Two kinds of these macromolecules are found in all cells: proteins and nucleic acids (DNA and RNA).

In the bacterial cell, there are essentially two types of proteins—enzymes, which act as catalysts of various metabolic processes, and structural proteins, which are part of the cell structure. In higher organisms, there are also many other types of proteins with specialized functions, such as the antibodies of the immune system or the hormones.

Since most metabolic processes are catalyzed by enzymes and enzymes are specified by genes, the cellular processes are genetically controlled, which gives them great stability. The RNA molecules serve as messengers, delivering coded information for the synthesis of enzymes from the DNA, thus establishing the critical link between the cell's genetic and metabolic features.

Membranes – the foundation of cellular identity
Let us now look at the cell as a whole. A cell is characterized, first of all, by a boundary (the cell membrane) which discriminates between the system – the "self", as it were – and its environment. Within this boundary, there is a network of chemical reactions (the cell’s metabolism) by which the system sustains itself.

The cell membrane is the first defining characteristic of cellular life. The second characteristic is the nature of the metabolism that takes place within the cell boundary. In the words of microbiologist Lynn Margulis: "Metabolism, the incessant chemistry of self-maintenance, is an essential feature of life ... Through ceaseless metabolism, through chemical and energy flow, life continuously produces, repairs, and perpetuates itself. Only cells, and organisms composed of cells, metabolize."

When we take a closer look at the processes of metabolism, we notice that they form a chemical network. This is another fundamental feature of life. As ecosystems are understood in terms of food webs (networks of organisms), so organisms are viewed as networks of cells, organs and organ systems, and cells as networks of molecules. One of the key insights of the systems approach has been the realization that the network is a pattern that is common to all life. Wherever we see life, we see networks.

The metabolic network of a cell involves very special dynamics that differ strikingly from the cell's nonliving environment. Taking in nutrients from the outside world, the cell sustains itself by means of a network of chemical reactions that take place inside the boundary and produce all of the cell's components, including those of the boundary itself.

The function of each component in this network is to transform or replace other components, so that the entire network continually generates itself. This is the key to the systemic definition of life: living networks continually create, or re-create, themselves by transforming or replacing their components. In this way they undergo continual structural changes while preserving their web like patterns of organization.

The Cellular Network

As soon as we begin to describe the metabolic network of a cell in detail, we see that it is very complex indeed, even for the simplest bacteria. Most metabolic processes are facilitated (catalyzed) by enzymes and receive energy through special phosphate molecules known as ATP. The enzymes alone form an intricate network of catalytic reactions, and the ATP molecules form a corresponding energy network. Through the messenger RNA, both of these networks are linked to the genome (the cell's DNA molecules), which is itself a complex interconnected web, rich in feedback loops, in which genes directly and indirectly regulate each other's activity.

Some biologists distinguish between two types of production processes and, accordingly, between two distinct cellular networks. The first is called, in a more technical sense of the term, the "metabolic" network, in which the "food" that enters through the cell membrane is turned into the so-called "metabolites"—the building blocks out of which the macromolecules—the enzymes, structural proteins, RNA, and DNA—are formed.
The second network involves the production of the macromolecules from the metabolites. This network includes the genetic level but extends to levels beyond the genes, and is therefore known as the "epigenetic"* network. Although these two networks have been given different names, they are closely interconnected and together form the autopoietic cellular network.

A key insight of the new understanding of life has been that biological forms and functions are not simply determined by a genetic blueprint but are emergent properties of the entire epigenetic (embryonic development by gradual change) network. To understand their emergence, we need to understand not only the genetic structures and the cell's biochemistry, but also the complex dynamics that unfold when the epigenetic network encounters the physical and chemical constraints of its environment.

**Emergence of New Order**

p. 13 The theory of autopoiesis identifies the pattern of self-generating networks as a defining characteristic of life, but it does not provide a detailed description of the physics and chemistry that are involved in these networks. As we have seen, such a description is crucial to understanding the emergence of biological forms and functions.

The starting point for this is the observation that all cellular structures exist far from thermodynamic equilibrium and would soon decay toward the equilibrium state—in other words, the cell would die—if the cellular metabolism did not use a continual flow of energy to restore structures as fast as they are decaying. This means that we need to describe the cell as an open system. Living systems are organizationally closed—they are autopoietic networks—but materially and energetically open. They need to feed on continual flows of matter and energy from their environment to stay alive. Conversely, cells, like all living organisms, continually produce waste, and this flow-through of matter—food and waste—establishes their place in the food web. In the words of Lynn Margulis, "The cell has an automatic relationship with somebody else. It leaks something, and somebody else will eat it."

Detailed studies of the flow of matter and energy through complex systems have resulted in the theory of dissipative structures developed by Ilya Prigogine and his collaborators. A dissipative structure, as described by Prigogine, is an open system that maintains itself in a state far from equilibrium, yet is nevertheless stable: the same overall structure is maintained in spite of an ongoing flow and change of components. Prigogine chose the term "dissipative structures" to emphasize this close interplay between structure on the one hand and flow and change (or dissipation) on the other.

The dynamics of these dissipative structures specifically include the spontaneous emergence of new forms of order. When the flow of energy increases, the system may encounter a point of instability, known as a "bifurcation point" at which it can branch off into an entirely new state where new structures and new forms of order may emerge.

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Quotes from *The Hidden Connection*, Fritjof Capra
This spontaneous emergence of order at critical points of instability is one of the most important concepts of the new understanding of life. It is technically known as self-organization and is often referred to simply as "emergence." It has been recognized as the dynamic origin of development, learning and evolution. In other words, creativity—the generation of new forms—is a key property of all living systems. And since emergence is an integral part of the dynamics of open systems, we reach the important conclusion that open systems develop and evolve. Life constantly reaches out into novelty.

The theory of dissipative structures, formulated in terms of nonlinear dynamics, explains not only the spontaneous emergence of order, but also helps us to define complexity. Whereas traditionally the study of complexity has been a study of complex structures, the focus is now shifting from the structures to the processes of their emergence. For example, instead of defining the complexity of an organism in terms of the number of its different cell types, as biologists often do, we can define it as the number of bifurcations the embryo goes through in the organism's development. Accordingly, Brian Goodwin speaks of "morphological complexity."

Now, let us return to the question posed at the beginning of this chapter—what are the defining characteristics of living systems?—and summarize what we have learned. Focusing on bacteria as the simplest living systems, we characterized a living cell as a membrane-bounded, self-generating, organizationally closed metabolic network. This network involves several types of highly complex macromolecules: structural proteins; enzymes, which act as catalysts of metabolic processes; RNA, the messengers carrying genetic information; and DNA, which stores the genetic information and is responsible for the cell's self-replication.

We also learned that the cellular network is materially and energetically open, using a constant flow of matter and energy to produce, repair and perpetuate itself; and that it operates far from equilibrium, where new structures and new forms of order may spontaneously emerge, thus leading to development and evolution.

Finally, we have seen that a prebiotic form of evolution, involving membrane-enclosed bubbles of "minimal life," began long before the emergence of the first living cell; and that the roots of life reach deep into the basic physics and chemistry of these protocells.

We also identified three major avenues of evolutionary creativity—mutation, gene trading and symbiosis—through which life unfolded for over three billion years, from the universal bacterial ancestors to the emergence of human beings, without ever breaking the basic pattern of its self-generating networks.

The Santiago Theory of Cognition

The central insight of the Santiago Theory is the identification of cognition, the process of knowing, with the process of life. Cognition, according to Maturana and Varela, is the activity involved in the self-generation and self-perpetuation of living networks. In other words, cognition is the very process of life. The organizing activity of living systems, at all levels of life, is mental activity. The interactions of a living organism—plant, animal or human—with its environment are cognitive interactions. Thus life and cognition are inseparably connected. Mind—or, more accurately, mental activity—is immanent in matter at all levels of life.
This is a radical expansion of the concept of cognition and, implicitly, the concept of mind. In this new view, cognition involves the entire process of life—including perception, emotion, and behavior—and does not even necessarily require a brain and a nervous system.

In the Santiago theory, cognition is closely linked to autopoiesis, the self-generation of living networks. The defining characteristic of an autopoietic system is that it undergoes continual structural changes while preserving its weblike pattern of organization. The components of the network continually produce and transform one another, and they do so in two distinct ways. One type of structural change is that of self-renewal. Every living organism continually renews itself, as its cells break down and build structures, and tissues and organs replace their cells in continual cycles. In spite of this ongoing change, the organism maintains its overall identity, or pattern of organization.

The second type of structural changes in a living system are those which create new structures—new connections in the autopoietic network. These changes, developmental rather than cyclical, also take place continually, either as a consequence of environmental influences or as a result of the system's internal dynamics.

According to the theory of autopoiesis, a living system couples to its environment structurally, i.e. through recurrent interactions, each of which triggers structural changes in the system. For example, a cell membrane continually incorporates substances from its environment into the cell's metabolic processes. An organism's nervous system changes its connectivity with every sense perception. These living systems are autonomous, however. The environment only triggers the structural changes; it does not specify or direct them.

Structural coupling, as defined by Maturana and Varela, establishes a clear difference between the ways living and nonliving systems interact with their environments. For example, when you kick a stone, it will react to the kick according to a linear chain of cause and effect. Its behavior can be calculated by applying the basic laws of Newtonian mechanics. When you kick a dog, the situation is quite different. The dog will respond with structural changes according to its own nature and (nonlinear) pattern of organization. The resulting behavior is generally unpredictable.

As a living organism responds to environmental influences with structural changes, these changes will in turn alter its future behavior. In other words, a structurally coupled system is a learning system. Continual structural changes in response to the environment—and consequently continuing adaptation, learning and development—are key characteristics of the behavior of all living beings. Because of its structural coupling, we can call the behavior of an animal intelligent but would not apply that term to the behavior of a rock.

As it keeps interacting with its environment, a living organism will undergo a sequence of structural changes, and over time it will form its own individual pathway of structural coupling. At any point on this pathway, the structure of the organism is a record of previous structural changes and thus of previous
interactions. In other words, all living beings have a history. Living structure is always a record of prior development.

Now, since an organism records previous structural changes, and since each structural change influences the organism's future behavior, this implies that the behavior of the living organism is dictated by its structure. In Maturana's terminology, the behavior of living systems is "structure-determined."

This notion sheds new light on the age-old philosophical debate about freedom and determinism. According to Maturana, the behavior of a living organism is determined, but rather than being determined by outside forces, it is determined by the organism's own structure—a structure formed by a succession of autonomous structural changes. Hence the behavior of the living organism is both determined and free.

Living systems, then, respond autonomously to disturbances from the environment with structural changes, i.e. by rearranging their pattern of connectivity. According to Maturana and Varela, you can never direct a living system; you can only disturb it. More than that, the living system not only specifies its structural changes; it also specifies which disturbances from the environment trigger them. In other words, a living system maintains the freedom to decide what to notice and what will disturb it. This is the key to the Santiago Theory of Cognition. The structural changes in the system constitute acts of cognition. By specifying which perturbations from the environment trigger changes, the system specifies the extent of its cognitive domain; it "brings forth a world," as Maturana and Varela put it.

Cognition, then, is not a representation of an independently existing world, but rather a continual bringing forth of a world through the process of living. The interactions of a living system with its environment are cognitive interactions, and the process of living itself is a process of cognition. In the words of Maturana and Varela, "to live is to know" As a living organism goes through its individual pathway of structural changes, each of these changes corresponds to a cognitive act, which means that learning and development are merely two sides of the same coin.

The first type, known as "primary consciousness," arises when cognitive processes are accompanied by basic perceptual, sensory and emotional experience. Primary consciousness is probably experienced by most mammals and perhaps by some birds and other vertebrates. The second type of consciousness, sometimes called "higher-order consciousness," involves self-awareness—a concept of self, held by a thinking and reflecting subject. This experience of self-awareness emerged during the evolution of the great apes, or "hominids," together with language, conceptual thought and all the other characteristics that fully unfolded in
human consciousness. Because of the critical role of reflection in this higher-order conscious experience, I shall call it "reflective consciousness."

Reflective consciousness involves a level of cognitive abstraction that includes the ability to hold mental images, which allows us to formulate values, beliefs, goals and strategies. This evolutionary stage is of central relevance to the main theme of this book—the extension of the new understanding of life to the social domain—because with the evolution of language arose not only the inner world of concepts and ideas, but also the social world of organized relationships.

p. 41 It seems quite mysterious that experience should emerge from neurophysiological processes. However, this is typical of emergent phenomena. Emergence results in the creation of novelty and this novelty is often qualitatively different from the phenomena out of which it emerged. This can readily be illustrated with a well-known example from chemistry: the structure and properties of sugar.

When carbon, oxygen, and hydrogen atoms bond in a certain way to form sugar, the resulting compound has a sweet taste. The sweetness resides neither in the C, nor in the O, nor in the H; it resides in the pattern that emerges from their interaction. It is an emergent property. Moreover, strictly speaking, the sweetness is not a property of the chemical bonds. It is a sensory experience that arises when the sugar molecules interact with the chemistry of our taste buds, which in turn causes a set of neurons to fire in a certain way. The experience of sweetness emerges from that neural activity.

p. 42 Thus, the simple statement that the characteristic property of sugar is its sweetness really refers to a series of emergent phenomena at different levels of complexity. Chemists have no conceptual problem with these emergent phenomena when they identify a certain class of compounds as sugars because of their sweet taste. Nor will future cognitive scientists have conceptual problems with other kinds of emergent phenomena when they analyze them in terms of the resulting conscious experience, as well as in terms of the relevant biochemistry and neurobiology.

p. 42 The great reluctance of scientists to deal with subjective phenomena is part of our Cartesian heritage. Descartes’s fundamental division between mind and matter, between the I and the world, made us believe that the world could be described objectively, i.e. without ever mentioning the human observer. Such an objective description of nature became the ideal of all science. However, three centuries after Descartes, quantum theory showed us that this classical ideal of an objective science cannot be maintained when dealing with atomic phenomena. And more recently, the Santiago Theory of Cognition has made it clear that cognition itself is not a representation of an independently existing world, but rather a "bringing forth" of a world through the process of living.

p. 52 As human beings, we not only experience the integrated states of primary consciousness; we also think and reflect, communicate through symbolic language, make value judgments, hold beliefs, and act intentionally with self-awareness and an experience of personal freedom. Any future theory of consciousness will have to explain how these well-known characteristics of the human mind arise out of the cognitive processes that are common to all living organisms.

Quotes from The Hidden Connection, Fritjof Capra
As I mentioned above, the "inner world" of our reflective consciousness emerged in evolution together with language and social reality. This means that human consciousness is not only a biological, but also a social, phenomenon. The social dimension of reflective consciousness is frequently ignored by scientists and philosophers. As cognitive scientist Rafael Núñez points out, almost all current views of cognition implicitly assume that the appropriate unit of analysis is the body and the mind of the individual. This tendency has been reinforced by the new technologies for analyzing brain functions, which invite cognitive scientists to study single, isolated brains and to neglect the continual interactions of those brains with other bodies and brains within communities of organisms. These interactive processes are crucial to understanding the level of cognitive abstraction that is characteristic of reflective consciousness.

p. 52 Humberto Maturana was one of the first scientists to link the biology of human consciousness to language in a systematic way. He did so by approaching language through a careful analysis of communication within the framework of the Santiago Theory of Cognition. Communication, according to Maturana, is not the transmission of information but rather the coordination of behavior between living organisms through mutual structural coupling. In these recurrent interactions, the living organisms change together through their mutual triggering of structural changes. Such mutual coordination is the key characteristic of communication for all living organisms, with or without nervous systems, and it becomes more and more subtle and elaborate with nervous systems of increasing complexity.

Three Perspectives on life.

p. 70 The synthesis is based on the distinction between two perspectives on (the nature of living systems, which I have called the "pattern perspective" and the "structure perspective," ) and on their integration by means of a third perspective, the "process perspective." More specifically, I have defined the pattern of organization of a living system as the configuration of relationships among the system's components that determines the system's essential characteristics, the structure of the system as the material embodiment of its pattern of organization, and the life process as the continual process of this embodiment.

p. 71 I chose the terms "pattern of organization" and "structure" to continue the language used in the theories that form the components of my synthesis. However, in view of the fact that the definition of "structure" in the social sciences is quite different from that in the natural sciences, I shall now modify my terminology and use the more general concepts of form and matter to accommodate different usages of the term "structure." In this more general terminology, the three perspectives on the nature of living systems correspond to the study of form (or pattern of organization), the study of matter (or material structure), and the study of process.

When we study living systems from the perspective of form, we find that their pattern of organization is that of a self-generating network. From the perspective of matter, the material structure of a living system is a dissipative structure, i.e. an open system operating far from equilibrium. From the process perspective, finally, living systems are cognitive systems in which the process of cognition is closely
linked to the pattern of autopoiesis. In a nutshell, this is my synthesis of the new scientific understanding of life.

In the diagram below, I have represented the three perspectives as points in a triangle to emphasize that they are fundamentally interconnected. The form of a pattern of organization can only be recognized if it is embodied in matter, and in living systems this embodiment is an ongoing process. A full understanding of any biological phenomenon must incorporate all three perspectives.

![Diagram of FORM, MATTER, and PROCESS]

p. 72 Take, for example, the metabolism of a cell. It consists of a network (form) of chemical reactions (process), which involve the production of the cell’s components (matter), and which respond cognitively, i.e. through self-directed structural changes (process), to disturbances from the environment. Similarly, the phenomenon of emergence is a process characteristic of dissipative structures (matter), which involves multiple feedback loops (form).

To give equal importance to each of these three perspectives is difficult for most scientists because of the persistent influence of our Cartesian heritage. The natural sciences are supposed to deal with material phenomena, but only one of the three perspectives is concerned with the study of matter. The other two deal with relationships, qualities, patterns, and processes, all of which are nonmaterial. Of course, no scientist would deny the existence of patterns and processes, but most of them think of a pattern as an emergent property of matter, an idea abstracted from matter, rather than a generative force.

To focus on material structures and the forces between them, and to view the patterns of organization resulting from these forces as secondary emergent phenomena has been very effective in physics and chemistry, but when we come to living systems this approach is no longer adequate. The essential characteristic that distinguishes living from nonliving systems—the cellular metabolism—is not a property of matter, nor a special "vital force." It is a specific pattern of relationships among chemical processes. Although it involves relationships between processes that produce material components, the network pattern itself is nonmaterial.

The structural changes in this network pattern are understood as cognitive processes that eventually give rise to conscious experience and conceptual thought. All these cognitive phenomena are nonmaterial, but they are embodied—they arise from and are shaped by the body. Thus, life is never divorced from matter, even though it’s essential characteristics—organizations, complexity, processes, and so on—are nonmaterial.

**Meaning—The Fourth Perspective**

p. 73 When we try to extend the new understanding of life to the social domain, we immediately come up against a bewildering multitude of phenomena—rules of behavior, values, intentions, goals, strategies, designs, power relations—that play...
no role in most of the nonhuman world but are essential to human social life. However, these diverse characteristics of social reality all share a basic common feature, which provides a natural link to the systems view of life developed in the preceding pages.

Self-awareness, as we have seen, emerged during the evolution of our hominid ancestors together with language, conceptual thought, and the social world of organized relationships and culture. Consequently, the understanding of reflective consciousness is inextricably linked to that of language and its social context. This argument can also be turned around: the understanding of social reality is inextricably linked to our surroundings.

**Meaning, purpose, and Human Experience**

p. 83-84 Having identified the organization of social systems as self-generating networks, we now need to turn our attention to the structures that are produced by these networks and to the nature of the relationships that are engendered by them. A comparison with biological networks will again be useful. The metabolic network of a cell, for example, generates material structures. Some of them become structural components of the network, forming parts of the cell membrane or of other cellular structures. Others are exchanged between the network's nodes as carriers of energy or information, or as catalysts of metabolic processes.

Social networks, too, generate material structures—buildings, roads, technologies, etc.—that become structural components of the network; and they also produce material goods and artifacts that are exchanged between the network's nodes. However, the production of material structures in social networks is quite different from that in biological and ecological networks. The structures are created for a purpose, according to some design, and they embody some meaning. To understand the activities of social systems, it is crucial to study them from that perspective.

The perspective of meaning includes a multitude of interrelated characteristics that are essential to understanding social reality. Meaning itself is a systemic phenomenon: it always has to do with context. Webster's Dictionary defines meaning as "an idea conveyed to the mind that requires or allows of interpretation," and interpretation as "conceiving in the light of individual belief, judgment, or circumstance." In other words, we interpret something by putting it into a particular context of concepts, values, beliefs, or circumstances. To understand the meaning of anything we need to relate it to other things in its environment, in its past, or in its future. Nothing is meaningful in itself.

For example, to understand the meaning of a literary text, one needs to establish the multiple contexts of its words and phrases. This can be a purely intellectual endeavor, but it may also reach a deeper level. If the context of an idea or expression includes relationships involving our own selves, it becomes meaningful to us in a personal way. This deeper sense of meaning includes an emotional dimension and may even bypass reason altogether. Something may be profoundly meaningful to us through context provided by direct experience.

**Learning from life**
The more managers know about the detailed processes involved in self-generating social networks, the more effective they will be in working with the organisation’s communities of practice. Let us see, then, what kinds of lessons for management can be derived from the systemic understanding of life.

A living network responds to disturbances with structural changes, and it chooses both which disturbances to notice and how to respond. What people notice depends on who they are as individuals, an on the cultural characteristics of their communities of practice. A message will get through to them not only because of its volume or frequency, but because it is meaningful to them.

Mechanistically oriented managers tend to hold on to the belief that they can control the organization if they understand how all its parts fit together. Even the daily experience that people’s behavior contradicts their expectations does not make them doubt their basic assumption. On the contrary, it compels them to investigate the mechanisms of management in greater detail in order to be able to control them.

We are dealing here with a crucial difference between a living system and a machine. A machine can be controlled; a living system, according to the systemic understanding of life, can only be disturbed. In other words, organizations cannot be controlled through direct interventions, but they can be influenced by giving impulses rather than instructions. To change the conventional style of management requires a shift of perception that is anything but easy, but it also brings great rewards. Working with the processes inherent in living systems means that we do not need to spend a lot of energy to move an organization. There is no need to push, pull, or bully it to make it change. Force or energy are not the issue; the issue is meaning. Meaningful disturbances will get the organization's attention and will trigger structural changes.

Giving meaningful impulses rather than precise instructions may sound far too vague to managers used to striving for efficiency and predictable results, but it is well known that intelligent, alert people rarely carry out instructions exactly to the letter. They always modify and reinterprete them, ignore some parts and add others of their own making. Sometimes, it may be merely a change of emphasis, but people always respond with new versions of the original instructions.

This is often interpreted as resistance, or even sabotage, but it can be interpreted quite differently. Living systems always choose what to notice and how to respond. When people modify instructions, they respond creatively to a disturbance, because this is the essence of being alive. In their creative responses, the living networks within the organization generate and communicate meaning, asserting their freedom to continually re-create themselves. Even a passive, or passive aggressive, response is a way for people to display their creativity. Strict compliance can only be achieved at the expense of robbing people of their vitality and turning them into listless, disaffected robots. This consideration is especially important in today’s knowledge-based organizations, in which loyalty, intelligence, and creativity are the highest assets.

The new understanding of the resistance to mandated organizational change can be very powerful, as it allows us to work with people’s creativity, rather than ignore it, and, indeed, to transform it into a positive force. If we involve people in the change
process right from the start, they will "choose to be disturbed," because the process itself is meaningful to them. According to Wheatley and Kellner-Rogers:

> We have no choice but to invite people into the process of rethinking, redesigning, restructuring the organization. We ignore people's need to participate at our own peril. If they're involved, they will create a future that already has them in it. We won't have to engage in the impossible and exhausting tasks of "selling" them the solution, getting them "to enroll," or figuring out the incentives that might bribe them into compliant behaviors. In our experience, enormous struggles with implementation are created every time we deliver changes to the organization rather than figuring out how to involve people in their creation... [On the other hand,] we have seen implementation move with dramatic speed among people who have been engaged in the design of those changes.

The task is to make the process of change meaningful to people right from the start, to get their participation, and to provide an environment in which their creativity can flourish.

Offering impulses and guiding principles rather than strict instructions evidently amounts to significant changes in power relations, from domination and control to cooperation and partnerships. This, too, is a fundamental implication of the new understanding of life. In recent years, biologists and ecologists have begun to shift their metaphors from hierarchies to networks and have come to realize that partnership—the tendency to associate, establish links, cooperate, and maintain symbiotic relationships—is one of the hallmarks of life.

p. 115 According to Nonaka and his collaborator Hirotaka Takeuchi: In a strict sense, knowledge is created only by individuals... Organizational knowledge creation, therefore, should be understood as a process that "organizationally" amplifies the knowledge created by individuals and crystallizes it as a part of the knowledge network of the organization.

**The Emergence of Novelty**

p. 116-117-118 If the aliveness of an organization resides in its communities of practice, and if creativity, learning, change, and development are inherent in all living systems, how do these processes actually manifest in the organization's living networks and communities? To answer this question, we need to turn to a key characteristic of life that we have already encountered several times in the preceding pages—the spontaneous emergence of new order. The phenomenon of emergence takes place at critical points of instability that arise from fluctuations in the environment, amplified by feedback loops. Emergence results in the creation of novelty that is often qualitatively different from the phenomena out of which it emerged. The constant generation of novelty — "nature's creative advance" — as the philosopher Alfred North Whitehead called it—is a key property of all living systems.

In a human organization, the event triggering the process of emergence may be an offhand comment, which may not even seem important to the person who made it but is meaningful to some people in a community of practice. Because it is
meaningful to them, they choose to be disturbed and circulate the information rapidly through the organization's networks. As it circulates through various feedback loops, the information may get amplified and expanded, even to such an extent that the organization can no longer absorb it in its present state. When that happens, a point of instability has been reached. The system cannot integrate the new information into its existing order; it is forced to abandon some of its structures, behaviors, or beliefs. The result is a state of chaos, confusion, uncertainty, and doubt; and out of that chaotic state a new form of order, organized around new meaning, emerges. The new order was not designed by any individual but emerged as a result of the organization's collective creativity.

This process involves several distinct stages. To begin with, there must be a certain openness within the organization, a willingness to be disturbed, in order to set the process in motion; and there has to be an active network of communications with multiple feedback loops to amplify the triggering event. The next stage is the point of instability, which may be experienced as tension, chaos, uncertainty, or crisis. At this stage, the system may either break down, or it may break through to a new state of order, which is characterized by novelty and involves an experience of creativity that often feels like magic.

Let us take a closer look at these stages. The initial openness to disturbances from the environment is a basic property of all life. Living organisms need to be open to a constant flow of resources (energy and matter) to stay alive; human organizations need to be open to a flow of mental resources (information and ideas), as well as to the flows of energy and materials that are part of the production of goods or services. The openness of an organization to new concepts, new technologies and new knowledge is an indicator of its aliveness, flexibility, and learning capabilities.

The experience of the critical instability that leads to emergence usually involves strong emotions—fear, confusion, self-doubt, or pain—and may even amount to an existential crisis. This was the experience of the small community of quantum physicists in the 1920s, when their exploration of the atomic and subatomic world brought them into contact with a strange and unexpected reality. In their struggle to comprehend this new reality, the physicists became painfully aware that their basic concepts, their language, and their whole way of thinking were inadequate for describing atomic phenomena.

For many of them, this period was an intense emotional crisis, as described most vividly by Werner Heisenberg:

"I remember discussions with Bohr which went through many hours till very late at night and ended almost in despair; and when at the end of the discussion I went alone for a walk in the neighboring park I repeated to myself again and again the question: Can nature possibly be so absurd as it seemed to us in these atomic experiments?"

It took the quantum physicists a long time to overcome their crisis, but in the end the reward was great. From their intellectual and emotional struggles emerged deep insights into the nature of space, time, and matter, and with them the outlines of a new scientific paradigm.

Quotes from The Hidden Connection, Fritjof Capra
The experience of tension and crisis before the emergence of novelty is well known to artists, who often find the process of creation overwhelming and yet persevere in it with discipline and passion.

Marcel Proust offers a beautiful testimony of the artist's experience in his masterpiece In Search of Lost Time:

“It is often simply from want of the creative spirit that we do not go to the full extent of suffering. And the most terrible reality brings us, with our suffering, the joy of a great discovery, because it merely gives a new and clear form to what we have long been ruminating without suspecting it”.

In human organizations, emergent solutions are created within the context of a particular organizational culture, and generally cannot be transferred to another organization with a different culture. This tends to be a big problem for business leaders who, naturally, are very keen on replicating successful organizational change. What they tend to do is replicate a new structure that has been successful without transferring the tacit knowledge and context of meaning from which the new structure emerged.

**Two kinds of leadership**

Finding the right balance between design and emergence seems to require the blending of two different kinds of leadership. The traditional idea of a leader is that of a person who is able to hold a vision, to articulate it clearly and to communicate it with passion and charisma. It is also a person whose actions embody certain values that serve as a standard for others to strive for. The ability to hold a clear vision of an ideal form, or state of affairs, is something that traditional leaders have in common with designers.

The other kind of leadership consists in facilitating the emergence of novelty. This means creating conditions rather than giving directions, and using the power of authority to empower others. Both kinds of leadership have to do with creativity. Being a leader means creating a vision; it means going where nobody has gone before. It also means enabling the community as a whole to create something new. Facilitating emergence means facilitating creativity.

Holding a vision is central to the success of any organization, because all human beings need to feel that their actions are meaningful and geared toward specific goals. At all levels of the organization, people need to have a sense of where they are going. A vision is a mental image of what we want to achieve, but visions are much more complex than concrete goals and tend to defy expression in ordinary, rational terms. Goals can be measured, while vision is qualitative and much more intangible.

Whenever we need to express complex and subtle images, we make use of metaphors, and thus it is not surprising that metaphors play a crucial role in formulating an organization's vision. Often, the vision remains unclear as long as we try to explain it, but suddenly comes into focus when we find the right metaphor. The ability to express a vision in metaphors, to articulate it in such a way that it is understood and embraced by all, is an essential quality of leadership.
To facilitate emergence effectively, community leaders need to recognize and understand the different stages of this fundamental life process. As we have seen, emergence requires an active network of communications with multiple feedback loops. Facilitating emergence means first of all building up and nurturing networks of communications in order to "connect the system to more of itself," as Wheatley and Kellner-Rogers put it.

In addition, we need to remember that the emergence of novelty is a property of open systems, which means that the organization needs to be open to new ideas and new knowledge. Facilitating emergence includes creating that openness—a learning culture in which continual questioning is encouraged and innovation is rewarded. Organizations with such a culture value diversity and, in the words of Arie de Geus, "tolerate activities in the margin: experiments and eccentricities that stretch their understanding."

Leaders often find it difficult to establish the feedback loops that increase the organization’s connectedness. They tend to turn to the same people again and again—usually the most powerful in the organization, who often resist change. Moreover, chief executives often feel that, because of the organization's traditions and past history, certain delicate issues cannot be addressed openly.

In those cases, one of the most effective approaches for a leader may be to hire an outside consultant as a "catalyst." Being a catalyst means that the consultant is not affected by the processes she helps to initiate, and thus is able to analyze the situation much more clearly. Angelika Siegmund, cofounder of Corphis Consulting in Munich, Germany, describes this work in the following words:

One of my main activities is to act as feedback facilitator and amplifier. I don't design solutions but facilitate feedback; the organization takes care of the contents. I analyze the situation, reflect it back to management, and make sure that every decision is immediately communicated through a feedback loop. I build up networks, increase the organization's connectivity, and amplify the voices of employees who would otherwise not be heard. As a consequence, the managers begin to discuss things that would normally not be discussed, and thus the organization's ability to learn increases. In my experience, a powerful leader plus a skilled outside facilitator is a fantastic combination that can bring about incredible effects.

The experience of the critical instability that precedes the emergence of novelty may involve uncertainty, fear, confusion, or self-doubt. Experienced leaders recognize these emotions as integral parts of the whole dynamic and create a climate of trust and mutual support. In today's turbulent global economy this is especially important, because people are often in fear of losing their jobs as a consequence of corporate mergers or other radical structural changes. This fear generates a strong resistance to change, hence building trust is essential.