THE EMERGENT PARADIGM: CHANGING PATTERNS OF THOUGHT AND BELIEF

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Analytical Report
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FOREWORD

It's all a question of story. We are in trouble just now because we do not have a good story. We are in between stories. The Old Story – the account of how the world came to be and how we fit into it – is not functioning properly, and we have not learned the New Story. The Old Story sustained us for a long period of time. It shaped our emotional attitudes, provided us with life purpose, energized action. It consecrated suffering, integrated knowledge, guided education. We awoke in the morning and knew where we were. We could answer the questions of our children. We could identify crime, punish criminals. Everything was taken care of because the story was there. It did not make men good, it did not take away the pains and stupidities of life, or make for unfailing warmth in human association. But it did provide a context in which life could function in a meaningful manner.

Thomas Berry says it beautifully and we agree: we are between stories. In this report we call the stories *paradigms* or *world views*, but we are saying the same thing: a fundamental shift in basic beliefs and assumptions about the nature of things and the human condition is going on. Because those beliefs and assumptions are among the foundations of human existence, when they change, radical shifts in individual values and societal conditions will follow. This VALS report presents the evidence for the thesis that such a paradigm shift is under way and explores the potential consequences of that change.

Our purpose is to provide a framework for understanding one of the most potent forces for change in our time: a shift in humanity's image of reality and self. It is so potent because those images and beliefs are the foundations from which human values arise. Every religious, spiritual, cultural, and political system in human history has embedded within it, either explicitly or implicitly, a "map" of the nature of things and what the human role in that nature is. It is not surprising, for example, to find a parallel between the hierarchical structures of monotheism, political organization based on the singular head of state, and the individual psychological search for singular identity.

An old systems theory axiom states, "You can't do just one thing." The point is that things change together. When any aspect of our most basic belief structures is altered, the other elements of that internal framework must also adjust.

We find strong evidence that a number of the underpinnings of our basic beliefs are under challenge. That challenge is coming from a multifaceted revolution of the sort that we have experienced only a few times in the course of our civilization's history: the revolution that began more than a century ago and has gathered momentum ever since involves as great a change as the Copernican revolution or the emergence of the Enlightenment. We believe that, by a systematic study of the manifestations of that revolution, it is possible to see the pattern of its dimensions and thereby anticipate some of its consequences.

What follows will attempt to cover a great deal of ground, exploring many different areas of human thought, inquiry, and activity. With such a scope, one or two authors run risks of either a lack of depth or a focus on the trivial at the expense of the significant, or both. We hope we have been guilty of neither.

Part I of this report presents a comprehensive summary of the process, the supporting indications, and the pattern of the current paradigm shift; it also covers the implications for business. Part II recapitulates the substance of the analysis in depth. A glossary of important terms and a bibliography of relevant readings follow Part II.

A number of people played an important role in helping to clarify our thinking and communication as well as pointing us in useful directions. The authors want to thank especially Arnold Mitchell, Paul Hawken, Edward Oshins, Hewitt Crane, Willis Harman, Walter Hahn, Jon McIntire, Alan Tryst, William Snow, Donald Michael, Marie Spengler, Thomas C. Thomas, Michael Murphy, Sam Keen, and Klaus Krause.

PART I

Summary and Implications

SUMMARY

Introduction

The world is round: a true description of reality, but once such a statement would have been false, foolish, and heretical. Our beliefs about what is true and real undergo fundamental shifts from time to time. And when our perception of the nature of things shifts, the complex system of human life also shifts. The movement toward a global society can begin only when the earth shifts from a limited plane to a whirling sphere.

Copernicus and Galileo took the motion of celestial bodies out of the realm of the gods and brought it over to the impersonal forces of nature — nature that could be understood by man. So began an era in which man, the individual, was ascendant. We created a politics where individual choice was at issue, not the will of competing gods or divinely endowed kings. We created a technology applying the comprehensible and predictable forces of nature. We created an economic system in which individual effort could lead to making real progress rather than being perpetually locked in a divinely rationalized economic order.

When there are major shifts in the fundamental pattern of knowledge and belief, the whole of the human condition will also change. Such shifts occur very infrequently, the last being the Enlightenment in the seventeenth and eighteenth centuries. We believe that another such shift is now in progress, signaling a major change in human values and beliefs. The indications of such a shift are found in changes occurring in the shared pattern of ideas over a broad range of human inquiry, thought, and interest. To anticipate the consequences of a major shift in the underpinnings of human values and beliefs, we must first identify and understand the patterns of that shift in and among the various disciplines.

A note of caution: What follows is difficult material and will not make for good light reading. It is difficult for two reasons:

(1) We cover many disparate disciplines, many of which will be unfamiliar. We have labored to make them comprehensible; nevertheless, even to experts in the various disciplines the material would be difficult.

(2) The essence of our argument has to do with a new way of thinking about and perceiving the world and ourselves. We make no claim that we as authors have begun to think or perceive in the new manner. It's somewhat like we "fish" trying to describe what it will be like when we evolve to walk on land.

Patterns and Processes of a Paradigm Shift

A civilization's fundamental view of the nature of things has been called *world view*, *Zeitgeist*, *episteme*, and *cultural paradigm*. As a convention we will adopt the term *paradigm*. *Paradigm* is used in two senses:

(1) Paradigm case: an example we use to teach basic concepts, which has a metaphorical nature (e.g., the father as the paradigm for authority).

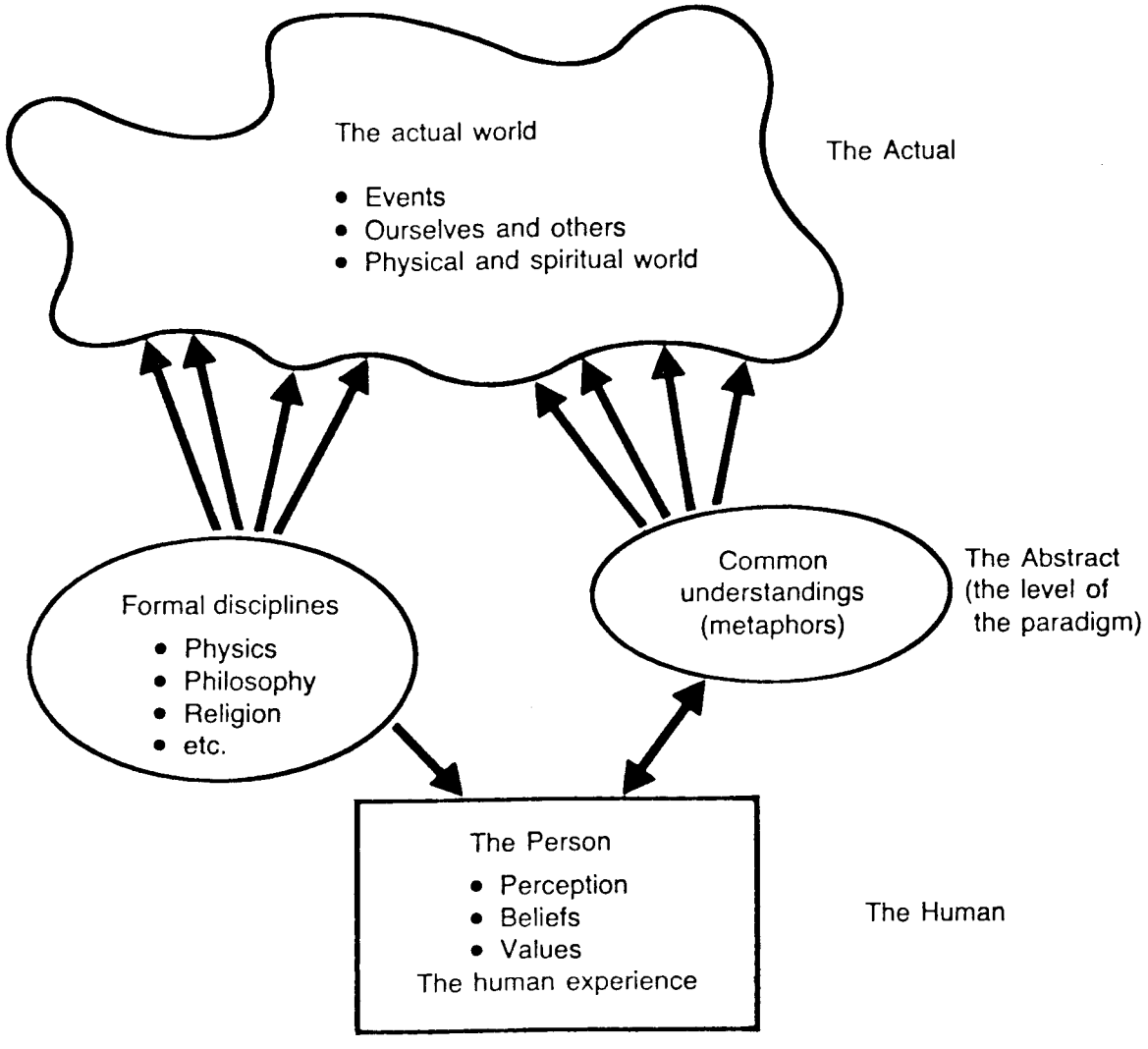
(2) The whole pattern of such metaphors, which leads to the internalization of a "map" of reality or a belief system.

A paradigm in the broader sense is the lens through which we see everything.

The role of a paradigm in human affairs is shown in Figure 1. The interactions are undoubtedly far more complex than shown. However, a simplified model can be useful at this point. The model distinguishes three levels:

- The actual — this is the world as it is, including ourselves. There may be many realities or only one reality, but whatever they are and however many there are is encompassed by the actual world.
- The abstract — this is the level of the paradigm (both formal and common ideas) which organizes our understanding of the actual world.
- The human — we ourselves; our perceptions, beliefs, and values. This is the level of the human experience.

Figure 1 The Role of Paradigms in Human Affairs



To be sure, these levels are not really separable. Humans are a part of the actual world and abstractions are a human artifact. For the moment, however, separating them this way is useful.

This picture of things is a dynamic model. Physics or philosophy, for example, can uncover new facets of the actual world or new models for thinking about it. The formal disciplines create models and metaphors for the way things are. These move out of the formal discipline to shape our common understandings and often back again to be applied in a new discipline. The physicist invents the hologram, the concept of which becomes a part of the vernacular. The brain theorist comes to understand the concept and sees in the hologram a metaphor for the complex system of brain functions, leading to new avenues of research.

Together these models and metaphors form a kind of atlas of mental maps of the actual world. They tell us what we know about the nature of things — what is real, what may be false, and what to pay attention to. To some extent the maps are taught in school in history, science, literature, etc. To some extent they are embedded in our language. To a great extent they have become a part of our cultural and social systems. We are rarely conscious of them because they are usually implicit: paradigms tend to surface mainly when they are changing.

But formalized knowledge is almost inevitably incomplete; i.e., the physicist describes molecules, but not living beings. For the purposes of each discipline, this incomplete description is usually adequate. Where it is not, a new discipline arises, e.g., biophysics. In contrast, the ordinary and common paradigm is in a sense complete. There are mysterious areas, to be sure; but we behave as if our mental maps were complete, as if reality were a seamless whole. Yet we know that there are gaps where our ordinary experiences simply do not fit the more formal abstractions. This dissonance between human experience and abstraction is an important motivator of study in the formal disciplines.

In historical terms, until the seventeenth century the Aristotelian model of organic growth provided for Western civilization an internally consistent world view or paradigm. It finally began to crumble under the onslaught of new ideas, beginning with the publication of *On the Revolution of the Celestial Spheres* by Copernicus in 1640. Newton, Bacon, Descartes, Leibnitz, Voltaire, and others carried on into what became known as the "Century of Genius," the Enlightenment, or the Age of Reason — all signifying the triumph of the human intellect over the natural order.

To be sure, the development of the Enlightenment was far from a smoothly ordered process. It is doubtful, for example, whether Newton would have accepted what quickly came to be known as the Newtonian world view. But there was a broad pattern of change across the natural sciences and the humanities that radically altered the existing common understanding of the nature of things. The most familiar example is the change from considering the earth as the center of the universe to seeing it as one celestial body among many. Ultimately, those new understandings were reflected in the human, social, psychological, religious, political, and economic orders. That era shattered and reformulated Western civilization's shared pattern of beliefs. On reflection, that pattern of change may seem like a one-time thing. But we shall attempt to demonstrate that such a pattern of change is under way again in the twentieth century, the old order having been shattered, at least at the level of formal disciplines, by discoveries in the sciences and understandings in the humanities.

This time, patterns of change have themselves changed. Among the greatest of the changes is the capacity to make just this kind of leap: from a series of thoughts about phenomena on one level to an entirely different level of thought *about those thoughts* on the first level. Not just more and different thoughts on the first level, but a meta-leap to meta-laws covering the laws on the first order of generality: thinking about thinking and knowing.

So, for example, organic change — growth — was the paradigm or pattern for change for an entire epoch of science. Aristotle is the chief ideologue of that epoch. Nonorganic, mechanical change became the dominant pattern for change during the centuries following Galileo and Newton. In place of the acorn becoming an oak, billiard balls, clocks, and pendulums were taken as models for the orderliness of the cosmos. Now the pattern is changing once again. Neither the

teleological interpretation of organic growth nor the causal account of physical mechanism is adequate any longer. And we know it.

Further, we know that we know it. We know that we have accomplished a break from our previous paradigms. We know that there are such things as paradigms. Before our era, most people didn't think of themselves as caught within a paradigm. Having never consciously experienced a shift of paradigms, the very existence of paradigms could not be perceived. Now, however, not only do we appear to be on the edge of a new paradigm, but in addition, we know that there *are* paradigms. Precisely *that* awareness is part of the new paradigm, that meta-leap to a self-reflective stance on all of one's thoughts, and how it is, finally, that thought thinks about itself.

This appreciation of the importance of the stance or perspective of the knower or perceiver, this reflection on the reflector, is uniquely modern. Further, this reflective capacity evident in a kind of meta-awareness is intimately linked to the leaps in the conceptual content of scientific and intellectual disciplines, the discontinuities that are part of the new paradigm.

Revolution is a modern pattern of change. So is what Bateson calls deutero-learning, that is, meta-learning, or learning to learn. Bateson's concept is an attempt to grasp the discontinuity of the "Aha! experience," the private "revolution" that takes place when one ceases to rote-learn more and more cases of a series of equations, for example, and suddenly makes a breakthrough to the pattern that not only binds together all that one has learned, but makes it possible to generate further members of the series. Although the series itself may be continuous, the mastery of the pattern of the series seems to involve a kind of discontinuity, a jump from one level to another — a different order of abstraction.

In our culture, there are three different sequential patterns: old, current, and emergent. The old pattern is the Newtonian paradigm that succeeded the Aristotelian world view. At the common level, the old pattern is still dominant. And, for many purposes, even in the formal disciplines the old paradigm is still valid but in a more limited way. In the formal disciplines, the current pattern is a fractured one, hardly a pattern at all — more appropriately, the fragments of a pattern. The emergent pattern is for the future; it is the underpinnings of future values and beliefs. Its outline is becoming visible; and, as the future paradigm begins to take shape in the years ahead, an understanding of that pattern should aid us in interpreting the meaning of various changes at a societal and individual level.

The Support for an Emergent Pattern

In this section we will summarize those fragments in the various disciplines that support the idea of a major shift in paradigm. We have selected these disciplines because the evidence seems strongest here; however, we found nothing in our search that would contradict our thesis. Some of the theories we will cite are controversial and not universally accepted; some may prove to be wrong. This is the perpetual condition at the frontier of knowledge. However, it is the whole pattern we are seeking; and this does not seem to hang on any one idea in one field. For our purposes it doesn't really matter whether the new paradigm in physics is more like David Bohm's holomovement, Roger Penrose's twistors, or David Finkelstein's quantum logic. They are all pointing in the same direction. It is that direction, and its links to directions in other disciplines, we want to identify.

There are areas where we expected to find evidence and didn't. Chief among these was economics. No area of human concern seems more fraught with confusion and urgency. The theoretical models no longer lead to an ability to predict or control the economy. It may be true, however, that a new economic paradigm will become evident only after the fact. The behavior of the economy may change, and then in retrospect we will "discover" the new paradigm. Necessity may outrun concept.

The evolution in each area we explored is highlighted in Table 1. In the following we will briefly summarize those developments. They are covered in greater detail in Part II.

- *Physics.* At the end of the nineteenth century, physics seemed to be headed toward a kind of closure. All the fundamental problems seemed

	From	Toward
Physics	Atomistic	Quantum mechanical
	Mechanical	Holographic
	Absolute space and time	Relativistic
	Universality	Complementarity
	Objective	Indeterminacy
Chemistry	Equilibrium (static)	Non-equilibrium (dynamic)
	Reductionist	Morphogenetic
	Entropy increasing	Order increasing
Brain Theory	Localized "bits" of information	Distributed "tuning" of system
	Circuitry model	Holographic metaphor
Ecology	Stable ideal	Resilience
	Closed systems	Symbiotic relationship
		Open systems
Evolution	"Random" mutation	Diversity
	Survival and conquest	Co-evolution
		Adaptability
Mathematics	Continuous functions	Mapping discontinuities
	Quantitative change	Qualitative change
Philosophy	Universal truth	Relationships of resemblance
	Eternal essence	Historical existence
Politics	Central hierarchy	Pluralism
	Authority	Legitimacy
	Necessity	Voluntary and inventive
Psychology	Identity	Harmony
	Individual	Transactional
	Conquest over the unconscious	Integration of the unconscious
Linguistics	Atomistic	Structural
Religion	Monotheistic	Polytheistic
	Transcendence	Immanence
Consciousness	Hierarchical	Heterarchical
Arts	Representational	Abstract
	Stable	Fluid

solved or close to resolution. The advent of quantum and relativity theories in the first quarter of this century fractured that closure and opened vast new domains for experimentation and theorizing. Today physics is still very much a wide-open discipline, but it appears to be headed toward a radical new vision of physical reality. The old vision conceived of matter as tiny particles — like miniature billiard balls — pushed around by identifiable

forces in the unchanging framework of space and counted out by fixed units of time. Particles were the fundamental level of the universe out of which everything else could be assembled. We as observers could stand outside and objectively study their behavior.

The twentieth century changed all that. First, we discovered that the nature of the observation process affects the results. Predictable outcomes were replaced by indeterminacy and probability. On the very small (subatomic) scale, one experiment found particles, another found waves; and ever more experiments seemed to "discover" ever more particles. We needed complementary wave and particle descriptions for this elusive fundamental level. On the very large scale, we found space and time no longer an absolute background. Instead, our measurements were determined by the relationship between the observer and the observed. Finally, this confusing picture appears to be headed toward a new order, which relies on an image of the complex interconnection of all things; indeed, all things are seen to arise from a dimension of the universe that has so far remained hidden in our theories. The relationship of this hidden dimension to our ordinary reality may be analogous to the relationship of real to imaginary (or complex) numbers. There is a shift in metaphor from the machine-like universe to the hologram-like universe (see box on holograms).

- *Chemistry.* Chemistry has dealt largely with relatively simple and stable substances. They are defined well by equations describing closed systems that tended toward stability (equilibrium). The second law of thermodynamics says that, left to itself, a closed system tends to decay toward disorder (entropy). The problem is that closed systems rarely occur in the actual world; and new, more complex, more highly ordered substances are produced from less highly ordered, simpler substances. Ilya Prigogine won the Nobel Prize in Chemistry in 1977 for his theory of "dissipative structures." That theory describes how complex systems evolve in an open environment from less order to more order and from simpler toward more complex structures. Fluctuations in a system interact, affecting each other and causing wholly new structures to arise. The process is known as morphogenesis. Strict deterministic causality is replaced by unpredictable innovation arising morphogenetically through mutually causal interactions of fluctuations. To completely understand something then, requires knowing its history, which cannot be completely known from its present conditions.

- *Brain Theory.* The common metaphor for the brain has become the computer. Brain cells are like the circuits and memory core of a computer. There are bits of information stored at a particular location, retrieved and operated on by a network of brain circuitry. Research by Karl Pribram and others suggests that instead of the computer the appropriate metaphor ought to be the hologram as in physics. Brain functioning and memory are not localized but rather are distributed throughout the brain. Interaction takes place not like the flow of current through a circuit but like that of a wave through a medium. Thus, very complex structures (thought, rich memories, etc.) can arise through the very dense and complex wave interactions rather than statistical summing of information "bits."

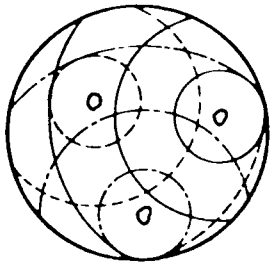
- *Mathematics.* The primary tool of mathematics has been differential calculus. It is useful in describing phenomena that change smoothly and continuously. However, the actual world involves many phenomena — such as the formation of crystals — that undergo discontinuous changes from one qualitative condition to another. Rene Thom, a French mathematician, has developed a new mathematics, which he calls "catastrophe theory." The theory describes the process by which one form gives way to another. The shift in paradigm is the ability to transcend the limits of continuous, quantitative change to describe discontinuous and qualitative change.

- *Ecology.* The dominant image of an ecosystem is that it is stable because it is a closed system;

What Is a Hologram?

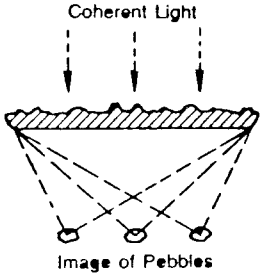
Holography is one of the key concepts in this new paradigm, yet many people have difficulty understanding what holograms are and how they work. The basic principle can be illustrated by a simple analogy of how nature stores information holographically.

Imagine you have a shallow pan of water into which three pebbles are dropped simultaneously. Each pebble is the source of waves spreading evenly across the pan. The waves cross and interact with one another, creating a complex pattern called an interference pattern (Drawing A). If you now



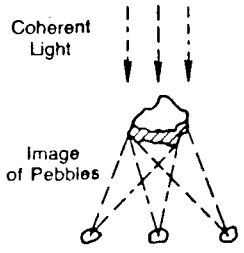
A.

quick-freeze the surface of the water in the pan and lift out the resulting rippled sheet of ice, you are then holding a record of the interference pattern of the waves. This is a hologram. (Drawing B)



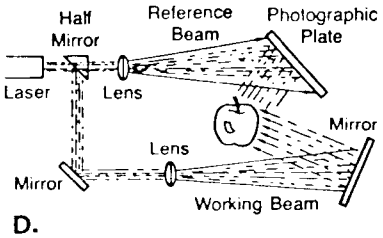
B.

If you illuminate the sheet of ice with a coherent light source (light of the same frequency, in which all waves are "in step" — e.g., a laser) and then look through the air toward the light, you will see an image of the three pebbles suspended in midair, and they look three-dimensional! The rippled ice surface acts as a distorted lens in such a way as to focus the light to points taken up by the pebbles that have caused the ripples. The chaotic-looking ice surface is actually a holographic information storage device. Amazingly, if you take the sheet of ice and break it into small pieces, and illuminate one of the chips, you will again see the image of all three pebbles projected in midair, just as each cell in our bodies carries all of the genetic information necessary to make an additional exact copy of our bodies. Holography is nature's most compact information storage device. (Drawing C)



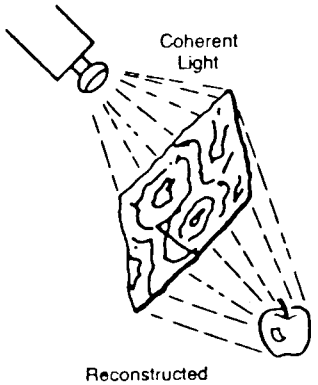
C.

Holography is actually a method of lensless photography in which the wave field of light scattered by an object — an apple, say — is recorded as an interference pattern. A laser light beam is split into two components by a half-mirror. This allows part of the beam to continue undisturbed while part of it is deflected to another mirror. Both narrow beams are spread open by lenses. The undisturbed beam, called the reference beam, arrives at a photographic plate after an eventless flight, and deposits its imprint on the film. The deflected beam, called the working beam, encounters the object and then is reflected onto the film. (Drawing D) In a sense, the working beam tells the reference beam about its experiences with the object by creating an interference pattern on the film that stores information about the object. Information can be elicited from the film by illuminating it with the same laser light used in making the hologram. As we do that,



D.

we see the apple appear suspended in midair, looking very three-dimensional and real. And because holograms have the property of total distributedness, illuminating any piece of the original hologram will produce the entire image of the apple. (Drawing E)



E. Reconstructed Three-Dimensional Image of the Apple

The important part of making a holographic image is the interaction of the reference beam — a beam that is pure and untouched — with a working beam, a beam that has had some experiences. The magnitude of these experiences is measured against the reference beam, which serves as a baseline for comparison.

Developed by Rick Ingrasci, M.D. in *New Age Magazine*.

i.e., it has no significant interactions with external forces. Perturbations in the system are damped back toward the stable ideal. Of course, there are no truly closed systems. All boundaries in actual ecosystems are arbitrary. C. S. Holling has developed ecological models that replace the concept of stability with that of resilience. If an ecosystem is adequately diverse and there exist symbiotic (mutually supportive) relationships among the diverse species, then a system tends to be resilient. The system as a whole can survive major perturbations, evolving toward a new condition even though the numbers of any particular species may fluctuate a great deal.

- *Evolution.* The commonly held image of evolution is that it occurs because of two forces: random mutation and competition. New possibilities are introduced by random mutation; these are then "tested" and the fittest survive. Jacques Monod called the process "chance and necessity." The change in paradigm involves both aspects. The new view of evolution recognizes that evolution works on individuals with diverse genetic material. In this view, the diversity among individuals — rather than mutation — is the source of "richness" in the gene pool of a species. Mutation merely adds to the richness. But individuals can also change themselves and/or their environment. More important than the conquest of one variant over another or one species over another is their effect on each other — their ability to adapt to one another. Through mutual adaptation they evolve together.

- *Philosophy.* Philosophers since the time of Plato have searched for eternal truths. Their search was for universal ideas that lay behind the seeming confusion of the world. They searched for the essence that gave something its particular character and sought to identify the universal forms that unify our use of words and concepts. Contemporary philosophy has moved far from those ideals. Philosophy now must account for history and detail rather than the permanence of eternity and generality. The search for essence has been replaced by an attempt to understand the meaning and nature of existence. Finally, the universality of forms is replaced by Wittgenstein's "family resemblances": identity gives way to resemblance. Philosophy has become in a sense democratized, with analysis and specialization replacing synthesis and insight. Now that the many specialized areas of philosophy have begun to face up to the complexity and ever-changing nature of the actual world, the discipline is held together only by the loosest of family resemblances.

- *Psychology.* The movement in psychology has been astonishingly rapid. The focus in traditional psychology was on the singular self attempting to master the contrary components of the psyche, including the unconscious. The shift is toward a more complex interactive model. The new paradigm is focused on achieving a harmony of the many dimensions of the psyche, not the suppression of any dimension. The aim is wholeness rather than identity. The individual psyche, like the organism in an ecosystem, interacts with its psychological environment. These transactions are a part of its definition of self. Finally, rather than conquering the unconscious, there is an attempt to integrate unconscious processes into the larger self.

- *Politics.* The shift in political theory began with the breakdown of authoritarian and monarchic structures of power. They drew their authority from strength of arms or from the necessity of a higher authority, as in the "divine right" of kings. The shift is away from centralized hierarchy and toward pluralism. Authority is based on legitimacy given by the governed. Finally, the necessity imposed by a higher order is replaced by a voluntary and inventive character. We choose to participate, and part of our participation is creating institutions of politics such as modern bureaucracies.

- *Linguistics.* Our understanding of the nature of language has undergone a major change in this century, dating from the work of Saussure.

Words in themselves no longer have any intrinsic meaning; rather, they are defined by their location in a context. Thus, words are no longer seen as "atoms" of meaning. To find meaning, one needs to focus on the complex interrelationships that create a linguistic structure.

- *Religion.* The shift in the nature of spiritual belief and practice is likely to be among the most controversial aspects of our argument. Historically, an important shift took place centuries ago when empirical science, with its focus on the "one truth," took over the role of metaphysical arbiter from monotheistic religion. As the metaphysical role of science diminishes, it is not surprising to see religion returning to center stage. But we have learned some things along the way. As the physics we encounter is a function of our perspectives, so are our gods. The current emphasis on tolerance (e.g., Vatican II) is indicative of a new kind of polytheism. Along with that, then, comes a return of the idea of immanence; to know the spirit requires looking within.

- *Consciousness.* The initial focus on the nature of consciousness more than a century ago represents an important step. It was an acknowledgment of the fact that consciousness is not merely a blank slate, but that its nature affects our encounter with the world and ourselves. More recently, especially in split-brain research, we have discovered that there may be a pluralistic structure to human consciousness, with several quite different (but partial) systems in the brain. Thus, rather than a hierarchy of functions we find a "heterarchy" of guiding principles. (See box on heterarchy.)

- *Arts.* Modern art is a mirror of contemporary consciousness. The fundamental shift is the rebellion against the concept of stable form. Thus, once the aim was to present reality in a style and form that would endure. Now art abstracts from reality its ever-changing nature. Rather than immortal works resisting the flow of time, the style is fluid, anticipating the ever-changing world and the evanescent moods of the artist.

These areas of formalized and abstract development form the underpinnings of our case for change. The issue for this analysis is how they will impact our common understandings of the nature of things. In the next section we explore how these may be transformed into a pattern of belief.

Patterns of Change

In the following discussion, we attempt to clarify the pattern that appears to be unifying these seemingly disparate threads. What we seek is the emergent pattern of our common understanding of the nature of the actual world. Qualities are brought to that common understanding from the more precise and rigorous descriptions of the formal disciplines. Thus, we make the statement that the world is complex rather than simple. Physics, chemistry, etc., teach us about complexity in precise terms. However, what we wish to do is relate that complexity to other qualities and then to explore the implication of that whole pattern. Table 2 shows the qualities to be discussed and the disciplines from which they derive.

There is a difficulty of communication that must be noted. Describing a quality, which is itself a descriptive term, is very difficult. How do you describe blue or big when the meaningful referents themselves are changing? Thus, a shift in color from blue toward red is not too difficult, but blue toward big is almost nonsensical. Not only has there been a shift in the quality itself, but in its context as well. The meaning of the new description has changed. We will describe the shifts in quality in sequence; however, their meaning is found in their whole pattern. Table 3 shows this shift in qualities, each aspect of which is discussed below.

From Simple Toward Complex – The task of most knowledge processes has been to reduce that which is studied to its elements and simplest relationships. These are called fundamentals and basic laws. $F = ma$ is an example in physics. Larger, more complex entities are simply the result of adding up the smaller components. If there are differences, they are taken care of by averaging.

We can no longer treat the actual world as simple. We have found in physics, chemistry, ecology, linguis-

Heterarchy

The concept of heterarchy provides an alternative to the simple opposition between order and chaos. If hierarchical order is rule by one and anarchy is rule by none (or by all - it amounts to the same chaos), then heterarchy is rule by some.

The formal definition of hierarchy describes what we refer to less formally as a "chain of command" or "pecking order", A over B, B over C, C over D, and so on. Further, the formal definition of hierarchy stipulates transitivity of preference or command: if A is over B and B is over C, then A is over C. The distinctive feature of heterarchy is the denial of transitivity. The simplest heterarchical system is one consisting of three "choices": A over B, B over C, and - surprisingly - C over A.

Some examples will demonstrate the differences among heterarchy, hierarchy, and anarchy. Take the simple game of paper, rock, and scissors. Paper covers rock, rock breaks scissors, scissors cut paper. No one choice always wins; no one choice always loses. The game has invariant rules. It is not anarchical, yet there is no fixed hierarchy of one option over both others.

A second example, the so-called Voters' Paradox, has received many treatments, from Condorcet to Lewis Carroll. One group of voters prefers A over B and B over C. A second group prefers B over C and C over A. A third prefers C over A and A over B. When we count the votes, we discover a preference for A over B (groups 1 and 3), and a preference for B over C (groups 1 and 2), but not a preference for A over C. Groups 2 and 3 prefer C over A. Some political theorists have concluded that the very possibility of such a preference pattern reveals an essential inconsistency or irrationality in the mechanisms of voting and majority rule. Arguing from a position that equates order with unambiguous hierarchy, they see the disorder of anarchy as the only alternative to the hierarchy undermined by the Voters' Paradox. A third example will show why it is unnecessary to infer anarchy from the lack of a clear hierarchy.

Neurophysiologists have discovered that some nets of neurons are arranged like switching mechanisms with the formal properties of the Voters' paradox. Heterarchical nervous nets do nothing to destroy the organization of the nervous system of which they are a part. On the contrary, heterarchical nervous nets may be precisely what distinguishes an intelligent system capable of choices from a thoroughly predictable automaton.

A fourth example of heterarchical organization might be drawn from theology: the polytheistic pantheon of Olympian deities. Zeus may be first among the gods and goddesses, but he lacks the omnipotence of the monotheistic Lord of Lords. Within a heterarchical pantheon, even the personification of power and authority himself turns out to be one power among others. Less than omnipotent, Zeus acts more like a deterrent. Less powerful than all the other gods and goddesses combined, he is nonetheless sufficiently powerful to keep any one god or goddess form exercising pretentions to supremacy. Zeus's limited power is not necessarily a primitive version of a more developed monotheidtic hierarchy. On the contrary, Zeus may be crucial to the maintenance of the complexity of the pantheon, Without him the Olympian order might yield to the supremacy of one of the other gods, devolve into the simpler form of monotheism, and from there into even less mysterious hierarchies. In bureaucracy, for example, the aim is to construct a hierarchical tree of decision procedures reducing every decision to an essentially unintelligent automatic function.

From the formal definition of heterachy and the concrete contents of the four examples, the following features of the heterarchical model emerge. Heterarchical systems exhibit patterns of preference that are nontransitive, circular, and complex. Unlike anarchy, heterarchy defines a tightly constrained limitation on the range of possible choices. Unlike hierarchy, heterarchy does not yield up all choices to one ultimate source of judgment, Heterarchy is thus a model for leadership that stops short of omnipotence, and for intelligent choice among real options whose range stops short of an anarchic "anything goes."

	Complexity	Heterarchy	Holographic	Indeterminate	Mutually Causal	Morphogenesis	Perspective	
Physics	•	•	•	•	•	•	•	
Chemistry	•			•	•	•		
Brain theory		•	•	•			•	•
Ecology	•				•	•		
Evolution	•		•	•	•	•		
Mathematics		•			•	•	•	
Philosophy	•	•		•			•	
Politics	•	•		•		•	•	
Psychology	•	•		•		•	•	
Linguistics	•	•	•				•	
Religion	•	•	•			•	•	

tics, and psychology that diversity, interaction, and open systems are the nature of things. The world is composed of diverse things, all of which interact; and it is in principle impossible to separate a thing from its interactive environment. These are the ingredients of a complex system. Imagine the increasing com plexity when one moves from an isolated individu to a married couple to a family with children a finally to an extended family of cousins, aunts, a grandparents. The fundamental shift is that t

Dominant Paradigm	Emergent paradigm
From	Toward
Simple/probabilistic	Complex and diverse
Hierarchy	Heterarchy
Mechanical	Holographic
Determinate	Indeterminate
Linearly causal	Mutually causal
Assembly	Morphogenesis
Objective	Perspective

:haracteristics and behavior of a complex system are ıot merely the sum of its individual elements: as ystems become more complex, they develop unique ıroperties.

'rom Hierarchy Toward Heterarchy — We find ıeterarchy as one of the new concepts in psychology, ıhilosophy, religion, brain theory, and physics. The ıld conception of order was hierarchical: there exists "pecking order," a chain of command, higher- and ower-order principles, and so on. The emergent order s heterarchical. There may be vertical orderings, but here are many on a comparable level; there is no one ıerson, principle, or object at the top of everything. 'here may be many peaks to these pyramids, and vhich one comes into play and its relationship to the thers depend on the situation.

Heterarchy is a shift from the rule by one to several rules by some. Today's political systems of interest groups, interlocking bureaucracies, and multinational companies seem to believe that there is a hierarchy of power. Yet they, in fact, operate heterarchically, creating a system of mutual constraints and influence. The whole system goes not where any one interest would take it. Rather than merely a compromise or average of all the interests, there is a movement that is unpredictable and different from those of the particular component interests.

From Mechanical Toward Holographic — The relationships among parts once were found in analogies to simple machines such as the lever. For example, an actor at one end of a lever can lift an object by a downward push — a very simple process in which nothing else happens. However, if the actual world is

complex and can be ordered heterarchically, then such simple metaphors may be inappropriate. A more useful metaphor may be the hologram.

With the holographic metaphor come several important attributes. We find that the image in the hologram is created by a *dynamic* process of interaction and differentation. We find that the information is *distributed* throughout — that at each point information about the whole is contained in the part. In this sense, everything is *interconnected* like a vast network of interference patterns, having been generated by the same dynamic process and containing the whole in the part.

From Determinate Toward Indeterminate — The success of the mechanistic description of the actual world gave a strong foundation to the argument for a deterministic view of the world. If the world consists wholly of particles and fields of force whose behavior is mathematically describable, then, given sufficiently sophisticated computational abilities, the behavior of whole aggregations should be predictable. Even if calculation is not possible in practice, the system is still strictly determined.

Those simplistic notions were laid to rest by Heisenberg's Indeterminacy Principle, which tells us that (1) at a subatomic level the future state of a particle is in principle not predictable, and (2) the act of experimentation to find its state will itself determine the observed state. Qualitatively, the implication of this is not that there are no causal linkages between past, present, and future; rather, in complex systems possibilities can be known, but precise outcomes cannot be predicted. It means that *ambiguity* about the future is a condition of nature. Not everything is possible, but among the possibilities choices do affect the actual outcomes. There is an analogy here in the shift from the fixed order of divinely endowed kings to the voluntary and evolutionary order of democracy.

From Linear Toward Mutual Causality — The indeterminacy in nature is mirrored in the evolution of causal models. The simplest causal model is linear; that is, a simple action leads always to the same predictable result: push on a chair and it moves every time. Thermodynamics introduced probabilities into causality to describe the average behavior of whole aggregations such as a gas. Cybernetics gave us feedback, but with a concentration on negative feedback. That means that if A causes B, then B provides a feedback signal to A such that A changes in a way to reduce or limit the magnitude of B. A heating system with a thermostat functions that way. Such a system tends toward stability. The new paradigm adds positive feedback, which means that the feedback signal from B affects A in a fashion such that A tends to increase B. In the simplest and most negative form that is called a vicious circle. However, when it is of mutual benefit for both A and B, then it is like symbiosis. Both A and B evolve and change together, each affecting the other in such a way as to make the distinction between cause and effect meaningless.

From Assembly Toward Morphogenesis — Our old metaphor for change is that of a construction project. We have components being assembled according to a plan with a predictable outcome. Forms in nature seem to evolve in a different way. There are no components and plans for waves, plants, or galaxies. Fritz Zwicky used the term *morphogenesis* to describe the evolution of galactic forms out of the primordial chaos. It is in the sense of order emerging from disorder that we use it here. If a system is complex — composed of diverse elements that interact by mutually causal and indeterminate processes — and the system is open to external inputs, then it can change morphogenetically. A new form, unpredicted by any of its parts, can arise in such a system. The form of a flower cannot be accounted for solely by the form of its component cells. However, not just any form is possible. The components constrain, but they do not determine the exact form; hence, a particular kind of rose may differ in hue, number of petals, and size from other roses of the same kind while still being recognizable as a rose.

The requirements for morphogenesis are diversity, openness, complexity, mutual causality, and indeterminacy. When these conditions exist, we have the ingredients for qualitative change. That process can be described reasonably rigorously by Rene Thom's catastrophe theory.

From Objective Toward Perspective — Along with the Indeterminacy Principle, the changes in pattern already identified lead us to one final change. Until this century, we were taught to believe that the way to know about the world was to stand outside it somehow and observe it objectively. We assumed that our mental processes, our experimental instruments, and our disciplines were neutral. But we've discovered that none of these are neutral to the world. Our instruments and experiments affect the results, especially in atomic systems and human systems. Our culture, language, and world view affect what we perceive and what we do not. Finally, the evolution of paradigms in disciplines such as physics shows that the disciplines themselves are not neutral to the world.

If objectivity is an illusion, is subjectivity the only alternative? We suggest that perspective is a more useful concept. Perspective connotes a view at a distance from a particular focus. Where we look from affects what we see. This means that any one focus of observation gives only a partial result; no single discipline ever gives a complete picture. A whole picture is an image generated morphogenetically from multiple perspectives.

Yet knowledge requires more than an image. But if knowledge is not merely the sum of objective facts, what is it? Following the same logic as above, knowledge may require engagement. In linguistics we found that the meaning of a word comes from its use in context; similarly, in ecology we must view the organism in its environment. To know something requires engagement with it so that it is seen in the context of our own concerns, and multiple perspectives so that we are not blinded by our own biases. This acknowledgment of the inescapability of perspective is very different from the attempt to gain objectivity by abstracting from all perspectives.

A further consequence of this shift in our process of knowing is that the concept of reality itself changes. There may, indeed, be an ultimate reality. However, every time we try to discover what it is, our efforts will be partial. Thus we see a shift from the "absolute" truth discovered by the "right" method toward a plurality of kinds of knowledge explored by a multiplicity of methods.

The New Metaphor — The total pattern of change is somewhat like a change in metaphor from reality as a machine toward reality as a conscious organism. Machines are mechanical and relatively simple. They are organized hierarchically from components, and they function linearly and predictably. We can stand outside them and study them.

A conscious being — say, a human being — is very complex and unpredictable. People behave one way now and a different way later. When they change, they often change suddenly. They are internally interconnected, consisting of many complex subsystems. They are externally interconnected with other people and the world around them. When people interact they affect each aother. Because of this complexity of interaction, people don't always see the same things; they have unique pespectives. In the same way, the emergent paradigm of the actual world is complex, holographic, heterarchical, indeterminate, mutually causal, morphogenetic, and perspectival. The shift in metaphor is from the machine to the human being. We are like the world we see.

IMPLICATIONS

In this section we want to draw out the implications of the multi-faceted revolution summarized in the previous section. We will first briefly examine certain mechanisms of change. Then we will apply those mechanisms to individuals, society, politics, science and technology, and finally business. With respect to business, we are interested both in the direct impacts and in those impacts that arise from changes in the other categories of impact.

Mechanisms of Change

The foregoing analysis suggests that there is a common pattern of development in diverse areas of inquiry. That pattern can be called a shift in paradigm, the evolution of new conceptual maps, a change in world view, or other similar phrases. We must now address the question of how such a conceptual and formal revolution translates into effects on human lives.

We suggest that it is not much of an exaggeration to consider this change akin in kind, diversity, and magnitude to the emergence of the Enlightenment in the seventeenth and eighteenth centuries. The heart of the Enlightenment was the idea that man's happiness would result from the application of "right reason" to the human, spiritual, and natural order. Rather than being in the hands of God alone, man was by dint of his intellect capable of pulling himself up toward some higher state. As in the present, the revolution was multifaceted. The Enlightenment is associated with such names as Bacon, Descartes, Galileo, Newton, Wesley, Voltaire, Rousseau, Locke, Hume, Kant, and Adam Smith. At its roots the Enlightenment was a profound intellectual transformation, and few would deny that our present economic, social, political, and technological order are a direct result of that transformation. To be sure, there were other factors at work as well, but the pattern that we label the Enlightenment shattered and reformulated nearly every aspect of human existence. Out of that complex of changes emerged new definitions of meaning, a new sense of the basis for man's existence, a new set of principles for ordering society, the entirely new phenomena of empirical science and its handmaiden technology, new language, new vistas of possibility for humankind, and the idea of progress itself. Over the span of two centuries these forces translated the abstract revolution into a concrete one. Similar forces will translate the current largely intellectual revolution into an actual human transformation.

We can expect that new belief systems will integrate our current understandings with more traditional beliefs and lead to value changes. New metaphors will permit approaching old problems afresh. New concepts will permit a similar reexamination of old issues as well as opening new avenues of inquiry. New categories and rules of evidence will permit attention to aspects of life that have been excluded or largely ignored in the past. New language will permit discourse about heretofore unnameable ideas. New organizing principles will permit a diversity of new forms of structure in human systems. New expectations and constraints will motivate new actions. The new science, of course, will lead to new technologies, which will have their own impact.

It is not possible to say precisely how long these forces will take to make concrete the intellectual transformation already in progress. It will certainly be less than the several centuries of the Enlightenment. For one thing, we are not at the beginning of the revolution, but probably somewhere closer to the midpoint, where the effects of the formal disciplines on the common understanding are likely to be rapid and extensive. The process is also facilitated by a worldwide communication and information revolution, the high levels of education in contemporary advanced societies, and the motive to change born of the dissatisfactions and problems of our era. It is, perhaps, indicative that less than three decades elapsed from the end of World War II, when colonialism stopped being an acceptable idea, to the death of centuries-old colonial empires. Furthermore, ours is a time that is becoming accustomed to rapid change. These arguments suggest that this intellectual revolution will have its profound and multifold impacts on society far more rapidly than many people might expect.

The Individual

At the level of the individual, this shifting pattern may have a number of effects, which can occur through several mechanisms. To those people for whom personal change is already a part of life, the emergent pattern will provide new maps, models, metaphors, and qualities. Another mechanism is the educational system, which has an implicit image of the goals of individual development. It can be expected that the definition of the desirable qualities to be developed through education will be enriched. As people change, they, in turn, may become models for others. Finally, as belief systems shift on the basis of the emergent pattern, we can expect still more pervasive changes to occur.

The qualities of knowing, we have suggested, include the need for perspective, a quality of receptivity and engagement, and a recognition of the partiality of knowledge. Knowing in the current paradigm, which holds that we are dealing with an objective world being understood through a neutral instrumentality, requires no knowledge of self. In the emergent pattern, knowing anything at all about the world does require knowledge of self. That is, knowing requires:

- An identification of the multiple loci of our perspective, i.e., the psychological locations from which we view and interpret the world.
- An understanding of the process by which we participate in the world — i.e., how we affect others and the world around us — which facilitates the qualities of receptivity and engagement.
- A definition of the boundaries of our partial knowledge, i.e., not overextending the reasonable application of any set of understandings.

Some contemporary psychotherapeutic modes, such as psychosynthesis, use a model that can be helpful. The idea is that we behave as if we were composed of a set of subpersonalities. Each subpersonality has some particular identifiable characteristics, which come to dominate our behavior in a particular situation; i.e., we behave as if we were only this subpersonality. The reader will undoubtedly recognize the feeling of being aware that you are behaving in some way that you don't like. The self controlling the behavior is the subpersonality, while the self that is watching is a much larger self encompassing that particular subpersonality. The process of withdrawing control from that subpersonality to the larger, more complex self is the process of disidentification, i.e., no longer identifying with the narrow interests of the subpersonality.

The process of self-knowledge involved with the emergent paradigm is akin to this model. It entails, first, the recognition of the many dimensions of the self; rather than the simple hierarchical model of a supreme self, we see a larger, more complex community of selves. There is, for example, the instance of the scientist who, by his or her ability to strip away the filters of bias, can uncover a remarkable new insight. However, that same scientist, because of his or her security needs, might behave with an almost unbelievable degree of bias when faced with the contradictory results of a colleague. In one instance, it is the "scientist" subpersonality that is dominant, while in the other it may be the "hurt little child." The psychological process in the individual that corresponds to the knowledge process is disidentification — being both the scientist and the larger, more complex community; denying neither and accepting both. In terms of the VALS typology, this can be seen as movement toward the Integrated stage.

Such a model of the psyche requires that we confront anew the problem of ethical judgments. How can we deal with good and evil? By acknowledging the multiple selves, have we slipped into an ethical abyss? Erich Neumann, in his remarkable little book *Depth Psychology and a New Ethic*, deals with this question most eloquently:

> In the new ethical situation, ego-consciousness becomes the locus of responsibility for a psychological League of Nations, to which various groups of states belong, primitive and prehuman as well as differentiated and modern, and in which atheistic and religious, instinctive and spiritual, destructive and constructive elements are represented in varying degrees and coexist with each other.
>
> All these groups of forces must be taken into consideration, since here, as in the collective life of nations, suppression or repression leads to hostile reactions

which disturb the life of the whole community and keep it in a state of continual unrest.

The principal requirement of the new ethic is not that the individual should be "good," but that he should be psychologically autonomous — that is to say, healthy and productive, and yet at the same time not psychologically infectious. And the autonomy of the ethical personality means essentially that the assimilation and use of the negative forces to be found in every psychic system takes place as far as possible consciously, within the process of self-realization. In fact, the central happening in the process of individuation is precisely the way in which the ego takes part in this transformation of the personality, by acting, suffering, shaping and being overwhelmed at the same time. Under the old ethic, it was a frequent, if not a regular, occurrence that a strong "ethical" personality did not live out his own negative drives, but projected them forcibly on to the weak spots in the environment, so that the negative suppressed and repressed contents had to work themselves out by compensation in his immediate surroundings (the family or the collective), without the "repressor" personality having the slightest notion of his moral responsibility for these phenomena.

This leads us, then, to another emergent attribute of individuals. The psychological model we are describing here is heterarchical and decentralized. As noted earlier, complex systems that have these properties tend to change morphogenetically. Such a change process will tend to produce more diverse personality types among individuals and less predictability within any one individual. The diversity will come from the complex interplay of the various dimensions of self, reaching some new accommodation among them, rather than repression to conform to a limited set of socially defined norms. Perhaps the complexity of the VALS typology, with its peak in the Integrated level is, in part, a manifestation of this process already at work at the unconscious level.

That same reduction or repression will also decrease individual predictability. As among the community of nations, there is a continuing process of negotiation among the various "selves," leading to new conditions. To be sure, the first expressions of this multiplicity in an individual are likely to be infantile and trivial; but most individuals do mature, having worked through their childish fantasies. One can expect that, as a result, people will undergo more frequent and more divergent changes in the major aspects of their lives (e.g., careers, lifestyles). Further, this diversity and unpredictability may tend to produce obvious inconsistencies in people's lives — for example, living conventionally in most respects, but very unconventionally in some particular aspect. Cultivating that limited eccentricity may become the norm.

There are two second-order consequences of these behavioral changes. First, interpersonal communication may become more difficult. Though presumably the qualities of reflection will enhance people's ability to communicate, the gulf between individuals may tend to widen. If we become more diverse, sharing our experience of the world will take greater effort, as today it takes considerable effort for an American and a Japanese to truly communicate.

A second consequence has been suggested by Jon McIntire. In this increasingly ambiguous social milieu, we are likely to see an increasing reliance on formality in manners and style, which becomes a shortcut way to communicate complex ideas. Perhaps an analogy can be drawn to medieval Japan. In that society, a very rich and complex inner life was not masked but was communicated by a set of highly stylized gestures, rituals, dress, and language. The ideal was to say a great deal with a minimum of effort.

The new physics leads us less directly to further consequences for the individual. The consequences of the new physics are indirect, not only because the findings of the physicists are far away from our everyday concerns; more profoundly, the new physics challenges our commonsense concepts of consequence and individuality. So when we ask how the new physics has consequences for the individual, the new physics answers with findings that challenge the very terms of the question.

Of course, a person is not an atom, and the causal efficacy of one person's shoving another will not be altered in the least by even the most fundamental revolution in the physics of microparticles. But the

way we think about causality and individuality — the paradigmatic models we employ in our imaginative reconstructions of the order of things — are heavily influenced by the physics of the last four centuries. And as we think, so do we act.

We stress these caveats against inferring simple causal consequences of the new physics because, following the old paradigm, we might be inclined to regard physics as providing the most basic causal account of everything. According to Bacon and Descartes, the best method of understanding anything is to analyze it into its smallest parts, understand their behaviors, then reconstruct the behavior of the whole as a sum of the behaviors of its atomic elements. The assumptions guiding the practice of Baconian science also served a metaphysical role, guaranteeing to physics the role of ultimate arbiter of reality. The new physics challenges precisely the analytic, atomistic approach at the heart of the Baconian method. It therefore challenges the very assumption that would take the smallest atomic elements as the most basic constituents of our explanations. The new physics abdicates the metaphysical throne occupied by the old physics. By vindicating holism over atomism, the new physics suggests that the theory of atoms — physics itself — can no longer serve as the theory of ultimate reality.

Metaphysicians and theologians of every school will undoubtedly find much to ponder and debate in the new physics. That debate and its secular repercussions will almost certainly have a profound effect on the spiritual life of humankind. If alienation was the consequence of perceiving the universe as a machine, perhaps comfort will be the result of perceiving the universe as a vast network, like a living organism of which we are a part, there being in each of us an impression of that boundless whole, which in turn bears the mark of our singular existence.

Society

The diversity suggested at the individual level will be mirrored at a social level. The past several decades have been a time of rapid homogenization in this country. Regional, cultural, and economic differences have diminished as economic prosperity has made us a middle-class and upper-middle-class society. (There are many exceptions, of course; we are not a fully homogeneous society). As people begin to discover their own internal sources of differentiation, old and new differences are likely to arise in their relationships to others. This will only add to the ethnic, cultural, and gender identification that has begun to grow in recent years. At its extremes this process of differentiation may produce more cults of the sort we have seen arise recently. In the vast middle, however, it is more likely to take the form of some conscious association with others in a way that distinguishes the group from the perceived historic norm. Various forums for this behavior could include religion, interest groups, unusual adventures, and so on. All express the same underlying desire to reinforce the self-image of uniqueness.

The current revolution in architecture is indicative of this movement toward diversity and expression of human qualities. The skylines of American cities for the last several decades have been the result of a particular design philosophy. It emphasized a rigid set of ideals best captured by the simple lines of the vertical boxes of Mies van der Rohe. The new design turns away from rigid ideals altogether, but not toward the extreme of eclecticism without principle. Rather, it attempts to draw from a wide reservoir of design tools, including our past, existing designs, new materials and construction methods, and ideal visions of human possibility. *Newsweek* writer Douglas Davis put it this way recently: "The modernist masters believed they were building an entirely new society — clean, rational, efficient. Now for the first time in decades, the architect is allowing himself to play a more limited — a more human role."

That diversity which can be a positive force in design may have its negative consequences as well. Perhaps the least significant, but annoying nevertheless, will be the conflicts that arise as neighborhoods and communities that have come to expect a bland kind of homogeneity in design are assaulted by this new diversity. More important will be the conflicts that arise out of the new diversity itself, and the conflict of the new order with the old. That conflict arises not merely because of differing interests, but out of a different view of reality itself. The kinds of social troubles

associated with the lifestyle differences of the 1960s are perhaps indicative of the difficulties of coping with this kind of conflict. The entire fabric of a person's existence is sometimes at stake; hence the intensity of the struggle. Current issues over homosexual and women's rights are a further indication of this difficulty. To a true believer, homosexuality is evil itself. To many others, it is merely a matter of a choice that is little more value-laden than career preference.

In the long run, the emergent paradigm may produce an enhanced capacity to cope with such conflicts — even to celebrate the diversity that is their basis. In the short run, however, it is far more likely that the forces for conflict will be more powerful. We can expect at least the next couple of decades to be a time of social turbulence and confusion, although to be sure, there will be periods of relative calm. The major social institutions, such as the family, are already undergoing profound change; and in the face of this newly emergent force, there is every reason to believe that the foundations of our social existence will be rocked still further. It would not be surprising to see many people retreating to smaller life worlds — people trying to carve out tolerable spaces in what must seem an increasingly alien, complex, and confusing social system. An aspect of the movement toward voluntary simplicity can be seen as consistent with this phenomenon.

On a more positive note, one can see increasing acknowledgment of the partiality of knowledge and the need for engagement. Professionalism is founded on the notion that the professional stands at the top of his field, master of all he surveys. Yet in our complex world the professional comes to cover a shrinking domain as the need for specialization grows. Further, the more senior and hence theoretically more adept he gets, the less engaged with the practice of his discipline he usually is. The medical fund-raiser rarely sees a patient; the college president has no time to teach. As a result, we see the rise of the paraprofessional, first in medicine, then in law, and now spreading to other areas. The movement toward paraprofessionals seems consistent with the emergent view. *Para* connotes in its original form both "beside" and "against." Thus, this movement can be seen as working with the existing system to use the strength of its expertise, as well as being posed against the excess of a rigidly hierarchical system.

Politics

The political implications of this revolution are a public mirror of the individual and social transformations. Politics is the tool we have created to mediate the relationships among people. As was noted in the political theory section, the basic change in the nature of politics has been a move from authority derived from natural or transcendent order to legitimacy granted by voluntary association.

The "system" of giant public and private institutions has largely replaced the hierarchy based on natural order. The institutions are treated as legitimate because they are there; and part of their contemporary function is to survive, even though their original functions have become obsolete. Both recent tax revolts and the huge liability awards against corporations can be seen as reassertions of the legitimating power of free citizens. If our suggestions about personal and social plurality and decentralization have any merit, then we can expect this emergent political force to grow. The division here is not between the traditional right and left but between those of either the right or left who would use centralized institutions, private or public, to carry out their social, economic, technological, or political goals and those who would withdraw as much authority as possible from those same institutions. To some extent this division is a characteristic of the two elites discussed in an earlier VALS report.

The scale of today's institutions tends to work toward national homogeneity. The same solution to a social problem is implemented in urban Boston and rural Arizona despite the geographic and historic differences between the two areas; supermarkets all over the country display almost identical arrays of products. One possible explanation for today's political climate is that people are trying to push back the boundaries of the "big system" that has encroached on their lives from every direction. As the forces of personal and social differentiation grow, they can be expected to add strength to the movement already evident. In its early stages this is likely to take the

form of a kind of simplistic localism and cynicism toward the political system. In the end a new balance will be struck. How long that will take is unclear.

Several aspects of the emergent paradigm may contribute toward accelerating that new balance. As the already growing awareness of our interconnectedness and hence interdependence increases, we can expect two parallel developments. One will focus on the need to span arbitrary boundaries to solve critical problems. The development of regional special districts for environment, sewage, water, and transportation is an example. The second is an internalizing into decisions of those aspects that have long been considered externals and hence ignored. Recent moves to constrain industrial pollution are examples of this process. Learning to both recognize and comprehend the multiplicity of perspectives, rather than merely interests involved in most major decisions, may aid us in reaching speedy and equitable decisions. Until these compensating forces become significant, however, we are likely to see paralysis and division in the political system increase for some time to come. That paralysis can only contribute to a further erosion of legitimacy and to greater cynicism as the political system remains ineffective in solving the many problems of our society. The central institutions of power, whether U.S. or corporate presidents, have already had their real power greatly diminished by the complexity of the system. Now, almost as a matter of faith, when people withdraw their support, the balance of power can be expected to shift again toward the individual.

Science and Technology

Until very recently, the most remarkable achievements of science and technology were big and bigger: tall buildings, awesome bridges, bigger planes, giant tankers, and a vast system of interstate highways. Yet a recent SRI report indicates that large-scale technological projects (LSTPs) are becoming increasingly difficult to launch. This is no accident. Like the dinosaurs, LSTPs are suffering from an evolutionary alteration in the ecology of modern society. Their sheer size seems to be less an asset than a liability in our changing environment, in which we see a shift toward small but smart in place of big and dumb.

Miniaturization in the computer industry is both an example of and a stimulant toward decentralization in science and technology. Advances in microcircuitry let "smart terminals" take over more of the tasks that used to be performed by centralized management information systems. The new Distributed Systems approach to information processing permits other industries to move from a model of hierarchically centralized command toward heterarchical communication. That movement facilitates a further proliferation and development of new (and old) technologies. In different geographical locations and in fields as various as mining and education, the resources of a single corporation can support the in-place development of technologies adapted to unique conditions. As we face limitations on our natural resources, it makes sense to forego the sometimes wasteful imposition of uniform procedures in favor of support for indigenous technological resourcefulness.

Information processing provides the most dramatic example of miniaturization leading to decentralization, but the computing revolution is not an isolated case. Other scientific advances have generated technologies that reflect a trend toward smaller rather than bigger as an index of progress. For example, scientific research led to new methods of steel production that no longer require giant Bessemer converters for maximum efficiency.

Within science itself the new paradigm finds support in the form of a new sense about the nature of scientific research and discovery. Whereas the old paradigm stressed a continuous approach toward objective truths quite independent of the human mind, the new paradigm reflects a reciprocal involvement between the knower and the known, the importance of the knower's perspective, and consequently a likelihood of sharp discontinuities between scientific truths. The scope of this change is suggested in the title of Thomas Kuhn's influential book *The Structure of Scientific Revolutions*. This new sense about the nature of scientific progress amounts to a Reformation in what had been the Holy Scientific Empire. One recent philosopher of science goes so far as to suggest

anarchy as the most fruitful guide for scientific research. Try anything, says Paul Feyerabend in his book *Against Method*. The concept of paradigm shifts opens up the possibility of an almost limitless proliferation of research programs based on widely differing assumptions.

Scientific research, of course, takes money. A limited economy will no more support just any hare-brained proposal than a limited ecology will support just any mutant species. So the matter of human choice becomes all the more important. If the new paradigm of knowing challenges the simple assumption of a clear dichotomy between the subjective and the objective, then the old ideal of disinterested science comes into question. All knowledge is ultimately interested knowledge, however much we may agree to condemn the individual researcher who fudges his results in the interests of making his experiment come out right. The interests of humanity in general are at stake in what is to count as "objective" knowledge. Likewise, the interests of humanity in general are at stake in contesting a "technological imperative" that says, "If it *can* be done, *do* it!" In place of disinterested science and the old technological imperative, the new paradigm suggests a science as if people really mattered, and an increasing preoccupation with appropriate technology.

Many of the trends mentioned so far are dramatically evident in the realm of health care. In place of the top-down, doctor-to-patient, expert-to-object manner of current medicine, the new direction emphasizes the active role of the patient in prevention and healing. New and widely differing modalities of response to illness need not all be quackery. To the contrary, even some of the experts are beginning to acknowledge that the guiding assumptions behind millions of dollars of cancer research may have been mistaken, namely, the old paradigm assumption of a single cause that might be conquered with the discovery of a single miracle drug. This "magic bullet" approach to the cure of cancer may give way to a holistic health model involving the recognition of a multiplicity of causal conditions from nutrition and air quality to character types and levels of stress. At this point, of course, no one knows. For our purposes it is enough to note that no one knows, and that the assumptions guiding the research at the edges of our ignorance are themselves changing.

Business

As individuals, society, government, science, and technology adapt to the emergent world view, the impacts on business are likely to be extensive and profound. It is the thesis of this report that the intellectual revolution we are in the midst of is one of the most potent current forces for shaping the future societal and business environment. We can speculate here on the character of the impact of that force on business. It is likely, however, that we will not foresee even some of the most significant of those impacts. Taking to heart the concept of mutual causality, many of the impacts will be a result of the response of business to these emergent qualities. Obviously, there will be many surprising and unpredictable aspects to that response.

Management

The changing picture of causality may have one of the most interesting impacts on corporate life. The executive at every level is the basic model for corporate life. In the model of the executive there is an implied command and control hierarchy. That control is the exercise of hypothetical power, both inside and outside the corporation. Yet if one were to ask senior executives whether they feel powerful, most would probably reply "no." More and more a complex of constraints restrains the dimensions of their control. If power is the ability to carry out intention, i.e., having your intentions realized, then power is an increasingly elusive phenomenon. Perhaps we might do better to speak of impacts. A decision may indeed produce quite noticeable results, but these often have little to do with what was intended. Rather than control or power, it may be more useful in the emergent context to focus on the concept of influence. Influence connotes a multiplicity of causes for any desired effect. The successful executive may be the one who has the sensitivity to identify that multiplicity of forces, and then, like the adept at aikido, helps guide those forces into a more desirable outcome. The old paradigm focuses on suppressing or resisting those forces to accomplish the aim of control. In a simpler

world, that may have been possible. Now, influencing the results through skill and sensitivity will be the hallmark of success. The process is much more like facilitation than command.

As the process and structure of management have become more sophisticated and complex, one of the key developments has been the growing reliance on equally complex information systems as an aid to management. These information systems, whether they report on the external world (e.g., market surveys) or the internal workings of the company (e.g., inventory control), all serve an objectifying function. In the theoretical ideal, that information is transformed by the methods of management science into action decisions. The unique role of the manager begins to diminish. It is still true that the real success in corporate life comes not from narrow adherence to prescribed procedure, but from a variety of other, more traditional skills. Indicative of the current direction of management, however, senior management is increasingly coming from the ranks of accountants and lawyers.

Many of today's businesses were founded by entrepreneurs. Part of their genius was a way of knowing the world that was consistent with the emergent paradigm of knowledge. Most of all, they were so engaged with the world that they had the capacity to sense a potential opportunity, yet had the perspective to be able to exploit the opportunity. The history of professionalization of management has been an attempt to transfer to the organization the necessary qualities of the genius entrepreneur. In times of smooth growth and a stable environment, professional managers may have been successful. If, however, the years ahead are as turbulent as appears likely, then perhaps the challenge will be to shift the entrepreneurial qualities back to the individuals rather than to the system. This is no small challenge, because it appears that large organizations tend to punish just the sort of deviance (and often early failure) that makes an entrepreneur.

One of the critical functions of management is planning. In the old management paradigm, planning required prediction and control: predicting future conditions and objectives and controlling the organization's behavior so as to realize those objectives. Having already abandoned control in favor of influence, what of prediction? Donald Michael, in his book *On Learning to Plan and Planning to Learn*, suggests that planning ought to be conceived of as learning, which in his terms means "error embracing." Michael (along with Phillip H. Murvis) suggests that

> the *competent* person is one who designs his or her activities to provide the *maximum amount of feedback* about what is happening in order to detect and respond to errors. Competence, then, is measured not by skill in avoiding errors but by skill in detecting them and in acting on that information openly so that all can continue to learn about where they are and where they might go — about what kind of world we have created for ourselves and what we might do toward recreating it. (p. 317)

Specifically, "error embracing" means an openness to a multiplicity of interpretations and theories, as in the emergent paradigm. Furthermore, a good manager is one who facilitates error embracing in others and in the structure of the organization.

We are suggesting that the qualities of management consistent with the new paradigm involve three major shifts: from control to influence, from prediction to ambiguity, and from scientific management to entrepreneurship. Influence entails the delicate orchestration of a community of forces to produce action. Planning as learning requires a tolerance for error and multiple interpretations. Entrepreneurship requires engagement with the world of the supplier, the customer, the politician, the production floor, and so. An appropriate metaphor is the steersman floating downriver on a raft. In the smooth water, there are opportunities for real control and the steersman can stand tall and survey the situation. In the rapids, the degree of control is diminished — the white water will not be resisted. The task of the steersman then is to be in touch with the water to sense its sudden twists. If we are in the rapids, then a new kind of executive is needed.

Personnel

The diversity that is likely to affect society and politics is also likely to be reflected in the structure of the work force. The difficulties of integrating minorities

and women are indicative of the problem. There will certainly be a heightened need to focus on interpersonal relationships and improving communication. Without that, diversity will almost certainly result in conflict. Again, it is worth noting that the gap to be bridged here is not one of slight attitudinal differences, but often of differing perceptions of reality itself. For example, in a conflict situation, because of differing world views people will often pay attention to quite different elements. Hence, they may draw radically different pictures of the situation. A more complete picture can be found in the diversity of the two, rather than in the supremacy of the "right" one over the "wrong" one.

Incentive structures will need to reflect this emergent diversity. More money and a limited set of benefits have long been a nearly universal set of incentives. However, in a diverse work force, some people will want to trade time for money; some will accept high risk for high rewards; others will want security above all else; still others will want interesting people to work with and opportunities for learning or personal growth. At best, the situation will be confusing and will require flexibility and inventiveness on the part of management.

If our morphogenetic model of change is valid, simple career ladders may be less desirable to many workers. They are likely to undergo rather sudden changes of career directions surprising even to themselves. As people permit the internally diverse psyche to evolve, different drives and interests are likely to become dominant at different times in their lives. Such shifts may be as minor as moving from biology to chemistry on the part of a scientist. More often, they will be shifts of the magnitude of movement from a professional, technical, or managerial specialty to something radically different, such as managing a hardware store or becoming a carpenter. This behavior is not the same as that of the person who has been frustrated in a particular career and has long harbored a secret desire to do something else. Often it will be the person who has enjoyed success in a career who will change, because the aspects of psyche motivating that career may have played themselves out.

Markets

Probably the major impact implied by the shifting paradigm is a movement toward market differentiation and volatility. Fewer markets will be susceptible to mass appeals. Indeed, just such a mass appeal is most likely to drive away the narrow market segments. Further, these consumers are less likely to display the kind of product loyalty that has been an important factor in the past.

It is important to point out that there is a danger of exaggerating this phenomenon: mass markets are not a thing of the past. This paradigm shift is likely to become manifest last in those consumers who are most susceptible to mass appeals. However, the shift is likely to be visible sooner in those smaller markets that set the fashions and trends that form the basis of mass markets. Thus, for quite different reasons, marketing strategy must be sensitive to this deeper dimension of change, no matter which segments are sought.

Products

The product implications of new science and technology are multifold; far more detailed analysis would be required to spell them out. Instead, we will focus on several needs that are already evident and are being responded to in a manner consistent with the new paradigm. These will provide examples of the product opportunities associated with the new paradigm.

One of the central features of our time is the growing feeling people have that they exert vanishingly small degrees of control over their own lives. We have already noted the overwhelming role that a massively complex and expertise-oriented health care system plays. We can add to that the role that media such as television play in delivering a selective, predigested picture of the world to a mass audience. In both instances there are opposing commercial ventures under way, the primary appeal of which is resistance against the homogenizing, individual-diminishing forces of the existing system. One of these we have already mentioned — the holistic health care move-

ment. Giving the rising dissatisfaction with the costs and effectiveness of the health care industry, there would already be strong support for a movement away from industrialized health care. The new paradigm provides both a deep motive toward selfhood, leading toward self-care, and a many-dimensional conception of self that permits complementary roles for mind, body, and spirit. Health care that facilitates the self and acknowledges that disease is often much more than a collection of biological malfunctions represents both a historic redirection and an important opportunity.

A second emerging area is personalized information systems. This includes such diverse products as the hardware of calculators and home computers and the software of specialty journals and newsletters. As the complexity of the world increases, comprehending it becomes more difficult. One of the few assurances of validity will be availing oneself of a catholicity of perspectives. Active participation in an information net of multiple media may begin to challenge the passive receptor quality of television and such mass journals as *Time* and *Newsweek*. One company, for example, is already marketing a computer teleconferencing service. Sophisticated information systems tailored to the individual and small business are likely to be growing markets as people try to perceive the world as a holographic net rather than accepting the one-dimensional version of reality presented by the mass media.

Regulation and Public Attitudes

One of today's favorite business myths is that, as the public comes to understand the costs of regulation, somehow those regulations will, for the most part, vanish. There is nothing to support that myth. However, support can be found in the emergent paradigm for a shift in the nature of regulations. This arises because of two changes in the public view of business.

The existing regulatory strategy is based on the notion that businesses are powerful, independent entities motivated almost entirely by the self-interest of their owners. Regulation is the means by which the rest of the system constrains the abuses of that independent power. A more sophisticated view will be based on the interconnectedness and mutually causal nature of complex systems. As has been observed in politics, "we get the leaders we deserve," so it may be that we get the business system we deserve. Such a view would hold that companies both shape and are shaped by their environment. To get the business system we want may require more subtle means than the direct regulatory assault on institutions whose real power may be less than imagined.

This same view, however, may also extend the domain of the regulation. As interconnectedness becomes more apparent, the role of the business system in structuring society may also become more evident. Areas that are likely to be questioned are some familiar ones such as scale of business, competitiveness, and so on, and some new areas such as the allocation of capital, location decisions, constraints on private innovations, compensation structures, and others. The means by which such issues are confronted may be more in the direction of incentives and disincentives than a regulation *per se*.

Goals

There is an image of corporate goals which holds that corporations have an unwavering devotion to the twin gods of growth and profit. Although there is some truth to that image, it also contains a pernicious myth. In fact, corporations pursue multiple goals in addition to growth and profit, including survival, innovation, maintaining a reputation, opportunities for employees, and so on. However, these other goals are usually justified in the name of growth and profit.

As reflection and self-awareness on the part of individuals is associated with the new paradigm, similarly, reflection on purposes and balancing among a community of goals is the direction of corporate change. Thus, it is likely that profit and growth will migrate from the top of a hierarchy of goals into a more complex relationship of a heterarchical sort: two goals among others in a mutually reinforcing system.

A Final Note on Implications

In the consideration of implications, it is easy to fall into the trap of thinking in the old paradigm to describe the nature and consequences of the emergent perspective. In this sense, the style of this report is much more consistent with the old view than the new. We have presented objective data in a variety of disciplines that range from "hard" to "soft." We have, on the basis of that data, deduced a pattern with discernible characteristics. Finally, in a step-by-step linear fashion, we have applied those characteristics to a number of areas of interest. Such an approach is comfortable, relatively undemanding, and probably appropriate to a first attempt at depicting the overall process. It may be instructive, however, to imagine for a moment how this enterprise might be approached in the way of the new paradigm.

To comprehend the evidence of a shift, we would consciously probe each of the disciplines ourselves, testing them not only intellectually but far more rigorously against the metric of our own experience of the world. We would not be very concerned with any apparent sequence of the disciplines; we would apprehend the pattern in the complex interplay of the diverse themes of the various disciplines. Finally, we would study the change that results from introducing a new contextual force into a complex interactive system. That change would be expected to arise through the morphogenetic evolution of elements of the system mutually affecting each other.

It is always difficult to imagine the kind of change this report describes. The implication of this difficulty is that we will almost inevitably fail to see important consequences. The shift may occur in surprising ways, far more rapidly (or slowly) than we imagine, and with unanticipated consequences far more significant than any we have foreseen.

PART II

The Paradigm Shift in Depth: Process, Support, and Pattern

WHAT IS A PARADIGM?

The Definition

A paradigm is, broadly construed, the set of those beliefs, axioms, assumptions, givens, or fundamentals that order and provide coherence to our picture of what is and how it works. These beliefs are like our map of reality. They are not the reality itself, but the directions we use to find our way across the terrain.

Most of this report is devoted to assembling the evidence for and implications of the emergence of a new paradigm in Western civilization. The present discussion summarizes two centuries of intellectual history that have led up to the concepts of paradigm and paradigm shift.

During the past decade the term *paradigm* has been bandied about in a number of disciplines. When used in the phrase *paradigm shift*, it often carries a reference to Thomas Kuhn's influential book *The Structure of Scientific Revolutions* (1962). Kuhn revolutionized our common understanding of scientific progress by pointing out an important distinction between what he called *normal* science, which grows by gradual additions to our fund of knowledge, and *revolutionary* science, marked by discontinuous breakthroughs that seem to demand a whole new perspective on, or map of, the data. Normal science depends on the shared acceptance of a given paradigm among a community of scientists; revolutionary science requires a shift of paradigms.

Kuhn's use of *paradigm* is, as he later acknowledged, ambiguous. On the one hand, the word means "exemplary experiment," or a set of procedures that every member of the scientific community learns to accept as definitive of scientific method. On the other hand, *paradigm* has a much broader use associated with one's entire belief system or map of reality: the lenses, as it were, through which one sees everything. Thus, a paradigm shift may mean either an alteration in the set of exemplary experiments defining the education of a scientist, or it may mean an alteration in the shared consciousness of a culture — or both. Clearly, the two meanings are not unrelated, for a given set of exemplary experiments contributes to our general sense and understanding of the orderliness of the universe. And, depending on our general belief system, we may accept the lever or the voodoo doll as the proper experimental mechanism for understanding causal efficacy.

Though Kuhn has given remarkable currency to the concept of a paradigm, the basic insights have been around since the German philosopher Immanuel Kant. Kuhn's essay came as a surprise to the Anglo-American tradition only because the paradigm of discontinuous paradigm shifts was part of a European tradition that, though two centuries old, was largely unfamiliar to English-speaking scientists. To put the point as paradoxically as paradigm shifts sometimes demand, a paradigm shift was necessary before these scientists could understand the concept of a paradigm or a paradigm shift. The paradox is created by the fact that the old Anglo-American paradigm of empiricism amounts to the view that there are no such things as paradigms; the only things of interest are "the facts." The empiricist has a tacit theory of consciousness: that mind is a mirror of the world and knowledge is an undistorted representation or picturing of things as they really are. Recent advances in a number of different disciplines, however, have presented anomalies or problems apparently insoluble within the old paradigm. With the passing of the empiricist paradigm of the mind as a passive medium, more and more scientists have begun to take seriously what some continental philosophers have known all along: namely, *how* we see things determines much of *what* we see.

Kant was the first to argue the importance of our subjective modes of seeing and understanding our experience. Where previous philosophers had seen the mind as a blank tablet receiving impressions from the outside world, Kant described consciousness as an active ordering of otherwise chaotic impressions. The order we experience is not "the order of the world" passively received as through a transparent pane of glass; instead, the order we experience is very much a function of an activity of ordering performed by the mind. To the extent that we experience the *same* order from our individual perspectives, we are inclined to think of that order as the world's order. According to Kant, however, we experience the same order because all rational creatures order experience using the same intrinsic categories — i.e., according to a shared paradigm.

Hegel, another German philosopher, was the first to appreciate the fundamentally different paradigms manifested in the history of consciousness. His account of a dialectical movement through different world views was a profound statement of the concept of paradigm shifts. Marx and his followers took up the dialectical interpretation of paradigm shifts, but rejected Hegel's characterization of the dominant paradigm as Spirit or spirit-of-the-times (*Zeitgeist*). The Marxist materialist interpretation of history placed more emphasis on economics than on intellectual history.

Early in the twentieth century, thinkers from several disciplines spawned a new area of inquiry now known as the sociology of knowledge. This relatively new discipline might be characterized as the study of the evolution and propagation of ideas and ideologies: Why do some ideas take hold in their disciplines and some fail independent of whether they are judged to be right? In this approach ideas are studied not in terms of their rightness in a scientific sense, but in terms of their influence. Sociologists of knowledge study the politics of intellectual movements, from the history of science to the history of utopian movements: What sorts of social conditions spawn the beliefs found in millenial cults? What kind of world view renders individuals most susceptible to authoritarian movements? In each case, the focus of interest is the ability of a given paradigm to mold the thoughts, perceptions, and opinions of those who share it.

More recently, the sociology of knowledge has proliferated into disciplines like Ethnomethodology — a quasi-anthropological study of the way contemporary ethnic groups manifest fundamentally different paradigms — and Frame Analysis — the study of the behavioral cues we give that instruct others on which paradigm is appropriate for interpreting our actions. General systems theory and continuing work on artificial intelligence have contributed to an awareness of subtleties that communicate mind sets such as "this is a joke," "this is serious." Just as "once upon a time" puts us into a fictional frame, so a dog's baring of fangs may mark a shift of frame from play to fight. We accomplish these mini-paradigm shifts so unconsciously that we become aware of them only when they are missed by someone, as in madness, or humor, or when a TV studio receives bottles of aspirin in the mail because the soap opera's plot calls for the heroine to have "headaches."

When Lavoisier discovered oxygen, he radically revised our understanding of phenomena as seemingly disparate as breathing, combustion, and rusting (oxidation). Prior to Lavoisier's discovery, some of those phenomena were described in terms of the addition or subtraction of a hypothetical substance called phlogiston. Though Lavoisier's discoveries required a wholesale replacement of phlogiston chemistry, many of his colleagues were as confused about the significance of his discoveries as were the sympathetic fans about the proper significance of the heroine's headaches. Lavoisier's colleagues admired his diligence in discovering this new substance called oxygen, but ultimately rejected his accounts of the different phenomena of oxidation because he had failed to tell them what was happening to the phlogiston while all these transfers of oxygen were taking place. Like the sympathetic fans, they didn't quite get the point; they received the relevant information but placed it in the wrong frame.

Sensitivity to the role of paradigms in our perception can be an important tool in problem solving. Once we know that all our problems cannot be solved within the frame of a current paradigm, then it is sometimes possible to solve a problem by reframing its terms. One thinks of the French sergeant who was ordered by his commanding officer to clear the rabble from a crowded square, and to shoot if necessary. His problem: apparently either shoot "the rabble" or disobey orders. He solved this apparently insoluble dilemma by reframing the terms of the problem. "Mesdames et Monsieurs," he addressed the crowd, "I have been instructed to fire upon the rabble, but since I see many law-abiding citizens in front of me, I would ask that you leave the square so that my men can fire upon the rabble without injuring any innocent bystanders."

Other terms that have been used for the general concept of a paradigm include, as noted earlier, *Zeitgeist*, *world view*, *pattern of culture*, and *epistemes*. This last concept is especially interesting. Michel Foucault, a contemporary French philosopher of his-

tory, coined the term to mean epistemic domains. In this case, the term refers mainly to the structures embedded in the language within which the human sciences (e.g., sociology, anthropology) are expressed. Language, according to Foucault, unlike the mathematics of physics,* is itself not neutral. It is a mirror of the contemporary consciousness and so conditions, links, and shapes the study of human affairs.

Whether it is called a paradigm or a world view or something else, there is a widely held conviction that behind the seeming chaos and conflict in intellectual life there is a pattern, even if temporary. Although understanding of it evolves and shifts with time, that pattern, like a map, is central to understanding how change takes place in a society, especially when there are rapid and deep changes in progress. As we explore the terrain more carefully, our maps inevitably change. What appeared to be an island becomes a peninsula attached to a continent. As our interests change and our abilities to map increase, the nature of our maps changes, becoming richer and more complex. Instead of the solid earth beneath our feet, we find floating plates colliding with earth-rending and mountain-building force.

Paradigms, Reality, and Truth

It is possible to talk about paradigm shifts without facing certain implications. Some talk, for instance, as if it were only a question of a new *method* for approaching closer to the truth. It is as if Kuhn's distinction between normal science and revolutionary science — between the continuous and the discontinuous — were a merely methodological distinction. But the implications of Kuhn's thesis are much more radical. The point is not only that we make breakthroughs in the representation of reality, but that there are fundamental alterations in what counts as reality. So it will not do to think of merely methodological differences between cumulative continuity and revolutionary discontinuity "on the way toward reality," for the destination itself — even the idea of a singular destination — is in question.

Once we have several times altered the criteria for what counts as reality, the old connotations of the term *reality* must fall away. We can no longer think of reality as something that remains what it is no matter what people think about it. A rose by any other name is still a rose, but an atom by another name may not be what people used to think they were naming by atom. We can no longer think of reality as utterly independent of human cognition.

Certainly, the commonsense usage of *reality* retains its sense. Thinking something or stating an opinion does not necessarily make it so. We check our opinions against reality. But the publicly shared reality we use to check our private opinions is not unchanging as we once thought. Instead, the shared paradigms for what counts as reality shift from time to time. Parts of an old reality take on new roles as our perception of reality itself alters. Think of the history of the sun from direct object of worship in sun cults to a slightly less central role in the colorful narratives of Greek mythology; from the chief body in heavens that revolve about the earth to the center of a solar system in which the earth is but one of several satellites. And finally the sun becomes the focus of hopes as a possible source of energy. These changes accompany epochal shifts according to which the ultimate horizon of human experience is experienced first religiously, then scientifically or astronomically, and finally ecologically.

Just as the individual changes an opinion when it does not check with reality, so from time to time entire civilizations change their paradigms for the concept of reality itself. The difference between an individual's altering an opinion and a civilization altering its paradigm is that the civilization can hardly check its paradigm against reality since it is precisely the paradigm that determines what is to be taken as reality.

*Strictly speaking since mathematics has certain human-derived structures embedded within it, it is not a purely neutral medium of expression; i.e., it colors what can be said or computed.

THE SUPPORT FOR A PARADIGM SHIFT

In this section we will explore a number of different disciplines and areas of inquiry into the nature of things. Our approach is to examine the history of ideas and to focus on the frontier developments in each. What we seek are shared patterns of change and common threads of ideas. In some instances there will be clear anomalies that may require a new paradigm for their resolution. In other areas the threads and patterns will be found in the evolution of ideas.

Physics

One of the most basic constructs of human life is what we believe about the nature of physical reality. What is real and what is not? By what mechanisms does reality function? What are its constituents? These questions have occupied physical scientists and metaphysicians for thousands of years. How they answer the questions has a profound effect on human existence. It is one thing to believe that the night sky is a roof overhead strewn with lights slowly spinning by and that your fate unto eternity is in the hands of spiritual forces beyond your mastery. It is quite a different thing to see the same night sky as reaching off into infinite depth punctuated by distant stars around which spin other worlds — and to see in that field of stars a rocket on its way to the moon. One perception of reality leads to a sense of a comfortable but limited world over which you have little control but of which you are the center. The other is a vision of an empty and intrinsically meaningless universe over which we are able to exert a certain mastery through science and technology. What we believe to be possible, especially scientifically and technologically, is very much a function of our view of reality. That view has evolved with time, and our understanding appears to be in the midst of another step forward.

The Current Paradigm

Our current view of the physical world dates mainly from the seventeenth century and the work of Sir Isaac Newton; hence it is usually called the Newtonian world view. Of course, there have been substantial modifications since then, especially the development of thermodynamics in the early nineteenth century. Seen from the present, thermodynamics was the opening wedge in challenging the Newtonian paradigm. In the Newtonian view, the world is composed of two fundamental things: matter and energy existing in the void of absolute space and time. The basic equation of Newtonian physics, $F = ma$,* can be reduced to these fundamental parameters: m, the mass, is the measure of matter; a, the acceleration, is the variation over time of the rate of movement of matter through space; F, the force, is linked to the energy required to accelerate the mass. By understanding the laws that govern these basic quantities, we can understand *all* of the physical universe.

Matter is composed of very small particles (atoms and subatomic particles like electrons and protons), which interact through such forces as gravitation and magnetism. They are assembled into larger and larger collections until we find our ordinary world and ultimately the cosmic scale of planets, stars, and galaxies. The motion of each piece is governed by the predictable interactions of gravitational and electromagnetic forces. In most respects, the current paradigm is captured by the image of billiard balls colliding on a table. Indeed, in most college physics courses atomic interactions are modeled in the laboratory by collisions of macroscopic objects of the billiard ball sort. Thermodynamics, and the concept of entropy in particular, complicate this picture by making most events irreversible, i.e., simply reversing the order of events may not take you back to your original conditions. Nevertheless, it is fair to say that even this amended view can be called mechanistic in that the analogies used to understand the dynamics are simple mechanical metaphors.

This view, of course, led to the supposition that if we knew the location, mass, and velocity of all the particles in the universe at any given instant, we could predict the future by the laws of physics. In turn, this paradigm supported a deterministic metaphysics. In its most extreme form, this view held that since we are composed only of matter and energy, the behavior of which is governed by the known laws of physics, human fate is simply the inevitable result of the

*More accurately, Newton's equation described force as equal to the rate of change of momentum, i.e., $F = dp/dt$.

working out of the trajectories of the particles of which we are composed.

Embedded within the mechanistic view of the world are three basic assumptions. The first is that there is a most fundamental level of reality (i.e., the basic building blocks) composed of the smallest particles and the complete set of forces that govern them. Once we find that fundamental level and the laws that govern it, the world will be predictable. Second is the assumption that the laws that govern matter and energy on the very small scale must be similar, and hopefully identical, to those that apply on the very large scale. The governing laws thus should be universal, so that we ought to be able to build a picture of planets moving about the sun out of an understanding of the particles of which matter is composed. Finally, there is the assumption that we, as observers, can be isolated from the experiments and the world we are studying to produce an "objective" description. All of these basic assumptions are now being challenged by theoretical and experimental findings.

The notion of a fundamental level of reality is being challenged in several ways. The search for the elusive most fundamental particle continues to uncover ever more particles. Rather than a simple billiard ball structure, a far more complex ecology of subatomic structures seems to be emerging in which a single particle observed in different ways transforms into a variety of new particles. The very notion of particle begins to break down, to be replaced by far more complex descriptions of field interactions. This in turn leads to a breakdown of simple models of causality. If billiard balls no longer collide in predictable patterns, then the direct causal linkages are less apparent. There appears to be a complex of mutually interacting causes leading to a particular outcome.

Einstein's theory of relativity was one of the first major steps in the direction of a new paradigm in physics. But after setting out the theory, Einstein spent the rest of his life in an unsuccessful quest for the principles that would unify our description of the very large with that of the very small. The goal was to return to the elegance of a universal model as in the Newtonian paradigm. However, it was Einstein himself who closed the door on universality by bringing in the perspective of the observer. The results of a particular observation are a function of the relative scale and velocity of the observing and observed systems. Space and time, the absolute background of human affairs, lose aspects of their difference to become the space-time continuum, and the "basic building blocks" of matter and energy now become mere reflections of each other in the famous equation $E = mc^2$.

The objectivity of the observer broke down further with Heisenberg's discovery of the Indeterminacy Principle. The central idea was that at the submicroscopic level any act of measurement — even merely looking with light rays — disturbs the thing being studied. More recently, the Russian mathematician Kalmagaroff has shown that, at least in theory, uncertainty applied not only to atomic particles but to the macroscopic domain of ordinary events.

Thus, our old and enduring picture of physical reality is breaking down. We have particles that refuse to behave as simple particles, domains that refuse to be reduced one into the other, and laws that apply on one scale but not another. Most important, we can no longer leave ourselves out of the equations: what we do affects the results.

Such profound rifts in our world view can be resolved in one of two ways. One is the accumulation of small advances that lead to patches in the cracks. Much of physics in the last half-century has been devoted to patching the old paradigm — without much success. A second way is to accept the cracks as indications of fundamental flaws in that world view. This approach implies the need for a radical restructuring of the sort that occurred when we moved from a geocentric to a heliocentric view or from the mechanical universe of Newton to the relativistic universe of Einstein. The current leading edge seems to favor this more radical way.

The New Physics

Our emergent picture of reality is found in the current work of such physicists as David Bohm, David Finkelstein, G. F. Chew, Roger Penrose, and John S.

Bell. They are making more rigorous what was only hinted at by their predecessors such as Bohr, Heisenberg, and even Einstein, each of whom made major contributions to twentieth-century physics and yet remained dissatisfied with the picture of reality that resulted. One foundation of the emergent paradigm is known as Bell's Theorem, after John Bell, its originator. The theorem states, "No theory of reality compatible with quantum theory can require spatially separated events to be independent." In other words, it is a misconception to see the universe as made up of *independent* separate parts. Rather, it must be seen as an interconnected network, an indivisible whole. For many purposes, such as dealing with the world of normal human perception, it is useful to *consider* them as separate, but that does not make them so. Though their interactions on this level are usually immeasurably small, all events are interconnected.

David Bohm makes the distinction between manifest and nonmanifest orders. The manifest order of particles is what we observe under ordinary conditions. The nonmanifest order — the fundamental network of interconnections — is a domain like the interference patterns in a hologram. Holography, conceived mathematically by Dennis Gabor, who won the Nobel Prize for his discovery, is a lensless method of photography that uses the "coherent" light of a laser beam reflecting off the object to be photographed (see box on holograms). The image of reality we are now building toward is in some ways like a hologram. In this view, particles are the result of an underlying structure of interference patterns. Thus, particles are really the visible tip of a very complex, vibrating domain of interference patterns; so that when we observe them in some ways, they appear to be wavelike, while in other forms of observation they display particle-like behavior. Also, every time we interact with particles, including by observing them, we "interfere" in new ways, hence new particles are found. But in the paradigm, particles can no longer be considered mere points of matter; and they are interconnected in Bell's sense in that they have the same origin, the hidden domain of nonmanifest reality that we are now only beginning to explore. Whether we come to call this nonmanifest reality another dimension, another level, or another aspect of reality, it is a discovery new to Western science.

An important aspect of this theory is that not only can the part be found in the entirety, but the entire reality can also be found in the part. David Bohm, who has explicitly adopted this view, puts it this way: "A total order is contained in some implicit sense, in each region of space and time." This enfolding of all of reality into each point he calls the "implicate order," another name for the nonmanifest reality. Our ordinary reality is the unfolding of that dimension into its "explicate" forms — atoms, molecules, and so on. This is the "explicate order." Bohm, of course, was not the first to see this dual view of reality. Planck, the father of quantum theory, and Heisenberg described it, but less rigorously. One can even see it in the philosophy of Anaxagoras in ancient Greece, who called it "homoeomery." The chemist Ilya Prigogine and others have suggested that this description also corresponds to the vision of many poets and mystics.

This picture of a complex implicate dimension of reality has not yet been applied to the very large scale of the cosmos: Why is it that stars and galaxies behave as they do? We may find in this approach the resolution of such strange cosmic phenomena as black holes and the curvature of space. More generally, the theoretical work of David Finkelstein is leading toward a more rigorous description in a mathematical formalism he calls Quantum Logic, which may lead toward a precise model for the way in which our ordinary reality is generated.

The universality that Einstein sought may thus again be restored, but there is no necessary reason to believe so. The situation is at least as likely to be as Rene Thom, the French mathematician, suggests:

> To each partial system, relatively independent of the environment, we assign a local model that accounts qualitatively and, in the best cases, quantitatively for its behavior. But we cannot hope, a priori, to integrate all these local models into a global system. It it were possible to make such a synthesis, man could justifiably say that he knew the ultimate nature of reality, for there could exist no better global model. For myself, I think that this would be extravagant pretension; the era of grand cosmic synthesis ended, very probably, with general relativity, and it is most doubtful that anybody will restart it, nor would it seem to be useful to attempt to do so.

Another characteristic results from the complex, net-like picture of causality that is emerging: we are a part of the net. What we do affects the other parts, including what we wish to study. This means that any description of reality must always be partial. We may be able to experience the world as it is, but when we try to describe it we arbitrarily isolate ourselves and that which we would describe. We always lose something in the process of establishing those boundaries. Hence, no description, model, or theory is ever complete. What is required is a multiplicity of such perspectives, each of which enriches and complements the others.

The new physics, if confirmed, provides us with a radical revision of our image of physical reality. The old view was captured by the image of little bits of matter floating in space and interacting by forces. The entirety of existence could be built out of such bits and forces. In both principle and practice, we, as humans, could stand somehow objectively outside to predict and even control the behavior of this material universe. The emergent view sees the "holographic" interconnection of all things. The new physics uncovers a new nonmanifest aspect to reality, in which matter is the tip of the hidden iceberg. No theory is considered most fundamental: each theory describes only a portion of a larger, interconnected reality. Finally, we are part of that reality, not somehow disconnected from it.

Chemistry

In 1977 Ilya Prigogine was awarded the Nobel Prize in Chemistry for his theory of dissipative structures. His ground-breaking work has moved us much closer to an understanding of an age-old question: How can a new order (e.g., chemical structures) emerge out of an apparently chaotic, homogeneous old order? Prigogine has shown in chemistry (and to some extent in biology) that fluctuations in a system are not merely random errors or deviations from the significant average: rather, such fluctuations can be the source of a new order.

Prigogine's theory was developed to describe very complex chemical reactions such as the forming of polymers that go into plastics. Though it has been possible to carry out such chemical processes for some time, their nature has been mysterious. The existing chemical thermodynamics describe adequately how, in a relatively simple polymerization reaction, there can be a movement from a stationary state of low polymer density to another stationary state of higher polymer density. However, in more complex reactions, the possibilities are more extensive. Prigogine's theory describes how in such a reaction the creation of a new substance (a fluctuation in the solution) leads to an increasing rate of polymerization and more complexity through feedback among the newly evolving structures.

A biological example taken from Prigogine can be helpful. Insects such as termites are very limited in the kinds of behaviors they can exhibit, especially compared to man and the higher animals. Yet, employing only such simple behaviors termites are able to build complex and large structures, such as nests that can weigh several tons. They first erect pillars, which are connected to become arches and then closed to become walls. The work of construction begins with what appears to be uncoordinated and random behavior. The termites swarm around on their construction surface depositing little piles of building material. To that material they also give a slight scent. When one of the piles of material gets large enough to have a higher intensity of scent than the piles around it, the behavior of the termites near that pile changes. They start adding material to the pile to build first a pillar and then an arch.

This process can be described mathematically in several equations, which account for both the random behavior of insects and their coalescence toward a new order. In chemical terms, the random behavior corresponds to a homogeneous solution in equilibrium. From a slightly larger pile or a slightly higher concentration, a pillar can begin to appear. The fluctuation is being amplified. The new order appears through the accretion and assembly of such fluctuations.

Classical chemical thermodynamics deals primarily with equilibrium structures — structures that have persisted for a long time in an isolated system. A chemical solution in a beaker that has sat for a while

and a crystal are examples of such equilibrium structures. However, there are few (if any) truly isolated systems in reality. Interactions with outside environments can introduce new material, energy, or ideas (in the human world), which become fluctuations in the equilibrium state leading to a new order. Fluctuations in equilibrium chemistry are deviations that become damped toward a statistical average. In Prigogine's model, fluctuations become the essential element leading to dynamics, change, and evolution.

The key notion here for the history of ideas is that difference (fluctuation) produces change. Differentiation arises from mutually causal processes. Termites build piles that attract more termites, which accelerates the growth and amplifies the differences leading to a new structure. This process can be called morphogenetic, in that new and different (heterogeneous) structures arise out of the old structure through a complex process that amplifies deviation. It relies on reciprocal causality (positive feedback) and interactions with the surrounding environment. It does not rely on a hierarchy of simple causes and determined effects, but rather on a hierarchy of multiple causes and unpredictable innovations. In systems theory, Gordon Ashby devised the "law of requisite variety," which shows why this sort of diversity is needed for evolution.

Out of what appears to be an undifferentiated and static situation, a deviation — if large enough and replicated elsewhere in the system — can lead to a dynamic and different order. In this way, the infusion of new ideas into an old culture can lead to social change, so that Prigogine's chemical model provides a metaphor for the kind of societal change this report is about. The frontiers of knowledge represent the fluctuations in the solution. When there are enough of them and they are large enough, a whole new order can arise.

Brain Theory

The last two decades have been an especially rich period for increasing our understanding of the biological basis for mental functioning. The analogy for understanding the brain in recent years has been the computer. In this model, which is associated with the behaviorist school of thought, mental activity is the result of electrical impulses moving through a neural network in linear sequences. A neuron (a brain cell) is stimulated electrically by impulses from previous cells in the sequence and in turn sends an electrical impulse (the equivalent of "on" in the binary mechanism of a computer) to stimulate appropriate neurons downstream. The problem with such a mechanical model is that it cannot describe, let alone explain, such common mental functions as memory or learning.

For a long time the theory was that somewhere in the brain there were physical memory traces called engrams, which represented the location and substance of memory, as magnetic patterns represent music on a piece of recording tape. If one cuts a piece out of the tape, there will be a gap in the music. Similarly, that theory said that cutting a piece out of the brain ought to remove something learned. Karl Lashley, a pioneer in brain research, did just that with animals for 30 years. The anomaly in the experiments was that he found that he could not selectively destroy what had been learned. That model of mental functioning relies on the idea, believed to be true then, that brain cells are sensitive only to on-off signals. Hence, information could be built up only out of such a limited code.

In the last 15 years, Karl Pribram and others uncovered two other aspects of the nature of brain cells. First, brain cells are sensitive not only to the existence or nonexistence of a pulse (on-off), they are also sensitive to the rate of change of the pulse or its frequency. This enormously increases the amount of information a pulse can carry. Second, they identified the function of a fine fiber network linking brain cells in parallel in addition to their normal sequential linkage. Thus a wave, like a light wave, can be propagated inside the brain. A complex wave can carry a great deal of information (see box on holograms). Those waves in turn can interfere to produce an even more complex pattern, leading to the distribution of functions throughout the brain. Thus, the simple notion of cells firing in sequence and memory located in a single cellular location, which cannot cope with the subtlety and richness of human mental phenomena, gives way to a more complex model of a field of thought built

out of the interactions and interplay of waves moving through and distributed throughout the neural structure of the brain.

Pribram has shifted the analogy from the computer to the hologram. Information is distributed throughout the brain, hence removing a piece of brain eliminates little information. Furthermore, the density of information can be much greater than under the simpler model because a complex interference pattern can be decomposed into a very large number of bits of information.

The similarity of Pribram's brain model to Bohm's quantum physical model has led to a great deal of interesting speculation. Perhaps altered states of consciousness are different levels and kinds of vibratory patterns in the brain, as in the different brain wave patterns measured by an EEG. In such states it may be possible to be in direct contact with the underlying vibratory structure of the universe as described by Bohm. If so, perhaps that may provide a model for how various psychic phenomena could occur.

There is also a link here to the morphogenetic model of change proposed by Prigogine. How do *new* thoughts arise? Perhaps, as new chemical structures arise in complex chemical reactions, existing patterns may interact in a complex but ordered way to produce new and unpredictable patterns or thoughts — new ideas literally bubbling up out of the old.

Mathematics

If the ideas presented in the previous few sections were amenable only to the imprecise sort of description used in this report, they would lack a great deal. Fortunately, new mathematical ideas have recently emerged which permit a far more rigorous mathematical treatment. They are in themselves a paradigm break in mathematics. These ideas are best represented in the "catastrophe theory" work of Rene Thom, described in his much heralded book *Structural Stability and Morphogenesis.*

In most areas of science (and now even in analytic philosophy), the principal tool of description is some formal model, usually mathematical. If the model works well in its primary test of prediction, scientists often attribute the quality of explanation to it, sometimes going so far as to call it a natural law. The primary mathematical tool for the past three centuries has been differential calculus. The main constraint in applying differential calculus is that the phenomena it describes must change smoothly and continuously. In many instances, even somewhat rough and discontinuous phenomena can be approximated by differential equations. However, there are many more phenomena that undergo sudden and apparently unpredictable changes to a qualitatively new order. Through the lens of differential calculus such phenomena appear chaotic. Yet, as Thom points out in the introduction to his book, the world is obviously not chaos. Regularity of form is evident everywhere: in the similarity of each of the endless succession of waves breaking on the shore, the cellular structures of an organism, and so on. Discontinuous change, according to Thom, can be treated as the succession of forms — one structure giving way to another. This is a shift from quantitative to qualitative change. Thom has been particularly successful at applying his theory to biological problems, especially cell growth in embryos.

Thom has derived seven elementary forms of sudden change or morphogenesis — how one condition gives rise to a wholly new one. These forms he calls "catastrophes," thus the name "catastrophe theory." The seven are shown in Figure 2. Only the fold and the cusp can be drawn in their entirety. The others entail more than three dimensions and hence cannot be represented on a flat surface. The theory itself is not very complex, though its proof is very difficult. (The basic idea has been widely accepted, though the proof that these seven are the only possible catastrophes is still controversial.) Essentially it states that if a process is controlled by some functional relationship (called maximizing or minimizing functions) of up to four factors and its behavior varies along no more than two dimensions, then the description of all possible behavioral outcomes of a process can be represented by one of the seven catastrophes. (In theory, more complex phenomena can be built out of assemblages of these elements.) The simplest catastrophe, the fold, has one control dimension and one behavior dimension; the cusp catastrophe adds another control dimension and so on up to the parabolic catastrophe,

Figure 2 Forms of Catastrophe

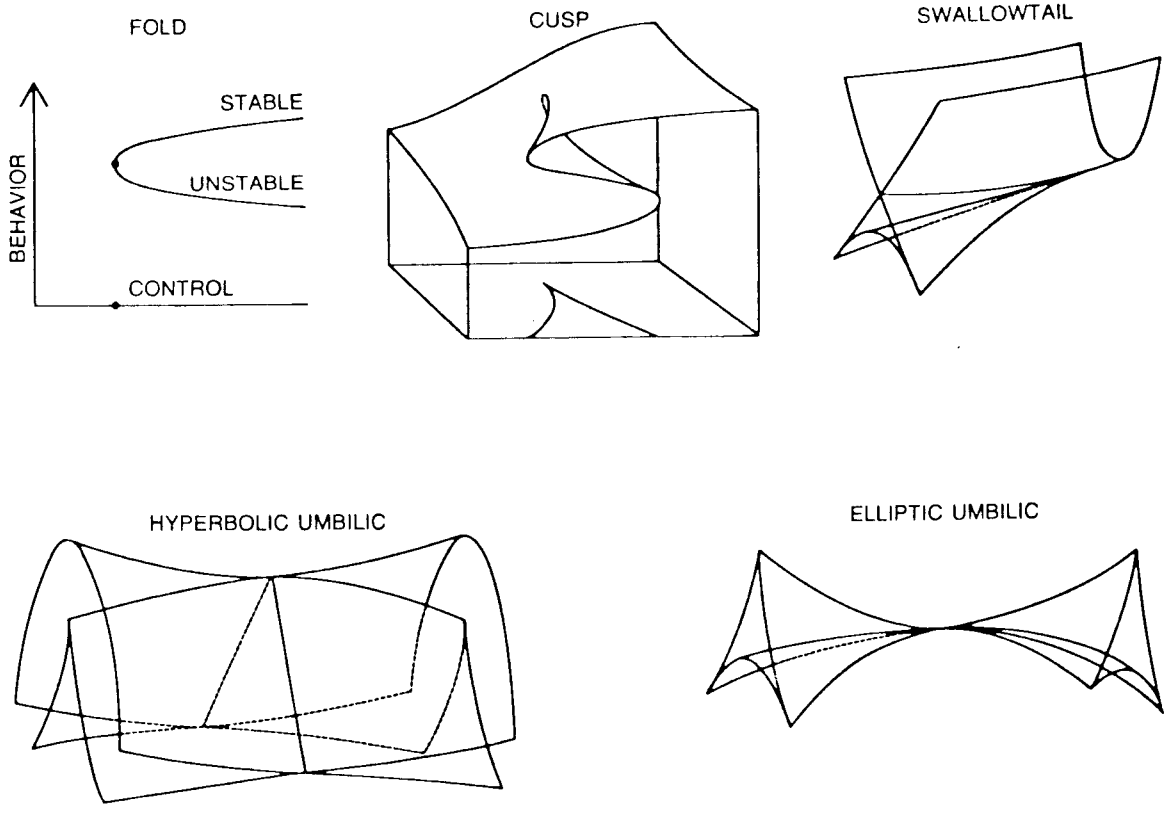
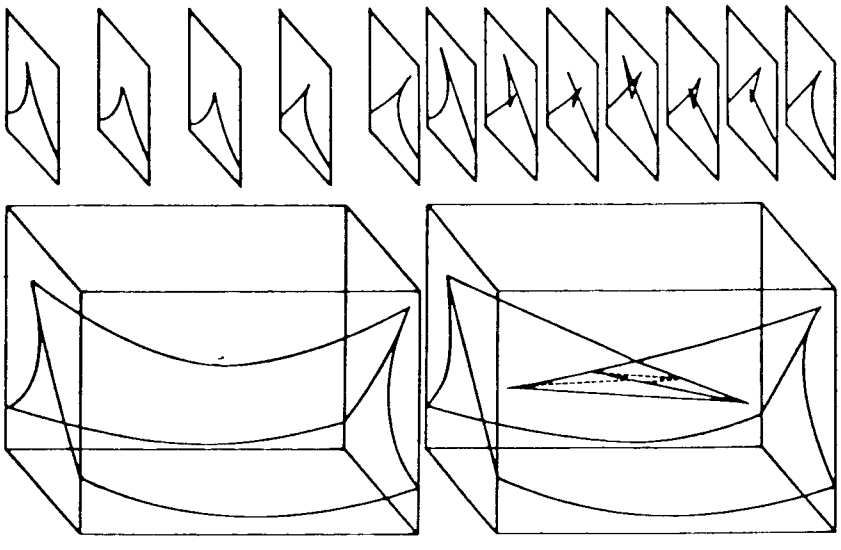
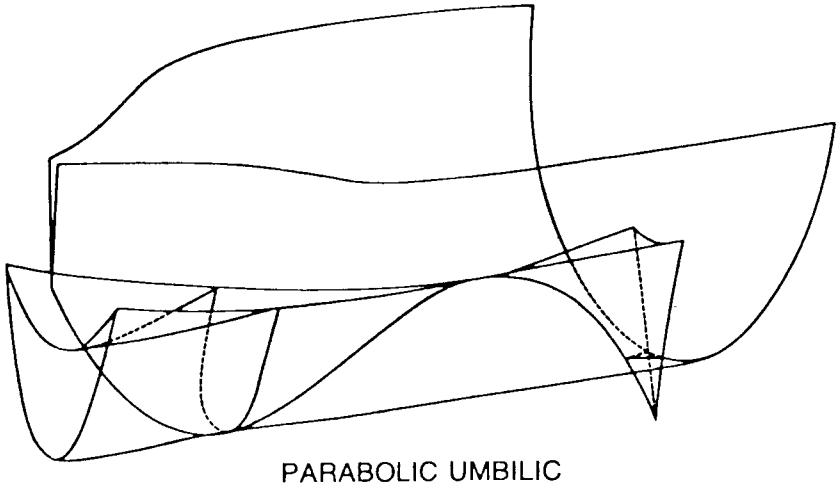


Figure 2 Forms of Catastrophe (continued)



BUTTERFLY



PARABOLIC UMBILIC

which has the maximum of four control dimensions and two behavior dimensions.

An application developed by E. C. Zeeman will help clarify the power of this new tool. If a dog is angered or enraged, it will usually attack. Conversely, if it is frightened, it will usually retreat. However, if it is both enraged and frightened, as in the normal case, it may suddenly shift its behavior from fight to flight or the reverse. This can be described by a cusp catastrophe (see Figure 3). If a dog is enraged and then increasingly frightened, its behavior will follow a path along the upper ("attack") surface toward the edge of the cusp. When it reaches the edge, the next increment of fear will push the enraged dog over the edge to the lower surface and it will suddenly begin to retreat. If, however, the dog is at first frightened and then successively angered, it will begin by retreating. But its behavior will move along the lower surface toward the fold in the cusp. At that point its anger will be sufficient to overcome the fear and its behavior will jump to the upper surface, where it will turn and attack. As was suggested earlier, such models are useful in that they provide insight into behavior. They are not, however, theories of behavior that have explanatory power, despite claims to the contrary.

The historic significance of catastrophe theory is, first, in its shift from continuous to discontinuous phenomena and, second, in its ability to describe qualitative change. The power of catastrophe theory is its potential generalizability. As earlier sections have shown, there are new classes of theories in a wide variety of disciplines, each of which entail complex and suddenly changing structural phenomena. Catastrophe theory may be a tool that will lead to a more precise description of mental phenomena in Pribram's brain theory, or how physical structures arise from the underlying vibratory pattern in Bohm's quantum model. These other developments might have remained in the class of interesting but not useful speculations without the availability of the tool of catastrophe theory.

Biology

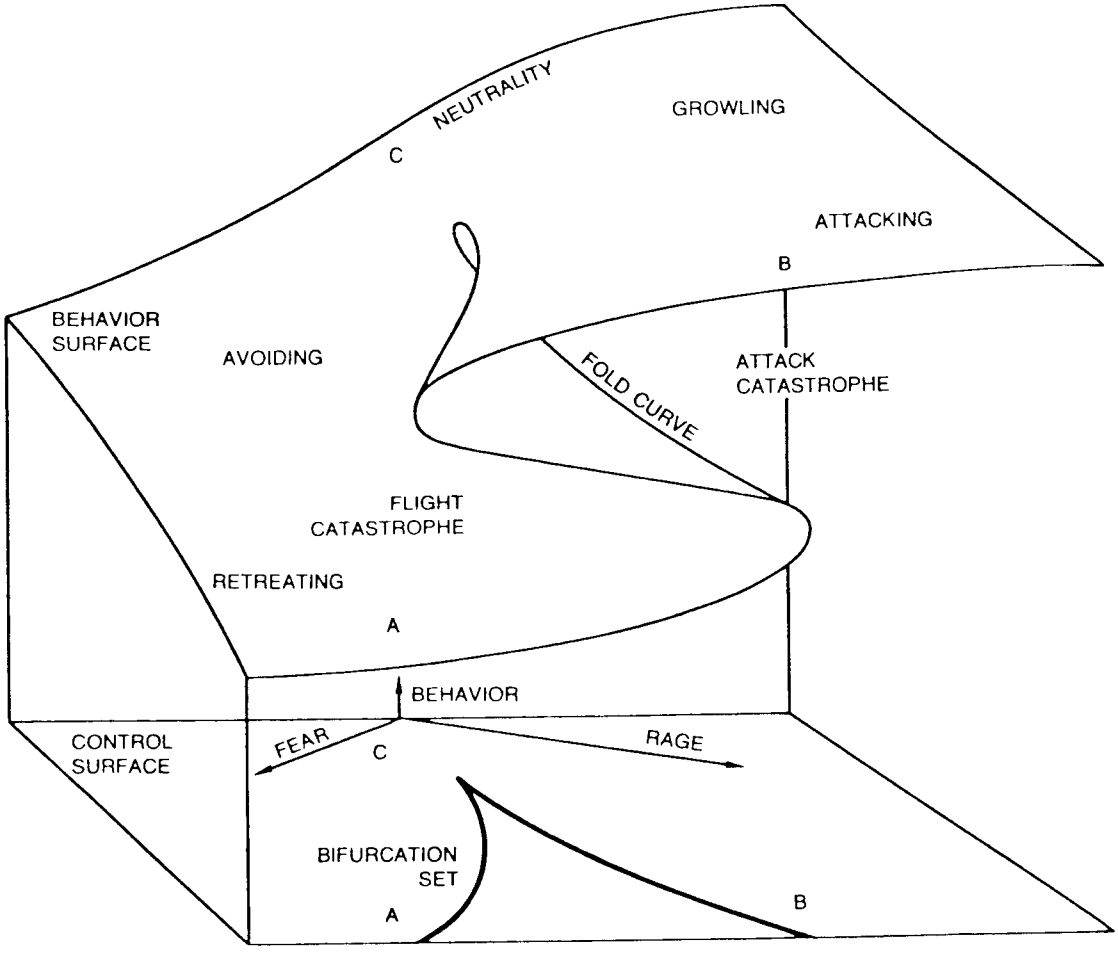
In two subdisciplines of biology, aspects of the emergent paradigm are visible at the frontiers. The model of the process of evolution has itself evolved since Darwin and today is different in several important respects. Similarly, our understanding of the nature of ecosystems has been extended from a static equilibrium view toward one of ecological evolution, which more closely corresponds to the ever-changing character of the natural world.

Though much progress has been made since Darwin, the commonly held image of the evolutionary process is almost unchanged. In this view evolution occurs because of two factors: (1) random mutations of genes, which introduce new characteristics into an organism; (2) interactions with the environment that naturally select those genes most favorable to survival. Jacques Monod called this process "chance and necessity." There is here a very simple causal model. New characteristics arise by chance. They are tried in the real world, and if they make the species in some way more successful, the population of organisms with those characteristics tends to expand at the expense of those without them.

Several developments in recent years led to some important changes in that simple model, pushing us toward a more subtle and complex model. The experimental work of Theodosius Dobzhansky in the 1940s led to one such development. The old model implied that all the organisms in a given population have almost the same genetic structure; mutation of a gene then introduces a vector for change. Dobzhansky discovered that the genetic variation among individuals is actually quite great. Thus, a population can be conceived of as possessing a large "pool" of genes, with any individual having some particular subset. The evolutionary forces from the environment act, then on a very diverse set of genetic characteristics already in existence. Mutation merely increases the richness of the gene pool in relatively minor ways. Far more important is the diversity of individuals.

The second concept that modifies the common image of evolution is that of the interaction of the individual organism with the real world. That organism can be called a phenotype (the assembly of genetic characteristics that biologically define an individual) in that it possesses a specific set of characteristics (hair color, skin tone, etc.) due to its genetic makeup. Earlier

Figure 3 Model of Aggression in Dogs



evolutionary theory dealt with change at a level in a statistical fashion. However, the forces of the environment act on whole organisms, not genes. When that view is taken, a somewhat different picture emerges of the interactive role of environment and organism. Some organisms, especially man, can modify their environments or move to new ones. They can become adapted in particular ways to their environment (e.g., grow stronger from use of muscles). Adapting to environmental stress then becomes an underlying force for evolution. Though particular adaptations are not transmitted from one generation to the next, adaptability becomes a meta-characteristic in that sense.

Conrad Waddington, the evolutionary biologist, recently put it this way:

> Once we consider evolution in terms of the selection of phenotypes which are produced by the development of a sample of genes drawn from a large gene pool, under the influence of an environment which is both selected by the organism and then selects the organism, we find ourselves forced to conclude that biological evolution, even at the subhuman level, is a matter of interlocking series of open-ended, cybernetic, or circular processes.*

In other words, biological systems evolve through complex, mutually causal processes. The question of how species evolve from one qualitative condition to another can best be seen in the theory of ecology.

In understanding ecosystems, we again find that the common image is at variance with contemporary findings. Our current image is that an ecosystem has some optimal stable condition. If a properly functioning ecosystem is disturbed, forces from within the system will act to return the system to its optimal stable state. The obvious example is the predator and the prey. The predator overfeeds and its food supply diminishes. Then its numbers in turn diminish, at least locally. Some move on, some starve, and so on, allowing the prey to flourish again. The cycle is then repeated endlessly around that stable optimum. Unfortunately, that image does not always match the reality.

*See Jantsch and Waddington in the Bibliography. The quote is from p. 15.

Consider, for example, fishing in the Great Lakes. There were problems even before the massive introduction of pollutants. Before 1930, a variety of species were intensively fished. This, of course, led to a rapid decline in their population. When fishing pressure eased, the theory would suggest, the fish should have come back. Yet their decline continued. The particular ecosystem had been shifted from a stable equilibrium domain to a collapsing condition. Though it had been stable, the system was not very resilient in that it could not recover from a large disturbance. Resilience is a new concept, then, counterposed to stability.

Resilience results from a combination of adequate diversity (heterogeneity), mutually supportive relationships (symbiosis), and open subsystems that are capable of sudden evolutions to new regimes. Thus, a survivable ecosystem is not necessarily one that is stable. Highly stable systems — ones with only small fluctuations — tend to have narrow and often shrinking domains of stability. Sudden perturbations can push them over a threshold toward extinction or a new state. This was the case with the closed, highly stable system of the Great Lakes. Up to a point, the impact of fishing was tolerable; but beyond that, in concert with new predators (the lamprey), competitors (the alewife), and pollutants, fishing pushed the formerly stable system toward extinction.

Holling uses the example of the budworm to demonstrate the concept of resilience.

> There have been six outbreaks of the spruce budworm since the early 1700s (Baskerville, 1971), and between the outbreaks the budworm has been an exceedingly rare species. When the outbreaks occur there is a major destruction of balsam fir in all the mature forests, leaving only the less susceptible spruce, the nonsusceptible white birch, and a dense regeneration of fir and spruce. The more immature stands suffer less damage and more fir survives. Between outbreaks, the young balsam grow, together with spruce and birch, to form dense stands in which the spruce and birch, in particular, suffer from crowding. This process evolves to produce stands of mature and overmature trees with fir a predominant feature.
>
> This is a necessary, but not sufficient, condition for the appearance of an outbreak; outbreaks occur only when there is also a sequence of unusually dry years (Wel-

lington, 1952). Until this sequence occurs, it is argued (Morris, 1963) that various natural enemies with limited numerical responses maintain the budworm populations around a low equilibrium. If a sequence of dry years occurs when there are mature stands of fir, the budworm populations rapidly increase and escape the control by predators and parasites. Their continued increase eventually causes enough tree mortality to force a collapse of the populations and the reinstatement of control around the lower equilibrium. In brief, between outbreaks the fir tends to be favored in competition with spruce and birch, whereas during an outbreak spruce and birch are favored because they are less susceptible to budworm attack. This interplay with the budworm thus maintains the spruce and birch, which otherwise would be excluded through competition. The fir persists because of its regenerative powers and the interplay of forest growth rates and climatic conditions that determine the timing of budworm outbreaks. If we view the budworm only in relation to its associated predators and parasites, we might argue that it is highly unstable in the sense that populations fluctuate widely. But these very fluctuations are essential features that maintain persistence of the budworm, together with its natural enemies and its host and associated trees. By so fluctuating, successive generations of forests are replaced, assuring a continued food supply for future generations of budworm and the persistence of the system.*

The old biological paradigm concentrated on the roles of "chance and necessity" in evolution and of stability in ecosystems. In the new paradigm, both evolution and survival are a function of interacting diversity, fluctuation, adaptability, openness, and resilience. Ecosystems evolve through the complex of mutually causal processes. Indeed, current studies of species in major nature preserves tend to confirm this non-equilibrium view of ecosystems. In those preserves, which are not very large, evolution seems to be at a standstill and the very survival of the affected species is in doubt.

Philosophy

The word *philosophy* derives from Greek roots meaning *the love of wisdom*. Philosophers were those who sought after eternal truths. As eternal standards of truth, Plato's *Dialogues* introduced the Ideas or Forms representing the common characteristics of all members of a given kind. Whether one was talking about horses or about justice, the standard for what it is to be a horse, or what it is to be just, was presumed to be a unifying Idea or *universal* held in common by all particular horses, or by all instances of justice. The task of the philosopher was to gain access to those eternal Forms, for then he would know, first, the eternal standards of an unchanging Truth; second, the essences behind historical existence; and third, the unifying formulas for all classes of things and virtues.

All that has changed, in three ways that we might call:

- From Eternity to History
- From Essentialism to Existentialism
- From Forms to Family Resemblances.

From Eternity to History — The sense of almost inevitable progress that we take for granted was virtually unknown to the ancients. Certainly, there were cycles of growth and decay, but the standards of perfection — the Forms — were unchanging and thought to be the same for everyone everywhere. Of course, there were heretical exceptions, but not until the nineteenth century did mainstream philosophers fully appreciate the import of historical change in the structure of rationality itself. Though Vico and Herder had begun to order history in distinct epochs, at the end of the eighteenth century Immanuel Kant could still accept Aristotle's list of the fundamental categories of cognition. But the importance of subjective perspective was appreciated by Kant. His contribution to the theory of knowledge consisted in showing that the forms manifest in experience derive from subjective consciousness, not from some great blueprint in the sky, not from some distant realm of Platonic Forms. Kant accounted for our perceptual agreements by appealing to universally shared subjective categories in place of the objective Platonic Forms. As stated earlier, in a sense it was Kant who first realized the importance of a paradigm as a *way* of seeing that determines *what* is seen.

But Kant still thought himself to be uncovering an eternal paradigm, albeit within human consciousness

*Jantsch and Waddington, pp. 80-81.

It was Hegel who first appreciated the importance of paradigm shifts or, in his phrase, "conversions of consciousness." For Hegel, history is more than a sequence of events. History shows us an evolution in the very consciousness that participates in those events, e.g., from Athenian culture to Christian culture, from religious superstition to the rationalist Enlightenment. We cannot assume, as Kant did, that modern consciousness obeys the same rules observed and classified by Aristotle.

Whereas Hegel historicized Kant's eternal paradigm into the lumbering movement of a World Spirit, Marx and Nietzsche further radicalized the fall from eternal Forms. Hegel saw differences of consciousness breaking down into broad epochs; Marx saw similar differences within the same epoch: "class consciousness" is a way of seeing things — a paradigm. The perspective of the ruling class is such that it can see some things but must remain blind to others; likewise for the proletariat. Hence the phrase "false consciousness," or what Gunnar Myrdal, in his analysis of good Christian slave owners, calls "selective objectivity." For Nietzsche this shattering of a universal order extends beyond epochs (Hegel) and classes (Marx) to even smaller groups, even to individual perspectives. His so-called perspectivism ushers in the movement known as Existentialism.

From Essentialism to Existentialism — Whereas Plato pointed toward abstract Ideas that stand apart from their physical instances, Aristotle questioned the separability of form from matter. He stressed indwelling *essences*. Like the Forms, however, these unchanging essences give characteristic form to their respective material instances. The paradigm case is organic growth, e.g., from acorn to oak; or, as the words from *The Fantasticks* put it, "Plant a carrot, get a carrot, not a brussel sprout."

As the singer, a father, goes on to lament, children are less predictable. Unlike acorns or carrots, children cannot be counted on to replicate their parents. Despite obvious biological inheritances, human character does not seem to follow from indwelling eternal essences; instead, in the words of the fundamental axiom of Existentialism, "Existence precedes essence." This saying, found in various formulations in the works of Heidegger and Sartre, means that our acts and our achievements — our relationships in the historical present — do more to determine our natures than do any indwelling essences. We do not *find* ourselves; we *create* our lives from the little we can find in the "rag and bone shop of the heart."

Like history conceived as progress, individual lives may produce novelties undreamt of when time was viewed as the "moving image and poor copy of eternity." Existentialism is thus a microcosmic expression of the macrocosmic perspectivism revealed in historical conversions of consciousness. Just as ancient consciousness may differ from modern consciousness, so my childhood consciousness is not a fixed essence determining my adult existence. Existence precedes essence. I will make myself who I am.

From Forms to Family Resemblances — Of the several functions served by Platonic Forms, one remained unchallenged as late as the twentieth century. Kant undermined the objectivity of the Forms by finding formal structures within subjective consciousness. Hegel and his more radical followers challenged the eternal stability of the Forms by drawing attention to conversions of consciousness in collective history as well as in individual biography. But Ludwig Wittgenstein dealt the final blow to the Platonic paradigm by questioning the *universality* ostensibly provided by the Forms.

Though a strong odor of Socratic irony hangs over the relevant dialogues, Plato's more orthodox interpreters take him to have intended the Forms as universals in the sense that each Form unified a class of particulars by specifying one thing they all had in common. The Form of Redness would be the unifying element held in common by all red things; the Form of Man would be the one thing shared by all men; and so on. Two things could be said to resemble one another by partaking of the same Form. Although many philosophers disagreed over the precise definition of a given Form, say the Form of Justice, most accepted enough of the Platonic argument to grant that *some* sort of universals, whether objective or subjective, eternal or historical, *must* be available to unify the many uses of the same word or concept. How could we understand one another if there wasn't some

single meaning of *friendship*, for example, some single reference for the many uses of the word *friend*?

Wittgenstein took a different tack. Instead of assuming that there *had* to be a single element, known or unknown but nonetheless common to all uses of the same word or concept, he argued that the several uses of a single word might be tied together by nothing stronger than a series of what he called *family resemblances*. Every game, for example, might resemble some other games in some respects, but there seems to be no single feature shared by all games. Rather than appeal to a unifying Form to find the meaning of a word, we do better to look at the several uses to which a word may be put. Those uses may resemble one another; indeed, they may revolve around one or several "paradigm cases." But paradigm cases provide a much looser unity to a class — as different from the Forms as resemblance is different from identity. No longer need two things share *the same* element to rightfully claim membership in the same class; now *resemblance* to relevant or related paradigm cases is sufficient. One might say that class membership has been democratized from the fiat of the Forms.

Philosophy was once regarded as the handmaid of theology. In the hands of defenders of the faith, philosophy could boast its access to ultimate truths. The Platonic-Christian tradition presented the universe as an ordered hierarchy. The dominion of the Lord of Lords stood as a model for secular Ideas of Ideas. Plato wrote of a realm of Ideas or Forms providing a kind of eternal blueprint in the sky for all earthly things, from tables and chairs to virtue and justice. The task of the philosopher was to move beyond the many things evident to the senses; he was to ascend a stairway of abstraction to reach the Ideas. Just as the Idea of circularity would provide a unified standard of perfection for many imperfect circles, so every other class or kind would be unified by an Idea to which the mind of the philosopher would find access.

If monotheistic theology provided a paradigm for Platonic-Christian philosophy, Wittgenstein's family resemblances provide a comparably influential and opposed paradigm for contemporary philosophy. No longer does one hear of vast systems designed to climb an ordered hierarchy of Ideas. Instead, the work of philosophers has become more modest and more closely tied to the manifest multiplicity evident to the senses. Modern philosophy has surrendered its quasi-theological aspirations of finding eternal truths.

One seeks the key to the universe, the fabled philosophers' stone, only when one retains an image of knowledge as sealed by a single lock. Now languages are regarded as holding a vast multiplicity of tangles to be unraveled by philosophers trained in logic and linguistics. Patient analysis has replaced grand synthesis. Professional specialization has pushed aside inspired insight. Rather than seek general truths, contemporary philosophers rest content with exposing specific confusions. A philosopher is more likely to build a reputation for understanding the deep structure of the use of adverbs than for anything as grand as wisdom. Consequently, professional philosophy, like many other disciplines, has become decentralized into a variety of specialized studies held together by the loosest of family resemblances. No longer the handmaid of theology presiding over a hierarchy of disciplines, philosophy, like the Platonic Forms, has been democratized.

Political Theory

Political power, according to Max Weber, rests with those who have a monopoly on the legitimate use of violence within a commonwealth. The question arises: by what authority do political leaders claim legitimacy in their exercise of power? The question of legitimacy yields a series of answers demonstrating the shift of paradigms.

One might be inclined to consider brute force as the first answer to the question of legitimacy. But brute force need not claim legitimacy, only the strength to have its way, "legitimate" or not. Primitive conquest or association does not become politics, strictly speaking, until leaders can claim legitimacy for their authority. The *divine right* of kings, for example, was an early and elegant — even if currently unconvincing — answer to the question of legitimacy. The tradition of *natural right* follows divine right as closely as Aristotle's immanent essences follow Plato's transcendent Forms. Legitimacy derived from natural right

rests on a real and eternal order in the nature of things, while divine right appeals to a transcedent order for legitimacy. And, just as eternal essences gave way to historical existence in philosophy, so in political theory statutory fiats for all time gave way to a common-law tradition in which there is a recognition of a history of growing and slowly altering earthly precedents, such as the series of paradigm cases in which the courts have been called on to alter precedents for the proper definition of equal opportunity and human rights. The timeless order of gods, monarchs, and patriarchs is democratized. The paradigm of down-from-the-top authority yields to an order in which legitimacy derives from participation, representation, and consent of the governed.

Though political theory hardly bears a perfect correspondence with political fact, it is nonetheless worth noting how sharply the ideals of liberal democracy and Marxism alike differ from the dominant concepts of authority prior to the age of revolution. Until the time of Rousseau, the universe was divided into Earth and Heaven, or sublunary and celestial (Aristotle), or the realm of Becoming and the realm of Being (Plato). In each case, the blueprint of the "higher" was fixed and only darkly evident in the "lower." To legitimate authority was to turn one's back on the lower and, like a priest or oracle, seek authoritative counsel from on high. All that has changed. Now the universe is divided, not between the lower and the higher, but between the natural order whose laws are fixed and a historical order whose laws are subject to human freedom. We are making up the order as we go along. Therefore, the sources of political legitimacy cannot be traced to any singular origin, whether a divine authority or a natural order. Instead, legitimacy derives from the tacit contracts forged in relationships among the governed. Politics is like a game that simply does not exist unless enough people are playing by the rules. The voluntary and inventive character of games replaces the necessary and fixed order of the cosmos as the dominant paradigm for postrevolutionary politics — at least according to theory.

In fact, the ancient paradigm of down-from-the-top authority persists in dictatorships and totalitarian regimes. More subtly, when we forget the voluntary aspect of tacit contracts, we experience the invented institutions of politics once again as parts of a fixed order of nature. This relapse into the old paradigm is not solely a matter of "forgetfulness." As the institutions grow and bureaucracies become entrenched, the inventive and voluntary origins become ossified or petrified like living growth turned to stone. Although this is not the place to attempt the grand solution to the problem of institutional ossification, we note the problem to account for the otherwise confusing appearance of a mix of paradigms in contemporary politics. The ancient paradigm of down-from-the-top authority has been challenged by a relational paradigm featuring voluntary association in invented institutions. Because freely evolving histories of human relationships may collectively invent different institutions, liberal politics is inherently pluralistic. Once liberated from the uniformity of nature, human histories may evolve in several (though not all) directions. Both individualistic and collectivistic societies have their strengths and weaknesses. What we gain in individual liberty we lose in capacity for long-range planning, and vice versa for socialist societies. The attempt to settle the matter of which society is "better" may be as foolish as the attempt to resolve, once and for all, the relative merits of team sports over individual competition. Just as there are several games related by family resemblances, and no one Form of the Perfect Game, so political organizations proliferate. If these organizations ossify, we sometimes forget that their plurality is an index of freedom. We are then inclined to revert to the old paradigm and aspire to the Platonic Form of a Perfect Politics that would homogenize all our bothersome differences.

That search for a Perfect Politics is associated with the forces for centralization and authoritarianism. The contemporary decentralist thrust, along with the active resistance to entrenched authority in its current form of the tax revolt, may represent a new attempt to recreate the voluntary and participatory nature of the new political paradigm. The shift in paradigm is from politics that rest on a static ideal (ideology) based on some necessary order found in the nature of things toward a politics based on voluntary association in evolving forms.

Linguistics

The paradigm shift in linguistics is more dramatic than the more gradual evolution observed in philosophy and political theory. The breakthrough dates from the work of Ferdinand de Saussure at the end of the nineteenth century. Prior to Saussure, linguists had been mainly preoccupied with deriving etymologies: they traced the histories of words. As for the origins of the first words, the obscurity of prehistory encouraged a silence broken only occasionally by speculations on the "bow-wow hypothesis": that primitive words gained their meanings from sound-alike resemblances to the nonlinguistic entities they named, e.g., the bark of a dog. Saussure changed all that.

In place of one-to-one correspondences between words and what they named, or between a word and its historical roots, Saussure showed how words derived their meaning from their relational context within an entire language. *Rot* (in German) means the same as *red* (in English), not because either "sounds like" the color *red*, or because they have a common root that somehow sounds like or names *red*; both mean *red* because both play similar roles or are used similarly in their respective linguistic and behavioral contexts. As Wittgenstein would put it, the use of *red* resembles the use of *rot*. Their uses fit into relational structures. Those structures are similar, despite differences in the linguistic terms — German on the one hand, English on the other. Saussure thus posits the "arbitrariness of the sign": the spoken sound or written shape of a word is arbitrary with respect to its meaning. What determines meaning of a word is location in a context. Structural relations constitute the meaning of a term; i.e., a word draws its meaning from its relationship to other elements of a linguistic structure, such as a sentence or a phrase. The *atomism* that began with terms and built up secondary relations among the terms now yields to a *structuralism* for which the physical form of the terms is arbitrary. The relations are primary. Thus, we see in linguistics a phenomenon similar to the paradigm shift in physics. The particle is no longer an isolated atom; it has been replaced by a complex of relationships with other particles and with a deeper, even less visible reality. Similarly, the word draws its meaning from its interactions with other words and the deeper structures of language that reflect the uniqueness of cultures.

Consciousness

Recent attention to consciousness is evidence in itself of a shift in paradigms. When the paradigm for consciousness was a blank tablet (*tabula rasa*), consciousness seemed less interesting than contents recorded on its passive surface. Now, however, we have become aware of the fact that consciousness is not some passive medium but is instead more like a highly selective filter that allows only certain kinds of information to enter awareness. Consciousness is always partial or perspectival: we do not take in everything, but only a preprogrammed portion of the available information. Furthermore, consciousness is plural in the sense that several consciousnesses are often processing information in different ways at the same time.

Both the partiality and the plurality of consciousness are manifest in the macrocosmic order of social systems as well as in the microcosmic order of individual brains. In the social order, the practitioners of sociology of knowledge speak of "false consciousness," by which they mean a mind-set that is so entrenched in a given way of thinking that it cannot see things from another point of view. This charge of partiality is, of course, mutual; each point of view declares opposed perspectives guilty of false consciousness.

Similarly, within the workings of single minds, there is a tradition that regards linear-deductive rationality as the only correct way to think; and another tradition stresses the intuitive grasp of wholes rather than analysis into parts. Recent brain research suggests (1) that the two halves of the brain function differently (not better or worse) in the service of both analytic and holistic consciousness (Ornstein); and (2) the entire brain stores information, not in discrete bits located in specific cells, but in a distributed fashion (Pribram). Other research suggests that there are different states of consciousness which are qualitatively different from each other (Tart) and that these may be arranged in some sort of spectrum, like the electromagnetic spectrum (Wilber).

The neurophysiology of the brain thus provides a kind of microcosmic hologram for the macrocosmic study of consciousness in social systems. In both orders, the old hierarchies — based on claims to a single "correct" and "objective" consciousness — have given way to acknowledgments of a plurality of differentiated, partial, and possibly complementary consciousnesses. Neurophysiologist Warren McCulloch suggests the term *heterarchy* to describe such systems, in which several principles (*archai*) combine in processing information. Although the displacement of hierarchy often provokes fears of anarchy, the point is that there is a middle ground. It is not necessary to choose between "anything goes" (anarchy), and falling back on the old paradigm of one highest principle (hierarchy); instead, a heterarchy processes information according to several guiding principles on a par with one another.

If all work and no play makes Jack a dull boy, so all play and no work makes Jill a dumb bunny. Similarly, the exclusive cultivation of analytic ability leaves one blind to the synthetic workings of whole systems, while the exclusive cultivation of the larger vision may leave one blind to specifics. Though we are here straying beyond the specifics of consciousness research, we can hardly find a better example of the workings of analytic and synthetic consciousnesses than that presented by the contrast between Keynesian and Marxist economics, respectively. Marxism offers an integrated vision of the entire sociocultural system, but never quite reaches the finer points of microeconomic pricing theory. Keynes and Samuelson tell us all we want to know about the dynamics of supply and demand, but leave us in need of a Schumacher to remind us of an "economics as if people really mattered."

Psychology

The paradigm shift in contemporary psychology takes the form of a challenge to the age-old metaphor of the self or psyche as a singular "captain of the ship." Freud, the father of modern psychology, likened the ego to a charioteer trying to control the contrary wishes of two horses: the instinctual demands of the id, and the socially responsible restraints of the superego. Though Freud's ego-psychology thus conformed in some respects to the classic paradigm of a single inner steersman struggling for control, Freud's own discovery of unconscious influences on behavior already opened a large chink in the armor of conscious self-control.

The singular self is, perhaps, analogous to the simple causes of Newtonian physics. It is not surprising that psychology, having adopted this mechanical metaphor, focused on behavioral and experimental directions. Traditional psychology ignores subjective experience, claiming that only that which is objective — i.e., behavior — is subject to meaningful study. Along with the entire subjective contents of the mind is buried the unconscious, to be treated as a barbarian in need of taming.

Recent years have seen a proliferation of psychologies that abandon the classical model of singular selfhood in favor of more decentralized models. Jung was the first to challenge ego-psychology by speaking of a multiplicity of archetypes — unconscious scripts or programs, any one of which might take control given the appropriate cues.

Transactional Analysis (TA) uses game theory to describe the way we shift players in our relationships with others and with ourselves. In place of archetypes modeled on the roles manifest in Greek mythology, TA adopts a model of the self as a triumvirate including a parent, an adult, and a child. Each assumes a perspective suggested by its title, and behaves according to its predictable preferences. Rather than asking *whether* the self is in control, TA seeks to understand apparently incoherent behavior by asking *which* self is in control in which behaviors, and how the several selves relate to one another. The approach is at once perspectival and relational.

Psychosynthesis, another school of contemporary therapy, similarly divides the self into a multiplicity of subpersonalities. Again, the attempt is to articulate each personality not merely as a part of the self but as a self-contained and fairly complete personality with its own perspective.

The therapeutic efforts of these and other contemporary psychologies are increasingly oriented toward a

"field theory" of psychic disturbances. Rather than regarding psychoses and neuroses as somehow located within separate, atomistic psyches, the newer therapies stress the transpersonal aspects of communication. Information theory contributes a model of selfhood as an open rather than a closed system, i.e., as engaged in a context which supplies part of the meaning of "self." The locus of mental health is no longer the individual, or even the family, but a network extending to community and culture. Modern psychology thus manifests the significant features of the new paradigm: it is a field theory that stresses the decentralization of psyche into a multiplicity of selves, each maintaining its own perspective on an experience that is ever subject to differing interpretations.

Thus, we see a movement from a relatively simple, mechanistic paradigm limited by a need for objectivity toward a more subtle, complex, and relational paradigm. Willis Harman has suggested that this change leads to a very different image of the human psyche:

(a) The potentialities of the individual human being are far greater, in extent and diversity, than we ordinarily imagine them to be, and far greater than currently in-vogue models of man would lead us to think possible.

(b) A far greater portion of significant human experience than we ordinarily feel or assume to be so is comprised of unconscious processes. This includes not only the sort of repressed memories and messages familiar to us through psychotherapy. It includes also "the wisdom of the body" and those mysterious realms of experience we refer to with such words as "intuition" and creativity." Access to these unconscious processes is apparently facilitated by a wide variety of factors, including attention to feelings and emotions, inner attention, "free association," hypnosis, sensory deprivation, hallucinogenic and psychedelic drugs, and others.

(c) Included in these partly or largely unconscious processes are self-expectations, internalized expectations of others, images of the self and limitations of the self, and images of the future, which play a predominant role in limiting or enhancing actualization of one's capacities. These tend to be self-fulfilling. Much recent research has focused on the role of self-expectations and expectations of others in affecting performance, and on the improvement of performance level through enhancing self-image. On the social level research findings are buttressing the intuitive wisdom that one of the most important characteristics of any society is its vision of itself and its future, what Boulding (1964) calls "organizing images." The validity of the self-fulfilling prophecy and the self-realizing image appears to grow steadily in confirmation.

Religion and Spirituality

The statement, "As above, so below," goes back to the ancient Vedic tradition and survives in the West through the Gnostic and Hermetic cults. Needless to say, those cults and their alchemical descendants have enjoyed only heretical status next to the Platonic-Christian establishment. In the hierarchical order of Platonism and Christianity, what is "above" differs radically from what is "below." To claim otherwise is blasphemy. The cosmic hierarchy had a place for each and put each in its proper place; and there was room at the top for only one. The Holy Roman Empire was a living expression of that pyramidal cosmic order. Monotheism and modern science both do away with apparently *ad hoc* hypotheses, from Ptolemaic epicycles to colorful but superfluous gods and goddesses. Polytheism is unnecessary to a culture that regards all men and women as imperfect copies of the same Form of Man, a Form cast in the image of a single God.

Since the fall of the Roman Empire, there has been a steady erosion of theological austerity: first, the Reformation spawned a proliferation of Protestant sects, then religious freedom in the New World further liberalized the question of belief. Now our spirituality is nothing short of polytheistic, not only in the sense that different cults worship different gods, but in the sense that some of the increasingly popular belief systems are explicitly polytheistic.

From the perspective of the old paradigm, polytheism is the curse of the heathen; within the new paradigm, polytheism is a spiritual manifestation of perspectivism. That is, polytheism acknowledges a plurality of divine perspectives, stances, and excellences. Polytheism demonstrates the important distinction

ıetween relational perspectivism and pernicious elativism. Polytheism is not omnitheism: it is not the ase that *all* is permitted. Only *some* — but more than ıne — are sacred. The distinction is important. Withıut it the first step away from the monotheistic ıaradigm looks like a step out onto a slippery slope hat leads into the depths of an insipid relativism levoid of any standards whatever: "You like what you ike, I like what I like." As polytheism demonstrates, ıerspectivism need not slide into that slough. There re many ways up to Mt. Olympus, and room at the op for more than one; but the top is still quite differnt from sea level in its intensities of excellence. The tatement "As above, so below" is not a leveling ıanifesto, not a denial of distinctions. The point is ather to acknowledge the *human* character of whatver is sacred for humans. In their dramas and inrigues the polytheistic deities sanctify human life by iving it themselves, but on a level toward which ıortals can only aspire.

ı addition to perspectivism and the manifestation of acred macrocosm in human microcosm in "As above, o below," polytheism demonstrates a third feature or orollary of the new paradigm, namely, a kind of cologically sensitive tolerance for difference which, gain, is not equivalent to "Anything goes." Historially, the most vicious religious wars have been ɔught by monotheistic cultures for whom total conuest (reflecting a total intolerance for difference) was he only satisfactory solution. Polytheistic cultures ıay trade the dream of perpetual peace for occasional order skirmishes, but at least they are not perpetually ɜmpted into wars to end all wars.

Monotheism leads to an image of the spirit as someıow "out there." We imperfect humans may be ouched by that spirit, but we are not the spirit or part f it. It is therefore not surprising that, along with a urning away from the objectified, mechanical unierse, there is a turning to inner spiritual sources. his focus on immanence is found both in the expeiential religions and in the traditions that focus on ıeditation as the route to the divine.

ı summary, the contemporary revival of polytheism s not to be dismissed as a regression to prescientific uperstition. A closer look reveals systematic connections between polytheism and the new paradigm: pluralism, perspectivism, tolerance, and the mirroring of the macrocosm in the microcosm adds up to a pattern showing why those who worry about genocide also object to pesticides. A consciousness that thinks it can do away with pests in the name of agricultural perfection may be tempted to do away with certain people in the name of human perfection. But the problem is deeper than a question of which organisms are "pests" or who are the "wrong people." The problem concerns our paradigm for perfection: an austere order or a rich ecology? It is a choice between learning to live with plurality and otherness, or attempting to eradicate differences by regimenting uniform adherence to a single ideal Form.

The Arts

The paradigm shift is nowhere more evident than in the arts, both in the content of particular arts and in the politics, so to speak, of the art world. The esthetic principles and movements that guide the art world are shaped by and help shape the intellectual revolutions discussed earlier. Modernism is an across-the-board battle against established forms, and against the institutions that would educate and pass judgment on aspiring artists. It is not a denial of the greatness and enduring beauty of the works of Shakespeare, Rembrandt, or Bach. The nature of the art we create is a reflection of our times as theirs was of their own periods in history.

The sonata form that dominated musical composition in the eighteenth and nineteenth centuries flourished in the relatively stable context of courtly patronage. The strict progressions of tonal changes and return to the tonic or home key reflected the aristocratic order of the context. When composers like Mahler, Wagner, and Stravinski began to monkey with odd tonalities, their audiences were moved to riot. Finally, Schoenberg abandoned the entire concept of a tonic or central key around which harmonic progressions might revolve as around a fixed center. Today the different schools and genres of music are so varied one can hardly imagine the scorecard, much less follow the score.

Similarly with literature: there was a time not too long ago when there were relatively few central works of

literature. Their unquestioned greatness established a common fund of images to which the literate could allude with confidence that their readers or hearers could draw from the same well. All that has changed, as any college teacher can tell. The fund of images in a freshman English class is an utterly unpredictable mix drawn from the Bible and Bob Dylan, Mark Twain and Sesame Street, Kurt Vonnegut, Milton, and yesterday's newspaper. And any of the above may be missing from any individual's repertoire. Nor is this diffusion restricted to freshmen. Among seasoned professionals one finds a proliferation of cults, little magazines, and specialized societies, any one of which may worship literary deities altogether different from any other. Is it any wonder, then, that an aspiring author or poet can feel free to go it on his or her own, invent new forms, or experiment with formlessness? The sonnet has gone the way of the sonata. Rhymes, like tonic cadences, are almost embarrassing in a world that does not permit such simple closures. No longer atomic and self-contained, the boundaries of what counts as poem and song, like the boundaries of our lives, trail off into an indefinite distance . . .

As for the plastic arts, painting and sculpture, consider Cristo's "Running Fence" trailing off into the sea. Far beyond any attempts at simple representation, twentieth-century art has broken the boundaries of the canvas, the frame, even the museum. Like theater that breaks out of the proscenium and goes into the streets, artists abandon the studio and museum for the streets (wall painting), the ocean (Peter Hutchinson's underwater Arc), and the desert (Michael Heizer's excavations in the Mojave).

In 1969 Samuel Beckett, the Irish playwright and poet, was awarded the Nobel Prize. His best-known work is *Waiting for Godot*, a play in which literally nothing happens; Godot never shows up. The two main characters don't even know why they are waiting for him. It is not reaching too far to draw a parallel with Heisenberg's Indeterminacy Principle — man stumbling along in a world guided only by the accidents of probability rather than by transcendent meanings. Both the form and the content of this masterwork of twentieth-century literature are a manifestation of the breakdown of the old paradigm.

It would be a mistake to regard *all* the odd developments in the art world as faddish manifestations of the far-out for the far-out's sake. Though surely there is enough tomfoolery to keep Tom Wolfe busy (cf. *The Painted Word*), current changes in the arts are, in fact, very much of a piece with changes taking place in the broader culture, and are significant as such. The point is not simply that we see new forms emerging, but that the very concept of stable Form in general has given way to an explosion of happenings, inventions, and events of ephemeral and ambiguous creativity. Process is replacing substance, free form is replacing Form, the very dimensions of time and space are straining against works which, like Escher's drawings, leave us wondering whether there is a clear difference between up and down. As above, so below, but which is which?

THE CHARACTERISTICS OF THE EMERGENT PARADIGM

The approach of this report until now has been analytic. In this section we will attempt to synthesize a pattern underlying the disparate elements presented in the previous section. That pattern is what orders our deepest belief structures, and those structures answer the questions:

- How do we know something is true? What is the nature of the knowledge process?
- How is the world put together, i.e., what is the order (or possible order) of things?
- Why do things happen as they do, i.e., what is the nature of causation?

Such concerns lie behind many aspects of ordinary experience. An example may help. Let us suppose a corporate president makes a decision to buy another company. Further, let's suppose that some of his employees at some organizational distance from the decision view it as a real blunder. Using a simple mechanical model of causality in trying to comprehend this "foolish" act, they might attribute certain motives to the president. Perhaps he has some self-interest at stake. Or maybe he's inept. Or perhaps some advisors have misled him. And so on. A deeper investigation of the reality often leads to a different conclusion. The simple motives imputed from a distance rarely match the complex of causes acting at the locus of decision. Most often a president makes a choice for a variety of reasons, often involving tradeoffs among conflicting goals. A simple causal model in this instance leads not only to a wrong conclusion but to mistrust as well. Action based on simple causal models may be based on a naive desire for certainty. A more thorough and subtle model considering the constraints on the decision may lead to greater tolerance, to greater appreciation of ambiguity; on the other hand, it can also lead to paralysis and indecision based on uncertainty.

In what follows we are not concerned with the issues of knowing, ordering, and causing in a scientific or philosophic sense. We are not, for example, very much concerned with the scientific standards of proof. Rather, we are concerned with an understanding of how the developments analyzed earlier can enrich and illuminate the ordinary world of human affairs. We wish to focus on what those many disciplines tell us about the nature of things, not on how those disciplines themselves are to be conducted.

In the various disciplines covered in the previous section, we discovered a number of characteristics, as shown earlier in Table 3. Before covering these in detail, a brief summary of the pattern of characteristics may be useful:

- Knowing — Historically there has existed a tension between the subjective/active (solipsist) modes and the objective/passive (empiricist) modes of knowing. The emergent mode is toward perspective/receptive, acknowledging the role and place of the observer, yet keeping some useful distance. This leads to a process of knowledge that is more interpretive, inevitably ambiguous, and partial. The process has rules, but they are rules for engagement rather than for objectifying.
- Ordering — The old ordering principles are atomistic, mechanical, and hierarchical. The image of the hologram is a central one to the new view, connoting the complex network of interconnections among events and the containment of the entire order within a particular one. Alongside is the heterarchical, decentralized, and many-dimensional structure. The change process is morphogenetic — that is, innovative structures arise out of fluctuations in the old order.
- Causing — Cause and effect has been considered a relatively simple one-to-one process. The movement in the new view is from the simple to the more complex, from single agents to multiple sources, from unidirectional to mutual, from determinate or probabilistic outcomes to innovation, and from control to influence.

In this section we will try to "unpack" and clarify these somewhat cryptic summaries by focusing separately on each of three domains of concern. We conclude this section with a note on a theme that cuts across all three domains.

Knowing

Our interest in the nature of knowledge arises not from philosophic concerns, as in epistemology, but from the fact that human choice and action depend, to a great extent, on what the person choosing or acting knows. The main issues are what counts as knowledge and how something comes to be knowledge — questions of substance and process, respectively.

The historical tendency has been to assume that in the nature of things there is some singular, ultimate truth. That truth may be as cosmic as the origin of the universe or as mundane as the level of air pollution that causes disease. According to the old paradigm, we conceived of science and other knowledge processes as taking us ever closer in an asymptotic fashion to the one "truth." The measure of success was how close we could come to that asymptote of ultimate truth.

This assumption of ultimate truth is analogous to the reductionist assumption of science. That view held (and for many still holds) that, if properly understood, anything can be divided into parts whose behavior and nature will determine the behavior of the whole. Reduction proceeds until we reach the so-called most fundamental subatomic particles. As noted earlier, however, that fundamental level increasingly appears to be an insubstantial foundation on which to build a world view. In physics, the fundamental particle may turn out to be a chimera, to be replaced by a complex ecology of particles in which the act of searching influences what is found.

The basic flaw in the view that ultimate building blocks can be found is also evident elsewhere. Nearly two centuries ago there began a quest to reduce the functioning of all organisms, especially human physiology, to the level of complex chemical and physical structures and processes. This attempt induced a debate as to the possibility of such a reduction. The last vestiges of that debate still continue in brain research. The main issues were laid to rest by Claude Bernard in the mid-nineteenth century when he identified the domains of relevance of biochemistry on the one hand and physiology on the other. To the extent that an organ in the body, for example, has certain localizable processes (e.g., digestion) these may be reduced to their chemical and ultimately physical elements. However, since these organs also have functions that cannot be reduced to inorganic chemical activity, their nature and behavior cannot be understood entirely in biochemical terms. Complementarity replaces conflict; and plurality among the explanatory aims of physiology and biochemistry requires a corresponding plurality of concepts and methods.

Physics and, later, chemistry served as the ideal image of knowledge. In those domains, at least until recently, it seemed possible to erect a unified reductionist world view. However, the attempt to explain more complex phenomena (e.g., biological systems) as nothing more than the sum of their parts caused continuing controversy. Even now in physics and chemistry, as Bohm and Prigogine have so elegantly demonstrated, we must speak of an ecology of particles and new forms that transcend their components. Reductionism was remarkably successful in sorting out the parts and their relationships; in this respect it has been a powerful and useful conceptual tool. As our perception now becomes more subtle, we need to understand the limits of that conceptual tool in aiding our further explorations into the nature of things.

What does all of this tell us about the human condition of knowing? Perhaps at the root of the change is a shift from the extreme of the "one truth" discovered by the "one method" toward a plurality of kinds of knowledge explored by a multiplicity of approaches. In almost every real-life situation we will find multiple truths, each revealed by a different perspective or approach. This is not to deny that there may be an ultimate truth. It is simply to say that for human needs there are many truths and many ways of knowing them. One kind of knowledge is spiritual knowledge, and the diverse spiritual traditions of humankind represent many routes to that knowledge. Another kind of knowledge is that of the natural order represented by the diversity of sciences. Still another kind is knowledge of the human condition, revealed by science, art, and our own experiences of ourselves and our fellows. Within these and other domains of knowledge there exist, of course, a multiplicity of perspectives. It is central, however, that one form of knowledge or method or perspective cannot be reduced into another. We will not explain God through science, nor will God reveal the workings of a computer. Each form of knowledge, method, or perspective has a contribution to make toward understanding and wisdom.

This plurality of knowledge is especially important in the day-to-day choices of life. The debate over national energy policy serves as an illustration of the

problems of a single-minded view of knowledge. The participants in that debate base their views on different assumptions, methods, criteria, values, and data, interacting them in a complex fashion to arrive at positions that they consider to be based on the "objective facts." The complexity of those interactions for each participant is key to understanding the acrimonious tone of the debate. Each participant viewing an opposing position almost inevitably imputes a simple set of motives to the opponent. The oil companies see the public interest groups as only naive, unrealistic, and elitist. Public interest groups see the oil companies as only trying to fill their coffers with undeserved wealth. Both see the politicians and bureaucrats as obstructionists merely trying to save their jobs. The technicians would like to reduce the issue to an engineering problem and wish that the politicians and the public would leave them alone to come up with an engineering solution. Each participant fails to see the perspectival nature of the debate. From where he or she sits, each participant "sees" a different situation. From each different perspective a different set of methods seems required to illuminate the situation and results in different conclusions. Each view is equally complex — not merely self-interest — and usually "right" from its point of view.

The first step out of this apparent dilemma is to recognize that each perspective gives only a partial and hence an ambiguous view. Before any resolution can even begin, the participants in the debate must accept the genuineness and uniqueness of the multiple perspectives. If that first step is possible, the participants may be able to move on to a mutual engagement in greater depth with their diversity of views. This interaction in turn may lead to a realistic set of compromises that takes into account not only the diversity of interests but the diversity of perspectives as well.

But if we let go of the apparently firm foundation of objective fact verified by rigorous method, do we not run the risk of a subjective and chaotic disorder? This tension between *objective* and *subjective* can often be resolved in favor of *perspective*. *Objective* connotes distance from the object of study; *subjective* connotes a personal view. *Perspective* borrows from both, defining a personal view from some distance. It suggests neither the universality of objectivity nor the personal bias of subjectivity.

The discipline of hermeneutics provides a good analogy. Hermeneutics is the discipline of interpretive principles used in biblical studies. Unlike literary critics, biblical scholars seek the meaning of a profound revelation for human experience. Like scientists, they seek a rigorous method to avoid the abyss of personal subjectivity. A carefully worked out set of principles of interpretation (rather than factual determination) has emerged over the centuries, but these principles will not lead to the one truth for all observers for all time. The results are a bit like the results of rules in sports: the rules allow us to make sure we're playing the same game; they do not produce the perfect football or basketball game, or dictate who wins.

This perspectival quality is also associated with the inevitable partiality of any description, which implies some degree of ambiguity in our state of knowledge of anything. More careful study will not induce that ambiguity or uncertainty to go away. Rather, given the nature of our times, study in depth usually increases our uncertainty. Simplicity and its attendant certainty exist only at the superficial level and perhaps at the level of ultimate truths. In the vast domain in between, where we find ourselves most of the time, ambiguity and uncertainty are inherent qualities of knowledge. There may occasionally appear to be a temporary solution, but each successive cycle of questions will almost inevitably produce as many new questions as answers.

The state of being associated with objectivity is passivity. It has the sense of detachment and distance and hence no motive force. Intellectually it is the domain of theory. At the other extreme, with subjectivity we associate activity or doing. It is the domain of practice. As we have resolved the conflict between objective and subjective through the concept of perspective, so now the tension between activity and passivity is resolved through the concept of receptivity. This state involves an active dimension of preparation — of being able to receive — and a passive dimension of openness — of being unblinded by bias. Similarly, the

apparent conflict between theory and practice is resolved in favor of engagement or involvement while retaining some detachment.

The nature of knowledge and the process of knowing are changing. In the multiple selves of psychology, in the value of differentiation in ecology, and in the diversity of religions we see the advantage and necessity of a plurality of perspectives. In the multiple levels of physics and the role of the observer we see the necessity of acknowledging the partiality of all descriptions. In the holographic metaphor for the brain, we find a need for perspective rather than the historic dualism of "in here" and "out there" of the mechanical model of the brain. And the linguists tell us now that meaning comes from location in a context, so that to know meaning requires engagement. These, then, are the emergent qualities of knowledge and knowing: perspectival, multiple, receptive, partial, and engaged.

Ordering

There is an apparent order to things. Understanding the nature of that order or creating new orders requires some understanding of the principles of ordering, i.e., what kinds of order are possible? We generally draw our lessons of order from nature. It is not surprising, therefore, that as our understanding of the natural world increases, we often uncover new kinds of order.

The issue of ordering has at least two aspects:

- What kinds of structures and relationships among their elements are possible?
- What are the processes by which an order changes?

At the risk of oversimplifying, the current view can be captured in a few concepts. It says that almost all structures — whether biological, physical, organizational, or informational — tend to be hierarchical. There exists a pyramidal order with an apex at which sits the "supreme commander," transmitting orders down through the ranks. At each level there is a similar top-down command relationship with all the lower levels. The inverse is also true in that each level can be viewed as being merely an aggregation of the levels beneath it. Thus, things may be related to each other as either equals — i.e., on the same level — or as building blocks — lower levels of components to higher levels of wholes. Given such an ordering, things change either by disassembly and reassembly or by addition and deletion.

A very different model of relationship appears in the physics of David Bohm. There we noted how an entire order can be enfolded into the local order. We used the example of the hologram; let us call this the holographic order. A more familiar example — the growth of a human child — may help illuminate the nature of this ordering principle. The basic question is: How can very complex, large-scale orders be contained within much smaller and apparently simpler orders? A child at birth is an extremely complex organism, vastly larger than the sperm and ovum present at conception. However, encoded in the invisibly small and relatively simple structure of the DNA in the two parent cells was all the information necessary to produce that very complex and relatively large organism. And making small changes at the chemical level of DNA can produce very large changes in the organism. Finally, that same information remains encoded in the DNA contained within every cell of the living and growing organism. The holographic order has this implicate-explicate quality, where information about the entire order is contained in each location within the order.

Another way of seeing the relationships of the new ordering is the concept of interconnectedness. A river delta provides a useful analogy. It is not possible to predict the flow in any one branch of the network of streams in a delta from the flow in the mainstream of the river. The flow in any branch depends in a complex way on flows in all the other branches. If the flow in one branch is restricted, the flows in all the others will change — some up and some even down — to adapt to this new condition. Similarly, in an order where the ordering information is distributed throughout, there is a kind of interconnectedness such that a change in any one aspect will result in a network of changes as the other aspects adapt to the new condition. As we saw in the discussion of evolution, when we conceive of a gene pool of genetic

information distributed throughout a population, it is the network of relationships among its many organisms and the environment that produces evolution. In the brain theory of Karl Pribram we find again the network of information distributed throughout the brain rather than tied only to a single cellular location. The metaphor for the new order is the pond with its traceries of ripples rather than the edifice of concrete and steel with a place for everything and everything in its place.

As we have pointed out, hierarchy has been the rule of structure. Further, the ordering principle has followed a narrow conception of hierarchy. What is above commands what is below. What is below determines the capacities of what is above. In his elegant book *Janus*, Arthur Koestler calls this the "nothing but" view, as in the notion that a human being is "nothing but" the assemblage of physical and chemical systems of the organism. Koestler enriches the concept of hierarchy and renames his version as holarchy. The essential shift is toward a new concept of each element in a hierarchy/holarchy. Each element has "both the independent properties of wholes and the dependent properties of parts." Each organ in the body is composed of cells and chemicals, but its behavior is not solely a function of its constituents. It also functions as part of a larger system that helps guide its behavior. The Janus concept suggests that each "organ" shows a different face looking up than looking down.*

Anyone who has worked in a large organization will be familiar with holarchy. Take a group of people and assemble them at random and chaos will be the result. Assign them to some functional task, as in a department, and the behavior of the group now becomes coherent — or so one hopes! Their behavior becomes not only more than the sum of the individual behaviors, but it is also — at least to some extent — independent of the wishes of the management above it. Outside of the military, it is rare to see a successful imposition of hierarchy where there exists a natural holarchy.

*In Roman mythology, Janus was a two-faced god associated with doorways and gates. The month of January is named after him because it looks both back on the old year and ahead to the new.

The concept of hierarchy can be enriched still further to encompass Warren McCulloch's concept of heterarchy — that is, overlapping or multiple hierarchies. A familiar example may help illuminate this concept, originally developed to describe neural processes in the brain. Most people belong to a heterarchical system; i.e., we may view a given situation from the perspective of several hierarchies: the family, the community, the company, the nation, the religion, the species, etc. Each hierarchy will have a different set of ordering principles, some of which are complementary and reinforcing, while others are conflicting. Sorting them out may sometimes require a Solomon-like wisdom when the conflicts are real and deep. Nevertheless, we do it all the time. We serve, as it were, several masters simultaneously.

Heterarchy can be viewed as a decentralization of the very concept of structure itself. The original, ideal notion of decentralization was the centrifugal movement of political power from some centralized seat down through a specified hierarchy and out to remote areas. In complex systems, however, it may be more meaningful to speak of decentralized hierarchies in the heterarchic/holarchic sense. Thus, rather than one single peak of power, there are several or many centers with overlapping domains. This shift is akin to a movement from the single-peaked paternal order of the omniscient father to a more complex fraternal ordering among co-equal siblings.

Human feelings provide a good analogy for this kind of decentralization. When we play with our children, we may actually feel childlike — witness the father with his children's toys after the children have gone to bed. Moments later we may turn to reading a spiritual verse and our feelings may be lofty, even holy. At another time, grief over the death of a loved one may overwhelm everything else. In each instance, in the life of one person a different hierarchy of values, beliefs and behaviors is dominant for the moment. Each is one of the many dimensions of the human experience. For one person to have childlike, holy, grief-stricken, and innumerable other feelings requires a decentralizing of the self via heterarchical ordering of information.

Our picture of structure has become quite complex: a holographic, holarchic, and heterarchic order. One more question must be considered: How do such complex structures change? They may change in small adaptive and familiar ways — by incremental additions and subtractions. They may also collapse. However, as Prigogine and Thom have shown in chemistry and mathematics, complex systems can also undergo qualitative rather than quantitative change. Often it appears as if a new order were born of chaos. This evolution of a new form or structure out of the old is called morphogenesis. Cellular growth displays morphogenetic change. The birth of the United States from the disarray of the colonies was a kind of morphogenetic transformation. The psychological changes that occur when a "normal" person suddenly moves to a behavioral domain of internal rationality but external insanity is often morphogenetic strategy for coping with apparently irreconcilable conflicts. As was noted earlier, morphogenesis requires differentiation and fluctuation, two conditions found in heterarchical systems rather than in hierarchical structures.

We thus have a new picture of how things can be ordered. From physics and brain theory we discover the mysterious quality of a holographic order. From psychology, political theory, philosophy, and the arts emerge the concepts of holarchy and heterarchy to replace rigid hierarchy. In chemistry, mathematics, and biology we uncover the morphogenetic model of change.

Causing

The issue of causality has to do with questions of why things happen as they do. Maruyama has identified three classes of existing causal models. The evidence now suggests that we are opening a new fourth class of causal models, which can be called complex, mutually causal models.

The first class of models is the most ancient and most familiar. These models focus on singular causes in a linear and mechanical sequence. Push the rock and it moves. Pushing it again produces the same result. Quite simple. The second class is the probabilistic world of equilibrium thermodynamics. Randomness and homogeneity are the ultimate condition of the universe. Thus, what appears to be order is simply the local and temporary result of a probability distribution. In time this order will change toward randomness, as is dictated by the nature of entropy.

Cybernetics provides the third class of models and opens the way for the fourth. Cybernetic models permit feedback from effects to causes; however, the primary focus is on negative feedback. As the magnitude of an effect grows, it provides some feedback to the cause in order to diminish the future effect. The thermostat is the classic model of a negative feedback loop. If air cools below the thermostat setting, the thermostat fires up the heater. When the air warms beyond the desired temperature, the thermostat reacts by turning off the heater. Eventually, heater and thermostat reach a stable limited cycle of off-on around the desired temperature. This condition, called homeostasis, is the result of negative feedback causality.

In addition to negative feedback, the new mutually causal models incorporate positive feedback which acts on the cause to reinforce or amplify the effect. In this case, difference grows rather than diminishes. Maruyama develops the example of the evolutionary interaction between the protective coloration in certain moths and the predatory behavior of certain birds to demonstrate this concept. Discovering the mechanisms of that interaction is an informative exercise. The "obvious" solution is that a predator, a bird in this case, eats more of those moths whose protection is poorer. Hence, each generation of moth has a proportion of better-camouflaged moths. Simple? Not quite. Such a model will predict a given rate of change and a growing moth population as more moths escape the birds. What happens in fact is that the moths change more quickly than predicted and their population stays stable. Something else must be happening.

When we observe the birds of each generation, we find the answer. Some of the birds are better at the than others to find hidden moths. These "smarter" birds have an advantage over their fellow birds, and eventually they tend to dominate. This accelerates the change in the moth, which keeps the moth population stable despite better moth-finding by the birds. Thus,

both species are evolving together or co-evolving. They are each other's cause and effect. The bird is a better hunter and the moth a better hider. They share a mutually causal relationship.

The system of the bird and the moth is relatively simple and predictable. Both natural and social phenomena, whether they are ecosystems or bureaucratic structures, tend to manifest behaviors of very much more complex systems; and mutual causality in complex systems tends to produce unpredictable results. When viewed this way, it is not surprising that government economic policy often produces effects that are unwanted, unanticipated, and sometimes even the opposite of what was intended. Simple causes in complex, mutually causal systems tend to have little efficacy in producing the desired effects. Such a simple cause can be associated, for example, with a paternalistic causality. Father or President knows best by virtue of age or election. He acts and the system carries out his will. Unfortunately, neither families nor societies seem to function that way. Rather than a paternal structure, we can speak of a fraternal structure: a fraternity of causes and effects interacting in a complex, mutually causal fashion — all changing together. Rather than being characterized by isolated points of cause and effect, the behavior relationships appear much more like a field or a network.

The nature of the change process in complex, mutually causal systems is morphogenetic. These systems tend to produce the needed fluctuations which, through positive feedback, tend to grow in magnitude and frequency. What is critical is that, unlike in the simple unidirectional model of causality, here everything changes together, more or less in harmony. If the system is resilient, such a process tends to be smooth and continuous (though not necessarily slow). Low resilience means high resistance and often fracturing or collapse. Furthermore, since change feeds back on itself, even the causes themselves change. Thus, when we speak of producing a particular change in our environment, we are not unaffected by the results: we change too.

The example of pesticides provides a familiar case. We spray chemicals on agricultural pests to control them. The hardier ones survive, increasing the resistance of the next generation. We increase the dosage and modify the chemical formulation, which produces even greater resistance in the pest. Greater and greater technological effort and cost go into controlling the pest. However, after several iterations of this cycle, it becomes difficult to tell who is being controlled, man or pest or both. This process of successive adaptation rather than singular solutions becomes the model of mutually interactive causal processes.

We find similar phenomena at the human scale. Divorce, for example, may result from a complex of little-understood causes. But often divorce is associated with other major changes in such aspects of life as careers, religions, locations, and lifestyles. Having broken one important bond, the psyche now needs to rearrange all its other significant relationships to achieve a new functional whole. Seen this way, divorce in some instances can be viewed as symptomatic of a greater pattern of change.

In evolution and ecology we discover the lessons of mutually causal systems. In chemistry and physics we discover complexity. Finally, in mathematics we find morphogenesis. Thus, from a simple, linear, mechanical causality we are moving toward a complex, mutually causal, and self transcending structure of change. If we reflect on this picture of causality, we will almost certainly find it a closer representation of our own experience than the more succinct and less subtle model.

From Unity to Multiplicity and Back Again

There appears to be a common thread that knits together those apparently disparate aspects of our emergent maps of reality. We see it as a shift in focus from unity to multiplicity. In science we no longer seek the one grand pyramid. And we no longer look for the one cause. This does not deny the unity of humankind but emphasizes it; we are all intimately interconnected at many levels. It is rather a shift in focus from the tyranny of unity to a tolerance for multiplicity.

There was a time when the affairs of humankind, especially in Western civilization, were guided by a set of unifying principles. In the confident unity of the religious order was found the basis for our values, sources of meaning, and even social and political orders. Over the past ten centuries we have moved away from the religious roots of our present order as we have become increasingly secularized. However, there appears to be in the human psyche a deep desire for unity (along with individuation), reflected in the powerful urges toward love, spirit, and association with others in common bond (e.g., family). As we became a secular civilization, we seem to have turned our quest for spiritual unity toward a search for secular unity. To find that secular unity may be a naive hope. There may be one religious truth, the "perennial philosophy" as Aldous Huxley called it, that lies behind all our diverse religions. Perhaps each is the unique cultural expression of that one truth by a particular people. However, what may be ultimately unitary in the spiritual domain may still be multiple in the secular experience of humankind.

As we have attempted to substitute secular unity for spiritual unity, we have also absorbed some of the mundane problems of the older rigid religious structures. The history of religion is rife with these problems: rigidity, exclusivism, conflict, and an all-too-frequent focus on the trivial rather than the exalted. We see these same issues confronted in the domain of ordinary existence — in the struggle against entrenched orthodoxy. How many political and scientific insights have been branded as heresy? How many conflicts have been engendered by that quest for a simplistic certainty and affirmation of unity? How many times has the cry been repeated, "Ours is the one right way," whether the domain be scientific, political, economic, or religious?

Perhaps we have a childlike need for a paternal authority to inform us of the nature of things. Once it was the One God. Now we have sought to replace that lofty figure with secular authorities (politicians, scientists, etc.). Unfortunately, while the One God could be experiential, our secular authorities have become far more obscure and remote. We have come to equate the necessity of a comprehensible natural and social order, handed down by our authorities, with the basis for meaning: if there is no order, then there is no meaning.

One of the qualities of maturation in the individual is the ability to exercise independent judgment in complex and ambiguous situations. Our analysis suggests that over the last century our endeavor to explore and map the natural and human universe has led us to see more ambiguous, complex, and multiple orders to the nature of things. Perhaps this reflects a maturation of humankind in its ability to transcend a naive and childish kind of unity. More and more, we are acknowledging the subtlety and complexity of ourselves and the world of which we are a part. That growing realization may also be a reason for what appears to be a current spiritual renaissance of diverse and great proportions. It seems more likely that unity, if it is to be found at all, will be found in spiritual pursuits rather than in the messy world of physics, politics, and the human psyche.

GLOSSARY

1. Catastrophe	A mathematical description of a sudden and/or radical change in form, or a similar qualitative change in condition; relates to the theories of Rene Thom.
2. Dissipative structures	A term invented by Ilya Prigogine to describe complex chemical structures undergoing the process of chemical change.
3. Entropy	In thermodynamics, a measure of energy that is expended in a physical system but does no useful work and tends to decrease the organizational order of the system.
4. Essence	An Aristotelian idea that everything has some characteristic quality which gives it form and defines its essential nature.
5. Family resemblance	Wittgenstein's philosophical concept that describes how a word relates to a class of examples or paradigm cases.
6. Form	From Plato, the term is similar to "essence" and "idea;" it denotes the eternal and universal quality that distinguishes one thing from another and defines the characteristics common to all elements of its kind.
7. Heterarchy	An ordering of things in which there is no single peak or leading element, and which element is dominant at a given time depends on the total situation; often used in contrast to hierarchy.
8. Hierarchy	An ordering of things in which one element is superior to all others and only that element is generally on top.
9. Holarchy	A concept invented by Arthur Koestler to describe the behavior of elements in a hierarchical system, in which that behavior is partly a function of their own individual nature and partly a function of the nature of the whole system.
10. Hologram (holographic)	A three-dimensional photograph created by the interference pattern of two laser beams.
11. Idea	See Form.
12. Immanence	A philosophical and theological term denoting that the Spirit dwells within all beings and things.
13. Indeterminacy principle	A principle formulated by Werner Heisenberg, which states that at a subatomic level the outcomes of physical processes are not predictable.
14. Interference pattern	A term in physics describing the bands of light and dark that result from the interaction of light waves.
15. Metaphysics	The philosophical discipline that deals with the ultimate nature of things.

16. Morphogenesis	The evolution of form or order out of apparent disorder.
17. Mutual causality	A relationship between two things in which they mutually affect each other, causing change in both, as in symbiosis.
18. Paradigm	The set of fundamental beliefs, axioms, and assumptions that order and provide coherence to our perception of what is and how it works; a basic world view; also, example cases and metaphors.
19. Quantum theory	A theory in physics that postulates energy to consist of discrete units (quanta), which exhibit characteristics of both particles and waves; similarly, particles of matter are also characterized by an associated wave function. The theory implies that no subatomic event is independent of other such events and that no sequence of such events is strictly predictable.
20. Reductionism	An idea that the nature of reality can be understood by comprehending the nature of its constituent parts.
21. Relativity	Einstein's theory that space and time are not absolute and distinct quantities, but rather their measurement is a function of the relationship of the observer and the observed.

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