A Twentieth Century Renaissance? The Price and Promise of Cultural Change

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I

European intellectuals diagnosed the end of the nineteenth century as "the sickness of an age." Schopenhauer's pessimistic books suddenly became popular; Nietzsche announced the "death of god"; and Max Nordeau's *Degeneration* was an international best seller. To be sure, this mood of despair was initially limited to a handful of poets and philosophers. But once the outbreak of World War I revealed what "the treacherous years were all the while making for and *meaning*," the sense that the West had somehow been betrayed by its own most fundamental accomplishments and beliefs was globalized. Thomas Mann's *Magic Mountain* captured the idea neatly by describing Europe as a tuberculosis sanatorium behind whose walls splendid accomplishment rapidly rotted toward calamity. Spengler's *Decay of the West* and the early volumes of Toynbee's *Study of History* argued that decline was inevitable. As Europeans lost faith in their ability to erect *The Heavenly City Of The Eighteenth Century Philosophers* [Becker, 1932], the era of "enlightenment optimism" gave way to Auden's "Age of Anxiety." If, as T.S. Eliot put it in *East Coker*, "the quiet-voiced elders" bequeathed us "merely a receipt for deceit," then, to cite again W.B. Yeats' famous poem, it became increasingly obvious that "things fall apart, the center cannot hold." "[F]ollowing some rough beast" that "slouches toward Bethlehem to be born," modern civilization began a desperate search for new values that could orient society in an unexpected world.

The sources of Western anxiety were structural and multidimensional. On the one hand, technological applications of science were transforming the natural environment, posing problems

that the political and economic systems were incapable of resolving. In fact, the political ideology of *laissez-faire* led to a policy that bound the hands of the community at the very time when new technologies were releasing unprecedentedly dynamic engines of change into the societal and natural environments [Polanyi, 1957]. By 1900 it was obvious that market mechanisms energized by private greed were incapable of addressing public issues of poverty, education, and health. Moreover, governments committed to the free-play of capitalist forces were incapable even of recognizing the resulting catastrophes. Nor were institutions geared to solving political and legal problems competent to deal with crises that were inherently economic and sociological.

Another reason for the Western crisis of confidence was the virtually self-defeating value system inherited from the "modern" era. Resting on a popularization of Newtonian science, Western culture had settled into a complacent materialism that virtually denied the existence of values. Modern science credited what could be counted, weighed, and measured – the primary characteristics of Galileo and Descartes. Anything intangible, whether God, soul, mind, or ideas, was inherently suspect. The march of science, defined by Ernst Mach as "the natural enemy of wonder" [Mach, 1910], meant, said Bertholet, that the "world was now without mysteries" [quoted in Capek, 1961]. In other words, scientism led to the conclusion that values were merely subjective prejudices. They were capable of misguiding intellect into metaphysical realms of pure and unverifiable speculation, but they had no objective meaning in a materialistic world governed entirely by mechanical forces.

Modern science was clearly part of the problem confronting Western culture, but, the experts agreed, by definition it could never be part of the solution [Brinton, 1959]. It could not address the Big Questions about the meaning of life, although its technological off-springs – increasingly described as Frankenstein monsters – made those questions agonizingly immediate. What, in fact, did life mean in a world where only material entities and mechanical motions were real? As young students at the Sorbonne like Jacques and Raissa Maritain inevitably concluded, the answer to that question was "nothing." Suicide was literally the only rational response [Maritain, 1988].

Of course, official propagandists sought to counter this mood, especially when they endeavored to motivate youth to answer the call to arms in 1914. With the less sensitive or the uninformed,

governments succeeded. With the more philosophically sophisticated, however, a new and terrifying response was engendered. Young people like Ernst Psichari in France, Ernst Junger in Germany, D'Annuzio in Italy, and T.E Hulme in Britain responded to the outbreak of war in a totally atavistic manner, which would become typical of a whole generation. They did not truly believe in the war aims of their respective governments, but they rushed to battle anyway. War, to them, became a vehicle for escaping the stultifying dreariness of a soulless bourgeois world where regimentation and calculation reigned supreme. In battle they found a real community instead of a marketplace, a primal reality where an archaic blood lust triumphed over the cold rationality alienating youth.

But war eventually revealed to the masses what earlier intellectuals had proclaimed, namely that a blind faith in progress was unwarranted. Combat on the Western front demonstrated the awesome power of science tied to technology and nationalism [Fussell, 1975]. It showed that all our learning could be put to uses that were unprecedentedly destructive, wasting millions of lives in battles with no measurable effects. Pitting patriotic spirit against barbed wire, breach-loading artillery, machine guns, and poison gas demonstrated that scientific and technological accomplishments were not necessarily progressive. All they seemed to do was magnify ancient destructive urges.

The war, that is, revealed the flaw in value-free modern science. Science provided knowledge, making us technological giants, but offered no ethical guidance, leaving us moral midgets [Koestler, 1959]. But in decoupling values from reality, early twentieth-century thought opened the door to an orgy of unrestrained ideology. As Mussolini – and D.H. Lawrence, Henry de Montherlant, Ezra Pound, and numerous others – pointed out, beliefs derived from passion, from the "blood." They were entirely artificial constructs that reason could not create and rationality could not judge. Leaders in the inter-war years, therefore, were admired for their capacity to mobilize the mob, another creation of the urbanized mass society produced by liberal politics and Newtonian science [LeBon, 1895/1960]. Unrestrained by any sense of reality or enduring notion of truth, these demagogues filled the void caused by alienating whole societies. The resulting "movements," whether fascist or communist, left a trail of blood and suffering behind them unmatched in the annals of history.

II

Neither the history of tragic devastation nor the record of shattered dreams is sufficient to make pessimism logically necessary, however. Twentieth century intellectual pessimism results from an inadequate understanding of the process of cultural change, which is itself dependent upon the impoverished scientific paradigm inherited from the "modern" world view. Cultural change involves the qualitative transformation of both people and institutions. A science that reduces reality to strictly materialistic phenomena whose motions are mechanistically determined cannot track qualitative change, for the simple reason that it rests upon the metaphysical presupposition [Burtt, 1925] that reality ultimately is "everywhere conformable to itself." When there is no structure for understanding change, only will and violence will prevail. But a more sophisticated scientific paradigm, recognizing that "nature is too rich to be described in a single language" [Prigogine, 1980; p. 53], can produce a description of nature as a process embracing symmetry-breaks where new levels of reality emerge.

If nature is capable of generating fundamental evolutionary discontinuities that lead to the emergence of qualitatively new realities, human societies should be able to do so as well. In the scientific image of nature, therefore, we have grounds for hope. But we must not forget the tragedies of the past: Our immediate ancestors did kill one another in vast numbers and with unexcelled enthusiasm – and rekindled religious, ethnic, and nationalist violence suggests we may be willing to do it again. Still, a "hopeful realism" is possible. But it will require using contemporary scientific models of self-organization and evolving complexity to understand both *why* the twentieth century has been a period of such terrible destruction and *how* it might lead to a renaissance of human values. Thus, the lessons of history and science converge to constrain our ambitions and inspire our vision.

III

Embedded in a culture that has lost faith in itself, the new scientific paradigm teaches us to look for randomness and expect discontinuities in evolution. Simply put, it says that nature is a process by which information is created through dynamic interactions. Each new step up the ladder of complexity, however, requires that the

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previously established plateau of stability be shattered. This shattering follows from both internal and external processes. Internally, an evolved structure will suffer "fluctuations" because it makes "mistakes" in the process of replicating its organization. Since networks of nonlinear relations lace complex structures, even small fluctuations can have effects disproportionate to their causes. Small causes, at points of instability, can have system-wide effects. Existing structures are also vulnerable to external "perturbations" generated by events in the environments in which they are embedded. Perturbations are destabilizing flows of energy, matter, or information across the boundaries of a structure. Both the perturbations and the fluctuations are random, but their interactions may lead to the "emergence" of new levels of stability.

Emergence implies that while self-organized structures may be indebted to history for their achieved levels of complexity, their evolved forms are underdetermined by past events. That is to say, when a perturbation carries "information" from an environment across the boundary of a system, the internal structure that processes the information – making it "meaningful" in either a positive or negative sense – must somehow be relatable to an unpredictable structural alteration that was itself "caused" by random fluctuations. In other words, we are no longer dealing with a neo-Darwinian model that ontologically posits a given environment naturally selecting mutations. Contemporary evolution theory posits a systems model that recognizes organism and environment as mutually captured and capturing. Emergence means that the symmetrical historical development of both structure and environment may break unpredictably as random events in each redefine the other.

Evolution takes place at symmetry-breaks, for it is only when structural organizations able to decode new environmental inputs emerge that information is "created." New structural organizations are produced when old ones break down. The breakdown of organization means the internal entropy of a structure vastly increases. At the same time, the perturbation of a structure by environmental information, energy, and matter leads to further increases in entropy. Entropy, here, means both that the internal coherence of a system is lost and that more waste is produced by its increasingly desperate efforts to regain stability. Market mechanisms driven by private profits, for instance, were incapable of perceiving or processing information, energy, and matter regarding, say, environ-

mental pollution or mass poverty. Poverty was interpreted as a measure of personal inadequacy, while wealthy individuals considered the ability to insulate their lives proof of private virtue and merit. But the independent actions of many individuals blaming or blinding themselves usually worsened problems rather than solved them. The worsening of unsolved problems is the measure of accumulated internal entropy paralyzing a society.

With the loss of internal organization, the components of a structure are free to behave randomly. In their random actions they search the environment. If these random behaviors discover new organizational procedures that are able to produce environmental flows in forms the structure can process, then a new stable state may be reached. But then the structure will have self-organized literally, for it will have extended the system of its organization to incorporate an expanded environment which was previously unknown and whose perturbations were previously considered "noise." The resulting structure will have an unexpected identity, which its future "development" will unpack in a logical, coherent manner until instability again occurs.

Societies appear to be self-organizing structures whose histories may be comprehended using this scientific paradigm. To begin with, they are multi-level complex systems that process environmental information, energy, and matter by correlating the specialized behaviors of their human members. There seems to be no unique way to organize societies in detail, so each has an identity of its own that appears wholly contingent upon individuals' creative responses to environmental challenges at the time the society emerged. However, once a group of people has found a way to organize its efforts so that the society survives, it is able to communicate that knowledge to succeeding generations. Moreover, through a variety of negative feedback loops, societies monitor the actions of their members, discouraging behaviors that threaten the whole.

IV

Social structures model their environments in the same way that, according to Bateson [1979], dolphins model the sea. Dolphins describe the sea by the design of their organic structures. Societies describe their environments by translating information from the domain of physical, economic, and technological realities into

orchestrated human actions. Effectively replicated human actions can stabilize a society, so long as the environmental flows in which it is embedded can be processed. For social structures to perpetuate themselves, every human member – and each succeeding generation – must share the information defining the society. This information describes critical environmental resources and prescribes the behaviors necessary for their exploitation. To communicate such information requires symbolization. Typically, tales, myths, and religions describing ancestors, heroes, and gods identify which resources are critical to a society, describe how the people learned to use them, and prescribe what actions are morally sanctioned by the collective. To elicit repetition of selected behaviors, value symbols orient people in favor of certain behaviors, and normative ethics specify how those behaviors are to be applied. Together, this information records behavioral patterns identifying a particular society and permitting its replication across generations.

It seems reasonable to suppose that environmental selection operates on the information structuring societies in essentially the same way that it selects between biological organisms. But it is important to remember that at the level of social structure it is collective behavior – not biological individuals – that is being selected. Selection now operates on the population of societies, and those better equipped to process environmental flows will be advantaged. Societies process environmental flows by shifting the behaviors of human individuals and groups. Behaving like computers, societies need "programs" to process information from their environments. Those programs trigger behaviors by individuals and groups that structure societies. Although the term is less than perfect, several social scientists have called the information operating societal computers "cognitive maps" [Boulding, 1956; Downs and Stea, 1973; Lynch, 1960; Gladwin, 1970; Artigiani et al., 1989].

A society evolves when changes on both the behavioral and environmental levels interact, amplifying one another. When that happens, a positive feedback loop can trigger a cascade of changes that ripple through an entire social system, driving it through a period of turbulence to a new structural pattern. Social turbulence results from the breakdown in communication between people. Some have begun to act in new ways because they have encountered new environmental realities. Others, of course, remain oblivious to new realities and oppose any departures from conventional behavior. Yet a third group learns from bitter experience that the

conventional values and norms inherited from the past are no longer functional in an altered environment. All find that others' choices of action are inexplicable, unsatisfactory, or both. People cease to understand what others are doing, feel themselves working at cross purposes, and lose faith in the ability of the societal whole to solve problems individuals cannot solve for themselves. They "fall out" of the social level of reality, reverting to biologically motivated urges to serve themselves.

Once the established social cognitive map fails to describe environmental realities and prescribe the behaviors appropriate to preserving social stability, a crisis in legitimacy occurs. Conservatives respond by arguing all contemporary problems arise because bad people have strayed from conventional norms. The conservatives demand a return to traditional values, which they tend to define with increasing narrowness as the crisis builds. More radical personalities, on the other hand, begin to explore new behaviors and to justify them by appeals to new beliefs. As in biological evolution, most of these deviations from established norms will prove unsuitable to either actual conditions or the sensitivities of the majority. That is, they will be selected against by either the society or the external environment in which it is embedded and with which it co-evolves.

Increasingly frustrated by failure and experiencing an ever deepening alienation from tradition, both conservatives and radicals become desperate. Both begin to feel so exposed and powerless that every aspect of their spiritual life is threatened. To defend themselves, they become ever more passionately committed to ever more extreme positions [Fromm, 1941/65]. Soon their own actions add to the experience of social breakdown, for as fanaticism spreads people become less and less able to bridge the ideological gap between them. Thus turbulence builds upon itself in a nonlinear fashion until the whole society threatens to come apart.

V

Twentieth century culture has been ripe with reflexive behaviors. Painting, for instance, developed the easel convention to such perfection that the entire external world was mapped repeatedly. At that point, it was no longer necessary to use painting as a medium for describing the world, and artists began an excruciating exploration of the medium itself. Art was no longer the painting of a

scene but the painting of a painting. Literature, similarly, reached the boundaries of modern experience and "exhausted" the potential of its classically modern medium, the novel [Barth, 1984]. Science too, in the Copenhagen Interpretation of the Quantum Physics, reached what Karl Popper called the "end of the road hypothesis" and plunged into a "muddle" [Popper, 1982].

The initial encounter with their systemic frontiers left the major elements of modern culture confused and apparently paralyzed. Einstein's agonizing lament that he could not accept a god who "played dice" with the world is a representative response. The innumerable novels from the first half of the century whose intellectual "anti-heroes" – e.g., "M. Teste" – were trapped within the boundaries of a coldly rational pattern of thought that left them incapable of action or choice, provide insight into the general state of Western culture. But by folding back upon themselves, art, literature, and science have all vastly enriched both their own ability to generate information and the content of contemporary consciousness. It is not yet clear that their accomplishments will be amplified by popular support, but each in its own desperate search for meaning has redefined itself so that what seemed to be entirely different, hostile subcultures [Snow, 1959] have suddenly begun to "converge."

The essence of Postmodern thought seems to be the final realization that both the content and the values established by the Enlightenment cognitive map have failed to keep pace with the social environment. Emphasizing a reductionist strategy intended to unearth ultimate "reality," Modern thought focused on concrete individuals, whether atoms or persons. Armed with knowledge of the real and the laws by which it worked, the Modern strategy was as absolutist and deterministic as Medieval theology. In fact, molded in the traumatic transition from the stable world mapped by the "Great Chain of Being," Modern thought demanded some vehicle for freezing experience in symbols so abstract that Catholic and Protestant, monarch and bourgeoise, could integrate their experience around the structure of the secularized nation-state [Toulmin, 1990]. Through the power of the state [Collings, 1989], the Modern human was promised that all obstacles to worldly happiness would be "overcome."

But when Nietzsche announced the Death of God he was doing more than measuring the seismic shift of the foundations of the Modern cognitive map. He was also stating that from his day on

humanity would lose the ability to anchor symbols in any absolute. To be sure, most philosophic, literary, and scientific encounters with Nietzsche's position were bewildered attempts to find an alternative foundation. Planck, for instance, spent nearly a decade trying to prove his "quantum theory" wrong because it "frightened" even him [Gamow, 1966]. Heidegger's Nazism, as Celine's and DeMan's anti-Semitism, suggest they were no less determined to find some emotional commitment upon which to build lives that could "transcend" the deracinated present.

Finally, however, leading intellectuals are beginning to realize that ours is an environment that must be mapped using wholly new kinds of symbols. We can no longer postulate any absolute knowledge of reality, says Richard Rorty [Rorty, 1989], for "reality" is merely a word. Anticipating the philosophers, Neils Bohr earlier described us as "suspended in language" [quoted in Petersen, 1963], leaving us forever trapped within a network of language from which there is no escape. Gianni Vattimo has built on this insight to argue that the very essence of Postmodern philosophy must be "weak thought," a generalization that says we can never "overcome" or "transcend" but only "leave behind" the errors of the past and the problems of the present [Vattimo, 1988]. Clearly quantum physics, as Bohr, Heisenberg, and Born interpreted it, confronts even science with exactly the same problem. What the scientist knows, according to the Copenhagen Interpretation, is not what exists but what appears within the context of experimental apparatus as the result of observation. In that context, said Heisenberg, "Reality evaporates" [Heisenberg, 1958]. Like the characters in Postmodern literature, scientists are part of the whole they are trying to describe. Caught in the "web" of their own actions, they change the structure of the whole every time they learn something new about it [Hayles, 1984].

Meanwhile, the crisis of legitimacy that decoupled thinkers from the fundamental presuppositions of their heritage has released them to begin exploring the environment of actual experience. Contemporary art, for instance, has permitted the very nature of painting to be redefined, as well as the technical prejudices about what constitutes the objects of art. From Duchamps' "objets trouvées" through Rauschenburg's trash and Cage's tapes to abstract impression, Western artists have abandoned the attempt to produce finished descriptions of the external world in favor of creating the conditions in which viewers explore the content of their spiritu-

al lives. Similarly, as in Borges' stories or the novels of Robbe-Grillet, there is no longer a God's-eye view monopolized by the narrative voice. The reader has been invited into the creative process, and the "work" of art has given way to the "text," in which the final outcome depends upon how the reader chooses to react [Barthes, 1977]. Even popular television shows invite the viewer into the program by self-consciously exposing all the techniques by which Modern tradition created the illusion that the world was being observed rather than created.

VI

Science itself, since World War II, has begun to map nature in similar terms. Once the limits of the Newtonian paradigm were revealed, science, like art, was free to explore an expanded environment. The aspect of nature that had eluded Modern science was life, the "noise" that had defied explanation in materialistic and mechanistic terms. From the Modern point of view life was, at best, a statistical miracle [Monod, 1971]. There was no way for Modern science to account for the symmetry-breaking transition from dead, inert matter described by trajectories to the evolving world of living things [Prigogine and Stengers, 1984; Nicolas and Prigogine, 1989]. For that to happen, information would have to be created, created from within nature itself.

Perhaps the critical breakthrough in scientific thought has come with the dawning realization that the practice of contemporary science is not as artificial as the Modern scientific paradigm would have it [Rae, 1986]. The stumbling block that Copenhagen erected as an obstacle to all future scientific progress, namely that observed phenomena depended upon the apparatus in which results were embedded, became an opportunity once it was realized that Bohr, Heisenberg, and Born had remained victims of the very paradigm within whose limits their research collided. That is, the limits of science Bohr announced at the Como Conference of 1927 depended upon retaining the Newtonian presupposition that nature existed once and independently in an external domain [Bohr, 1934/61]. If that were the case, then changes engendered by the act of observation would forever deny the scientist access to the nature being mapped. Thus reality does "evaporate," but only if you believe that science alone creates information.

However, if it is conceded that the Newtonian paradigm is an

"idealization" [Prigogine, 1980], then its claims about an ultimate reality not fully accessible to the scientific method become suspect. It is a small but revolutionary step to proceed further and suggest that the consequences of using the scientific method discovered at Copenhagen mimic natural processes. That is, as science creates phenomena when the information, energy, and matter released by an instrument interact with whatever is being observed, so thermodynamic flows interacting with natural structures can transform those structures as environmental energy and matter are entrained by emergent forms [Artigiani, 1992]. These forms are truly self-organized, for they record information that did not exist until the interacting processes constituting the structure mutually entrained each other. Thus nature is actively involved in the observation of itself, and evolution – the creation of information – is the result of those natural observations.

If this is the case, then reality is not made up of the smallest "things" to which it can be reduced. Rather, reality is a "process" by which Aristotelian "Becoming" replaces the "Being" of Galileo and Descartes. What exists at any moment is the product of a set of "relationships," which, because they redefine reality, take priority over objects. In a nature of process, life is no longer inexplicable "noise" but as "natural as a falling stone" [Prigogine and Stengers, 1984]. Thus, in Howard Pattee's lovely phrase, "life explains the quantum physics" [Pattee, 1971]. That is, the context in which scientific explanations are embedded has been expanded beyond the frontiers of laboratory idealizations and been brought back into contact with nature. When science shifts back from a self-centered, formalistic concern with its own method to ontology, it is not just traveling the same reflexive path characteristic of the arts and humanities. Science is also asserting once again that the human mind has the power to map its environment.

The revival of scientific realism implies that the world no longer appears, as it did to Copenhagen, "unintelligible, senseless and accidental" [Barroclough, 1964; p. 234]. Presumably, scientific progress measures the extent to which we have created a new cognitive map, one more attuned to the realities of a Postmodern environment. The device by which this breakthrough was accomplished is exactly the same one embraced by painting, literature, and philosophy. The reconceptualization of science, in other words, follows from the same sort of reflexive folding back upon its medium, the scientific method, that occurs in other elements of

twentieth-century culture. As art is redefined by the act of painting, philosophy is revolutionized by examining language, and literature is produced by reflecting upon the novel as a medium, so science transforms its map of nature by reading its own techniques into reality. In all cases, the claims to eternal, absolute Truth are as inappropriate as the ideological commitments of racism, nationalism, and the Cold War. This recognition that humanity is involved in creating truths that will necessarily evolve over time is essential to the more adaptive world order made necessary by dynamic technologies.

VII

Of course, when a thermodynamic flow transforms an existing structure into something new, energy is dissipated. The *price* of observation is the entropy produced. But now we can see that the *promise* of observation is that information is also created. Thus, when unprecedented energy and matter were released into the structure of Modern society, the second industrial revolution swamped the processing capacity of the Enlightenment cognitive map and shattered the liberal bourgeois society it described. The immediately obvious consequence was a deep sense of alienation – the inherited cognitive map could not process the new thermodynamic flow nor direct the way society should model it. People lived in a world they could not describe, control, or predict. Lost and powerless, they became desperate. They clutched at any simplification that seemed attractive and adopted policies that were designed to substitute escapist action for stable thought. Internal entropy increased the confusion as outmoded institutions and reductionist strategies failed to meet the test of "requisite variety" [Ashby, 1976].

But if most of the social, political, and economic policies only reinforced the sense that something was desperately wrong with the fundamentals, the cascade into turbulence characteristic of Western society in the first half of the twentieth century located both a wide range of new possibilities and a radically new pattern of thought. It is possible that, using this new pattern of thought, we will be able to restructure society in forms less prone to self-destructive behaviors and more able to cope with the accelerated rate of change contemporary science and technology have produced.

The failure of positivism in science, philosophy, art, and popular culture might all be an indication of a shared common denominator among local intellectual environments. Late twentieth century cultural sub-divisions may all be abandoning the illusion that they can supply clear and certain knowledge about the world we experience, because the world of social experience changes so rapidly through our own efforts that the artificial nature of contemporary cognitive maps becomes apparent. We are so obviously, as Wallace Stevens said, "the single artificer of the world" in which we live that confusing maps and territories is no longer likely. That is, science, philosophy, and the arts are all part of a more general cultural process. In that case, the real meaning of the twentieth century will not be in the details of its renaissance accomplishments, whether Relativity Theory, Cubism, or the popular arts. Rather the twentieth century may ultimately be heralded for creating a new world view, a cognitive map written with new kinds of symbols.

Under the influence of a general cultural process transforming how we think, the hostility to scientific models typical of the early twentieth century should, in principle, be left behind. To be sure, the Newtonian paradigm intellectuals reacted against was dehumanizing. Yet there is no way to track or direct a technological society independently of science, which is why I think the Postmodern scientific paradigm offers the best insight into the emerging cognitive map. However, it implies a radical reversal in attitudes toward science. Its willingness to "reenchant" nature [Berman, 1984], on the one hand, provides a vehicle for bringing science in from the cold. Its shift in emphasis from descriptions of what nature is to how nature works, on the other hand, alters the very nature of mental models. The emerging scientific paradigm attempts to understand nature in transition. It is a description of how nature creates new information by self-organizing structures that will, eventually, be superseded as a result of their own exploratory initiatives. In effect, contemporary science is built on a paradigm of paradigming.

VIII

Some of the most promising developments are appearing around the new mathematics of "chaos." Chaos was discovered by graduate students playing with computers [Gleick, 1987]. That in itself is a remarkable achievement, giving the lie to many criticisms of con-

temporary culture. It was transparently obvious to Modern intellectuals that the machine was the enemy of creativity, just as the masses it fed were the enemies of "culture." The dystopias typified by Aldous Huxley's *Brave New World* were unanimous in asserting that nothing of value could emerge "bottom-up," from the masses or technology [Ortega, 1930/57]. But it may well be that the linear conclusions drawn by logically extrapolating the future from the present were themselves consequences of the limited computational technology then available. Calculating how the machinery of modern society worked meant presupposing modern society as a machine. Under those circumstances, only relatively simple, deterministic equations describing idealized equilibrium conditions could be treated. Invariably, the answers were always that the future would be the present writ larger and in more totalitarian terms [Ellul, 1967]. The possibility that a future discontinuous with its past might emerge was incomprehensible, quite literally, because it could not be calculated.

The new, dynamic systems theory characterized by "chaos" depends upon computer technology. Computers can not only carry out the myriad of simultaneous calculations necessary to model living systems; they can now iterate descriptive equations showing how qualitative change spontaneously occurs. Moreover, computers can provide visual representations of qualitative data. Thus, computer technology makes the problems of describing real-world phenomena much less daunting than it was for traditional linearized techniques. It is no longer necessary to impose models derived from artificial simplifications on reality, models that can do no more than track trajectories of development. Chaos makes it possible to recognize that information is often generated bottom-up, and one hopes, its ability to track "orderly disorder" in the climate or stock exchange provides a method for dealing realistically with the evolution of complex contemporary societies.

Perhaps the lesson to be drawn is that we are advised to look at the "noise" in contemporary culture for clues about the culture's future, for information is created "at the edge of chaos" [Langton, 1990]. We will not, that is to say, track the transition from bourgeois to Postmodern society using the paradigms of the past. They simply interpret all new developments as immoral and all changes as degeneration. From the "Yellow Peril" to "Acid Rock," guardians of the Modern West have seen only inferiors rising from the muck to challenge the values of the white, male elite. Facts or

values that cannot be processed by inherited cognitive maps are seen as signs of decay. Of course, these voices of convention are right – from their perspective.

But the paradigm shift occurring in every aspect of contemporary culture represents a change in perspective. It cannot be justified logically, as a development from the Great Tradition. On the contrary, it is a symmetry-break, a revolutionary conversion from one incommensurable paradigm to another [Kuhn, 1962]. But, like the shift from Latin to the vernacular languages in the fifteenth century Renaissance, the new vocabularies of dissipative structures, chaos, and popular culture are bringing into consciousness new information; information gathered from direct contact with the societal environment.

This information is critical for the survival of complex systems, which requires the ability to read shifting environments rapidly and in great detail. Because they are far from equilibrium, societies transformed by the second industrial revolution are vulnerable to even small perturbations, which can trigger ripples with disastrous system-level effects. To locate specific environmental events, complex social systems depend on ever more creative initiatives by ever more uniquely defined human members. Specialized technical skills enable individuals to explore environmental dynamics in detail, permitting societies to get the information needed. However, creative people who are able to add information seem less likely to bind themselves to any particular social system. Rather, they are inclined to gather together in transient "webs of relationship" that pool resources from spacially diverse places [Reich, 1991].

Nor is it enough for complex social systems to individuate people; people must also be empowered to respond rapidly to whatever local information their initiatives create. Only through individual autonomy can complex societies globalize local information quickly enough to adjust system relationships to altered conditions. The traditional type of centralized, top-down, command and control model of society cannot be expected to process information fast enough. Rather, the survival of complex societies seems to require that they expand the number of people actively involved in their governance. The spread of democracy is, therefore, quite consistent with the experience of social evolution in this century.

There is reason to believe that personal diversity will be respected on the system level, for specialized technical skills can be

expected to protect the individual autonomy on which social survival rests. The totalitarian societies created earlier in this century, of course, did not respect individual differences. Protecting individual autonomy depends on erecting legal constraints that stand above parties and interests, curbing ideological demands for conformity. It seems reasonable to see the legal progress in protecting racial, religious, and sexual minorities, made by most advanced countries, as evidence that diversity will be tolerated publicly. But the psychological problems of preserving identity nevertheless remain. Specialization and shifting webs of relationship virtually guarantee that people see themselves as isolated or mercurial in their attributes. The pain of individuality may be overwhelmingly stressful, which explains the alienation that has plagued the twentieth century.

Gradually, however, metaphors are being forged and symbols found by which new information can be communicated globally. But communicating the information necessary to societal survival requires developing a context through which individuals can correlate their behaviors. The contexts decoding information, of course, are social cognitive maps. But the cognitive maps that can track and process information being generated by millions of individuals and transient associations at previously inconceivable speeds will have to abandon the absolute and static nature familiar from historical experience. In the contemporary social world, there are neither absolutes nor static mappings. Thus, we will have to learn to think in terms of constantly shifting relationships. A new language is needed to speak of constantly shifting relationships, for the variety required to represent them demands symbols of unmatched abstractness. Moreover, those symbols will have to apply globally. The prospect that they will succeed as mappings of contemporary society depends on returning to science as a model, for people will endorse an image of society that they think reflects the real workings of nature.

IX

At this point, we have developed the skills necessary to criticize our cultural heritage, to distance ourselves from the eternal truths claimed by past metaphors. But, so far as I know, we have not yet effectively named the realities with which we live. According to the purposefully clownish characters in Umberto Eco's second

novel, *Foucault's Pendulum* [Eco, 1989], our efforts to name existing realities are arrested at the verbal equivalents of the "liar's paradox." Eco's characters resort to phrases like "Parmenidian dynamics" or "Heraclitean statics" in vain attempts to symbolize the "processes" of collective experience in which erstwhile homeostatic structures are constantly changing. Eco's learned jokes are meant to suggest that societies are language-like phenomena, in many ways similar to the unstable dynamical systems described by chaos and dissipative-structures theory. They create information when new metaphors excite environmentally transforming behaviors.

Languages resemble the "strange attractors" described by chaos, for, although they are governed by very rigorous rules, it is impossible to predict what even proper sentences will mean in the future. Meaning depends upon the decoding context to which sentences appeal, but that context is not known in advance. Languages can evolve because the rules governing their behavior ignore the problem of meaning – "semantics" – and emphasize syntactical rules instead. Their grammars do not attempt to dictate what we say but only how we say it. As long as we agree to play by grammatically established rules of procedure, we are free to say whatever is on our minds. Similarly, obeying grammatical rules makes it possible to understand what is on one anothers' minds, although grammatical rules do not oblige the world to consent. Public endorsement, that is, globalization of our local information, requires that everybody play by the same rules – even when we are intent on changing the nature of the game.

Of course, there are fundamental objections to treating societies or nature like a language. Following Saussure [1966], most language theorists agree that the words with which the world is described are basically arbitrary. It is merely through convention that English speakers call a four-legged domestic animal that wags its tail when they come home a "dog." If the basic descriptors of reality are arbitrary, critics claim, then language is decoupled from reality. You cannot pet a word, no matter how fond of it you may be. Language creates a self-referential system in which the test for truth is merely the conventions of the language itself. If that is the case, linguistically described "possible worlds" are in constant danger of "running away," of simply following their own internal logic to conclusions that are fatally unrealistic.

But according to Daniel Hillis, the decoupling of language from reality is typical of the coevolutionary processes present in nature

[Hillis, 1988]. Courting birds, for instance, coevolve with their mating songs, for songs are part of the "display behaviors" that attract breeding partners. Since it is reasonable to assume that the physical attributes of a successful singer will be passed on to its children, who will also learn its song by imitation, the characteristics defining a species population will be functions of the song its members sing. The song, however, need not be genetically wired, and any variations in songs that succeed in attracting more breeding partners will lead to alterations in the physical characteristics of the species. Whether the musically selected attributes match environmental needs is not known in advance. The song represents ambiguous knowledge about the birds' environment. But if offspring do match environmental circumstances, then it is as proper to say the song is singing the birds as it is to say the birds are singing the song.

The same situation is true of the linguistically communicated cognitive maps that structure social systems. Being symbolic representations, they of course lose information about the social environment. Suspended in language, the people who speak those cognitive maps have no absolute knowledge that what they say is true. All anyone can know is that representing the world in a certain way leads to collective success or failure. A cognitive map training perceptions and generating behaviors that meet environmental needs means a society that reproduces its defining behaviors and artifacts. A cognitive map training perceptions and generating behaviors that do not effectively match environmental realities will find that its actions reduce successful reproduction of cultural structures and products. In other words, languages speak people as much as songs sings birds, and, in the dynamic environments created by advanced technologies, societies that embrace values encouraging the creation of new songs will be advantaged.

X

It is this kind of "Postmodern" perspective – as much as its artistic, scientific, and philosophic accomplishments – that makes the twentieth century a "renaissance" era, a period of cultural turbulence in which new metaphors are created. Just as the fifteenth century altered social perceptions by introducing perspective, instrumentalism, and narrative, the twentieth has revolutionized our collective attitude toward the world. We can no longer see ourselves as standing outside systems, at a centering position permitting a uni-

versal paradigm to be formed. Postmodernists are caught in webs of relations, and every attempt to describe the world marginalizes us. Our knowledge is ambiguous, not absolute; ephemeral, not enduring; hermeneutic, not reified. We treat knowledge playfully, maintaining an ironic distance born of reflexivity.

Symbolizing the human world in terms of processes thus does more than introduce a new level of abstraction. Changing the twentieth century perspective has profound consequences both for how we understand societies and how we identify ourselves. Transforming the social cognitive map from one based on reductive strategies aimed at locating atomic parts to a holistic strategy aimed at describing relationships means more than analysis and atomism are at stake. It means that we "leave behind" all attempts to freeze the world in universal idealizations and begin exploiting the advantages of ambiguity. We recognize our societies are cut loose from the ground of being, for socially selected symbols have no more *a priori* prospect of discovering the "reality" of nature than do bird songs. Linguistically created metaphors are, as Einstein said of scientific theories, "free creations of the human mind." When they match nature it is, he also said, a "miracle." So there can be nothing permanent about our commitment to the metaphors that shape our relations to nature, politics, and each other. As Eco says, we can no longer be "gullible" enough to believe the worlds we speak. We must become spiritual "nomads" [Deleuze and Guattari, 1984] – not because we want to be but because social survival demands it and Postmodernism is already successfully training us to hold our own beliefs skeptically.

Rather than feeling alienated by this revolutionary circumstance, the emerging twentieth century perspective permits us to now feel ourselves accommodating the underlying processes of nature. Of course, we are deprived of the illusion that we know what nature is. We must describe nature using the symbols of science, which like every other system is partly decoupled from the world it describes and is in danger of "running away." But the scientific system has built-in safeguards. It must test its theories and self-consciously hold its beliefs as "hypotheses." Testable theories are vulnerable to criticism, and hypotheses function as tools of inquiry. Theories and hypotheses are inherently pragmatic. Scientists cling to them as long as they work, but, despite whatever traumas of separation may be involved, they abandon theories and hypotheses when they become clumsy or dysfunctional.

Abandoning cherished representations is never easy, and scientists often do, as Max Planck lamented, embrace new ideas only when "old scientists die." But the transformation of scientific paradigms in the twentieth century is at least as dramatic as reconceptualizations in art, philosophy, politics, and popular culture. The difference in how the reconceptualizations in science and the rest of society occurred, however, is more dramatic. In the larger society, change was resisted by appeals to violence. But scientists in the laboratories at Copenhagen and Brussels never stooped to killing one another, although there were some scientists who endorsed racist or moralizing postures and others who placed obstacles in the paths of more adventuresome colleagues. But the point is that scientists know their whole future depends on the ability of individuals to break the rules and discover some fact the rest of the community can use to advance its own agendas. The race for Nobel Prizes often depends on how quickly an individual can abandon a presupposition and unpack the implications of an innovation. To exploit its treasures, scientists do commit themselves to a paradigm. But gullibility fast becomes structurally disadvantageous.

XI

All this leads to the conclusion that the introduction of the scientific spirit into the symbolization used to map societies lays a basis for "hopeful realism." We recognize the costs of cultural change, but we can now better understand the promise. This is a fundamental development, for until now we have been oriented toward the past, concerned to find ways to prevent change or to return to previous stable states – for example, the Edenic mythologies inspiring traditional utopias. Now we can see these ideas as theories or hypotheses serving a functional purpose – they separated gullible people in transition eras from environmentally outmoded symbolizations. But past tendencies to treat metaphorical possibilities as ontological absolutes made transition eras especially dangerous. People died in the name of symbols whose meanings are now recognized as contingent.

Apparently, this was a hard lesson to learn, but the historicizing of experience indicates that the entropy cost in human suffering extracted by our century has, at last, given birth to the possibility of a more truly human future. Our century of degeneration has

also been one of unexcelled creativity, and historians now concede that this kind of mixture is characteristic of the fifteenth century Renaissance as well. Perhaps the most important lesson to be derived from science is that all efforts either to preserve existing structures or dictate future ones are doomed to fail. Chaos theory tells us that the future of social systems is as unpredictable as their pasts are uncertain. To know the future of a complex dynamical system requires perfect knowledge of its present conditions. But we know from quantum theory that there is an information barrier forbidding the acquisition of perfect knowledge. If we do not know exactly the position and momentum of every member of a dynamical system, the nonlinear relationships defining it will make their future behaviors globally uncertain. Therefore, even rule-bounded systems have unknown futures, and attempts to capture them in utopian visions are doomed to fail.

Dissipative structures theory, meanwhile, calls special attention to the role of creative individuals and to the internal fluctuations altering system-defining relations, which are especially unpredictable. These are the human equivalents of random motions, which at bifurcation points can completely restructure a system. But the limitations on predictability recognized by chaos and dissipative-structures theory are actually valuable gains from a human perspective. They liberate the human spirit from the psychological and philosophical bondage that drove people like the Maritains to the brink of suicide. Twentieth century science has created a "world fit for men to live in," as James Jeans put it, by simply recognizing that the spontaneity, creativity, and esthetics defining human values are integral parts of natural processes.

Of course, we are not compelled either to internalize or adapt these values. We can always continue lusting after the absolutes typical of previous social systems. But in this case a transformation of values as dramatic as that of the fifteenth century "rediscovery of the world and of man" is possible, for in modeling our societies scientifically we are modeling reality, at least as we experience it. This realization suggests the promise of the twentieth century, i.e., that it finally will have found a way to end the alienation imposed by the Modern cognitive map. Amidst the bloodshed and the ruins, the distortions of racists and fundamentalists, we will have literally thought our way to nature and opened the cultural door to creative possibilities in which History – despite the claims of reactionaries – will never end.

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