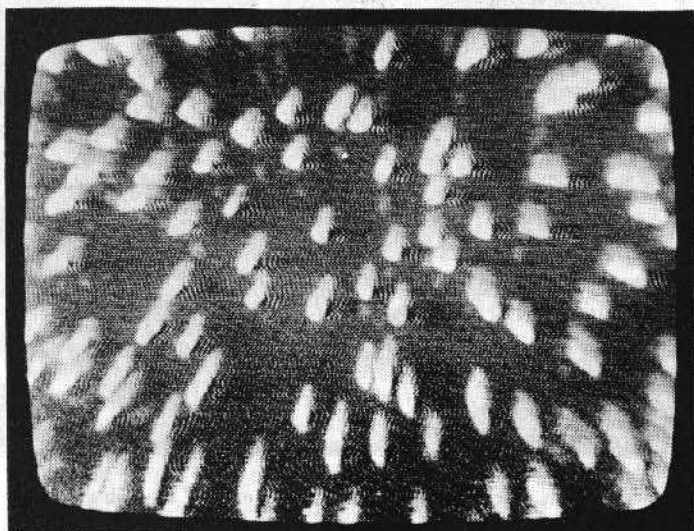


HIERARCHICAL RESTRUCTURING

by John Platt



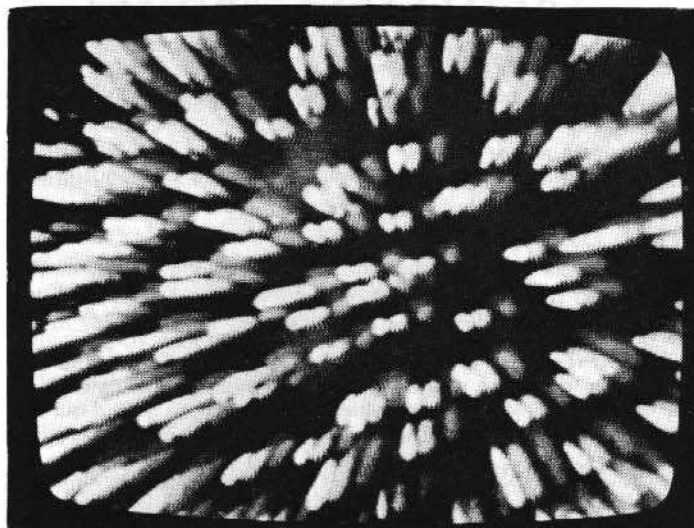
Sudden changes of structure are among the more startling phenomena of living systems. Until recently, they have not been much looked at or analyzed from the point of view of a general systems theory. Nevertheless, they may include such dramatic phenomena as falling in love, acts of creation, evolutionary jumps, social revolutions or reformations, and in general the sudden formation of larger integrated systems from malfunctioning or conflicting subsystems.

Process Metaphysics

One recent approach to these problems is that of the theoretical physicist, David Bohm. At a recent Conference on Theoretical Biology, he described a "process metaphysics" based on the idea that the universe should not be regarded as made up of *things* but of a complex hierarchy of smaller and larger *flow patterns* in which the *things* are invariant or self-maintaining features of the flow. The shape of a waterfall or a match flame, or the shapes of clouds, which have a certain constancy even though masses of moist air are flowing through them and continually condensing and evaporating, would be *things* of this type. Such a philosophy is evidently opposed to Democritus' view that nature consists of *things* (atoms) in the *void*. Or more exactly, it is a modern way of uniting at last this view with that of Heraclitus, who said that all was flow, or fire.

In Bohm's flow-picture, these steady-state patterns or *objects* (or steady-state organisms or observers) can only be understood in a holistic relationship to their "environment," with fields of flow extending outward indefinitely to the next such waterfall or flame, and the next. Likewise, the *environment* only takes on stable form and meaning and points of reference through the *objects* which it sustains. Everything is in relation to everything else, echoing the Tao, Husserl, Whitehead, Polanyi, and the transactional psychologists.

Bohm applies these ideas to electrons and the fundamental particles of physics, regarding them as patterns or perhaps something like knots being knotted or unknotted in a field of flow that extends throughout the universe. These fundamental patterns are assembled, of course, into larger but less stable patterns, such as chemical molecules, living cells, organisms, brains, and social networks and nations. These higher structures are built up in a hierarchy, in the *architecture of complexity* analyzed by Herbert Simon, or the complex systems and subsystems in the *living systems* approach of James G. Miller. But for Bohm (as for Miller), the emphasis is not on static structures of complexity, like the parts of a watch, but on a flow hierarchy, like the system of vortices, say, below a



waterfall—that is, on structures that are self-maintaining or self-repeating with a certain invariance, even though matter, energy, and information are continually flowing through them.

Hierarchical Jumps

But the important thing for our purpose here is that such flow systems can undergo sudden transitions to new self-maintaining arrangements which will in turn be stable for a long time. Bohm identifies the *quantum jump* of an electron, from one steady state of an atom to another steady state, as being a pattern-restructuring of this kind. Vortex patterns in a stream can be restructured in this way by a very slight motion of a stick or a rock, and they are sometimes unstable, slipping back and forth rapidly from one pattern to a quite different one.

And Bohm emphasizes that there is a similar restructuring by *growth* of a complex structure to larger hierarchical patterns with the passage of time, like the growth of large crystals from a mass of small ones under heat and pressure. The growth may not be uniform but by successive small steps as each crystal rearranges suddenly. Likewise in the biological world, a group of children brought together—or a group of industrial organizations—may rather suddenly develop leader-follower relationships and a defined pattern of roles throughout the group. In general, the growth picture is that of a hierarchical structure with stable pattern from the lowest levels (molecules, enzyme cycles, cells) up to the level *i* (say, the organism), which grows to a new structure because it comes in touch with new and different materials or information or another organism. This can make the patterns unstable at level *i* until there is a resolution (conflict, cooperation) with restructuring either by breaking apart or by a new organization at the *i + 1* level to make a new stable pattern encompassing the later experience or the larger system.

Examples of this hierarchical growth by restructuring to a higher level of organization may be found in many fields. Probably the best examples in the field of ideas are those Thomas Kuhn analyzes in *The Structure of Scientific Revolutions*, such as the jump within a generation or so from the Ptolemaic System to the Copernican system in astronomy, or the jump in 1895-1925 from classical mechanics to quantum mechanics in the field of physics.

Similar jumps occur in evolution, and such phenomena as the sudden development of eyes, or wings, or speech, or other *salutatory steps* of advancing organization may be of this type. Such sudden jumps have caused much controversy because they have such an appearance of *purposefulness* and develop

so quickly that the fossil record is poor; and it has not been clear until recently that the theoretical rates of natural selection could actually work fast enough to account for them.

It is important to note that such *self-restructuring* of a system, to emergent new forms and levels of organization that were not in it before, is very different from the assembly of a watch by an external watchmaker. In current biological language, it is not *teleology* or purpose, but *telenomy* or the appearance of purpose. It is also different from the emergence of a flower and fruit from a green plant; because, for the individual plant, the information needed to make the new structure was already present in the seed, having been selected by a long history of survival of such plants. The classical Greek analyses and the theological and philosophical analyses of "emergent evolution" have often confused these three cases, of external design (the watchmaker), of internal developmental design from information built into the chromosomes (the plant), and of genuine self-transformation, that is, time-emergence of better-organized patterns at a new level of organization that did not exist before, either externally or internally. *Evolutionary jumps may actually be much more common than we have supposed, with evolution in general not taking place so much by steady change as by small saltatory steps of this kind which reorganize one sub-system after another.*

The restructuring of individual personality may also take this sudden form, as in the case of flashes of understanding or psychotic episodes or sometimes in reorganizational crises in response to therapy. Learning to ride a bicycle is such a sudden restructuring of skills. Falling in love, and religious and political conversions, are likewise sudden and often permanent restructurings of emotions, goals, and activities. And there are sudden experiences of "ecstasy," which have the same character, with a moment of insight leading to a new awareness, a new simplicity, or a new organizational pattern for the rest of one's life. The accounts range from the conversion of St. Paul and the experiences of the mystics to the unitary and world-changing experiences reported by such non-religious philosophers as Ernst Mach and Bertrand Russell. It is not entirely false or even mystical to say that in these restructurings, as in the evolutionary and other restructurings, the system is "going beyond what it knows how to do," and the organisms or individuals are in the grip of "a power beyond themselves."

Finally, the area of social evolution exhibits the most dramatic and large-scale restructurings of this kind that we know about, such as the sudden collective restructurings that occurred in the Reformation and in the Industrial Revolution. These changes go deeper than ordinary political revolutions because they are not simply an exchange of power from one small group to another, but a thorough-going change in philosophy, personal attitudes, and ways of work and economic organization in every part of society. The democratic revolutions, starting with the United States, and the communist revolutions also represent this kind of sudden thorough-going self-restructuring, with whole populations united in the creation of change at every level. And the largest of all these changes, in its speed and scale and its long-range evolutionary implications, is the world transformation through which all human society is now passing.

Thinking of the parallels to the other types of restructuring mentioned earlier, we see that it is no distortion to speak of this world reorganization of all our patterns as a 'quantum jump,' or as a sudden collective change of awareness or flash of understanding for the human race.

If we are to understand these changes today, or if we are to have hope of channeling men in the direction of a more democratic and humane future, we must begin to study this whole phenomenon of hierarchical restructuring in much more depth and detail than we have so far.

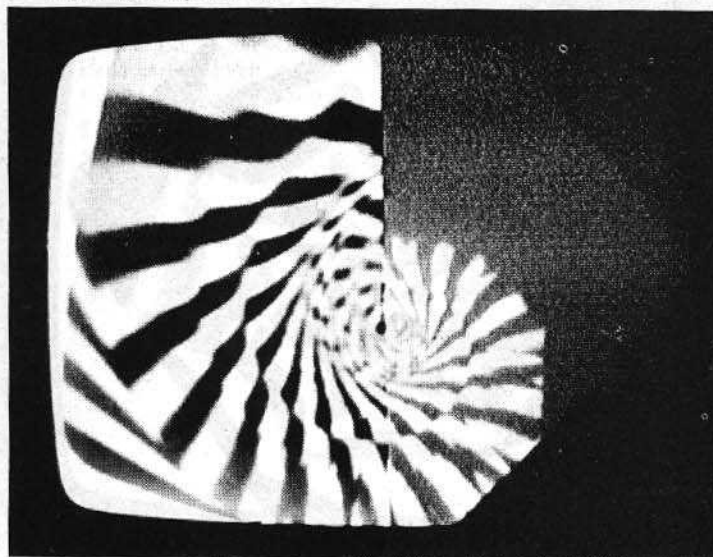
Characteristics of the Jumps

As a beginning on such a study, we may note that these self-generated jumps in a hierarchical organization have several common characteristics that stand out. One is that the jumps are always preceded and accompanied by "cognitive dissonance," as Gardner Quarton has emphasized in discussing these questions.

Thus, Kuhn describes in considerable detail the scientific dissonance that precedes his scientific revolutions. *First, there are accumulating bits of data that do not fit the old predictions, or rules of thumb in certain areas that seem to be justified only by odd assumptions.* In the beginning, these difficulties are dismissed as trivial, or as errors of measurement or crack-pot arguments, but they do not go away, and they get more numerous. After a time, the confrontation with the old system comes to be recognized as fundamental, and various proposals for a reconciliation are brought forward. Then suddenly a simplification from some entirely different point of view makes big parts of the problem snap into new and clearer relationships. There is a collective sense of relief and achievement, even though a long period of working-out may lie ahead.

Similarly in the restructuring of personality. Cognitive dissonance is now supposed to be the precondition for any kind of personal learning—that is, reorganization—experience. Who can doubt that Paul's violence against the Christians before his conversion—as with many persecutors—was based in part on beating down his own internal dissonance and self-doubt about what he was doing? Conversely, to prevent a restructuring, the paranoiac is fearful of any cognitive dissonance, and tries to fit everything he sees—an open window or a subway scrawl—into his general persecution theory. Strong cognitive dissonance, personal or social, has many side effects (system instabilities) such as anxiety, anger, over-assertion or aggression (pro- or anti-status-quo), or counter-responses such as withdrawal, nausea, and melancholy—which accounts for the sense of relief when it is resolved.

In the area of social change, the first stages of the Reformation were attempts to reform the church from within because of the feeling of dissonance between its ideals and its practice. Today, the transformation of our economic system or of the nation-state toward more humane structures is likewise heralded by a general realization that pollution, the ghettos, the military-industrial complex, or the Vietnam war, do not even fit the system's own goals or images of itself. These divergences can only be gotten rid of by forcing them either into a rigid delusional system like the paranoiac's, that redefines them as somehow "intended" and "good"; or else by a restructuring of the whole system toward better integrated higher-order patterns.



A second feature of self-generated hierarchical jumps is the overall character of the dissonance and of the later transformation. Thus, the industrial revolution turned out to be a revolution in attitudes, banking, commercial organization, and city structure, as well as in technology. The difficulties that led up to quantum mechanics appeared almost simultaneously in problems of atomic spectra, photoelectric emission, specific heats at low temperatures, and the curves of radiation from industrial lamp filaments. Likewise today, the dissonance in our society is shown by the widespread protests, not only among students or in the ghettos, but from labor unions, post-office workers, and suburban matrons concerned about bussing or oil spills.

A third striking feature of hierarchical jumps is the suddenness of the restructuring when it arrives. Five years before the French Revolution, who would have estimated that it would take only a few months to overthrow the massed power of the aristocracy, the church, and the army, with all the weight of tradition and power and immovable bureaucracy on their side. A rational man would have said that any deep change would take fifty years or more, the time to train teachers, say, to re-educate the sons of the nobility, or the time to achieve ecclesiastical reform or a more sympathetic court. Yet, when the change came, it came like lightning, though final working-out took many years.

The reason for the speed is that the change is prepared everywhere at once. Even though individual elements of reform seem weak, when they reach a certain critical density and begin to join forces, the old order finds itself overwhelmed from without and betrayed from within, from directions it never guessed. The new self-maintaining patterns, like new vortex patterns, are self-reinforcing to each other as soon as they touch, because they can form the beginnings of a better-integrated system with a speed of understanding and communications and economies that the old malfunctioning system cannot match.

To make this idea of suddenness more precise, it may help if we distinguish three kinds of time-constants in a hierarchical flow system. One is the time constant, t_s , for ordinary adjustment of the feedback loops of the overall flow system. In auto manufacturing, this is the time of a few months for a company to build up or cut down production to meet demand. In education, it is the time of twenty to thirty years for the children of one generation to become the teachers of the next. The second time-constant is the much longer time, t_L , over which the stabilization of the system may last or continue to be effective. This is perhaps twenty years for the more successful auto companies, and perhaps some hundreds of years for educational continuity or duration of most cultures, until our present era of rapid change.

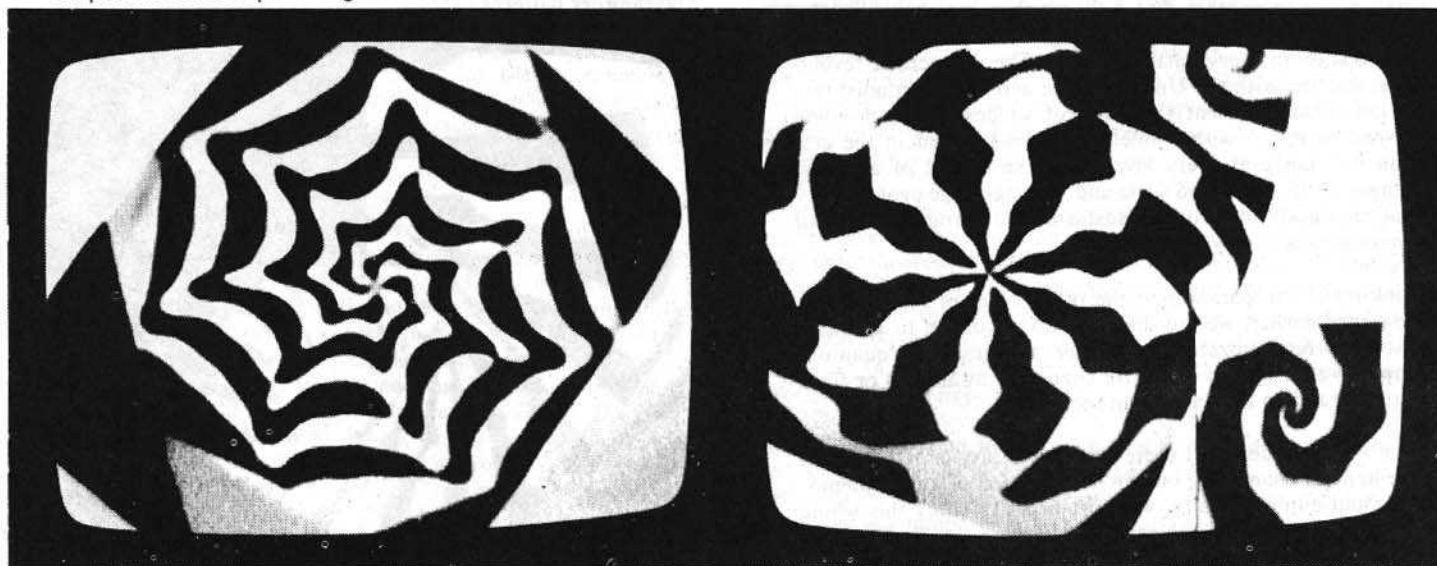
With respect to these time-spans, a hierarchical jump, like the quantum jump of an electron, is "unpredictable" because it can occur, as Bohm says, "at any time" in the normal cycle of the system, t_s , or in its normal lifetime, t_L . And when it occurs, the third time-constant, the transition time for the jump, t_J , may be as short as t_s or shorter. This is because the old feedback loops that determine t_s become irrelevant, and the all-over change does not have to wait for them to finish a cycle. The Russian Revolution shook the world in ten days, and the U.S. Constitution was hammered out in a few weeks.

A fourth characteristic which Paul Bohannon and others stress in discussing these jumps is "simplification." In scientific advances, the direction of advance is always toward simpler and more general explanations. Compare Newton's $F = ma$, which accurately predicts pendulums and projectiles, with the scholastics' longwinded theory of motion, which could predict nothing. Any restructuring toward greater complication of structure or explanation would be easily lost; but simplification represents a permanent step forward because it is "downhill," easy to hold onto and hard to go back from.

The power of money compared to barter is its additivity and interchangeability. Much of the power of democracy may be that it is so much simpler than complex ranks and obligations. And the power of a world system as compared to a national system will be partly that, at every step, it is more general, simpler to understand and operate, and usually much cheaper with its economies of scale and directness.

The Subsystem-Supersystem Relation

Finally, a fifth characteristic of hierarchical jumps has been emphasized by Karl Deutsch in discussing these questions, and deserves special attention. *It is the interactions jumping "across" the system level between the old subsystems and the new supersystem that is in process of formation.* The explanation for this novel interaction is that when there is dissonance or conflict at the **i-level**, restructuring generally cannot occur by changes at the **i-level** alone because of the *self-maintaining character* of all the **i-level** relationships. Thus, no simple restatement of the assumptions of classical mechanics at the **i-level** will account for the new quantum mechanical phenomena. A conflict between the production division (**i-level**) and the sales division (also **i-level**) of a company cannot be resolved by strengthening either one, because it simply generates counterstrengthening in the other. In an intellectual system or a living organism or a self-stabilizing flow system, any buildup of already conflicting elements generally calls forth a counterbalancing response that simply makes the stress greater.



Deutsch has made explicit, therefore, the need for a cross-level interaction, by stating what might be called the **i-1 Theorem**. *This states that any restructuring has to be built around the largest well-functioning subsystems—that is, at the i-1 level—by fitting them into the larger integrative needs of the i+1 supersystem within which the conflict has to be resolved.*

At first, this idea seems rather surprising, but it is hard to think of any other way in which the existing large and well-functioning components of the organization could be kept operating through the change, or could play their full and needed role in the reorganization and the new structure. And indeed, this idea fits out common observation that, when a division of a business organization is in trouble, the secretaries and junior executives (**level i-1**) begin to “go over the boss’s head” (**level i**) to the central office (**level i+1**) because the actions of their own boss are part of the trouble. Conversely, the last complaint that their boss makes before he resigns is that the central office (**i+1**) is “not backing him up” (**i**) and is “undercutting his authority” (**i-1**).

This need for **i-1-i+1** interaction has many important implications. In the world system, for example, our efforts for a more stable structure may not be effective if they are directed either at armaments security, or at peace treaties between existing national governments at the **i** level of instability. What is needed, rather, is to help the subsystems at the **i-1** level—such as tourism, or aviation, or non-government organizations of science or communications, or businesses like IBM and Coca Cola—to build elements of world order at the **i+1** level, which will begin to reach more and more extensively across national boundaries. Note, for example, the effectiveness of the airline pilots’ (**i-1**) international organization (**i+1**) in persuading governments (**i**) to return hijacked planes. (It might even be claimed that world-wide armies have some **i+1** integrative effect of this kind, to the extent that their activities are non-combatant and constructive, as in building schools, hospitals, roads, and dams, and in stimulating world radio and educational networks and a world exchange of peoples.)

There are also interesting applications of Deutsch’s theorem in the field of psychology—for example, in the curious connection between things we regard as sub-rational and as super-rational. Thus in *The Ides of March*, Thornton Wilder has Caesar say that four things keep him from being sure there are no Gods. They are: love, mystical experiences connected with his epileptic seizures; creative acts such as poetry, and his sense of destiny. Today, most of us would likewise regard love or great music as uplifting experiences—and yet, viewed cynically, these would seem to be no more than sexual or rhythmic excitations of the lower nervous system.

These are all non-rational responses of some part of the brain at the **o-1** level which cannot be explained or justified by the logic of the higher brain at the **i** level. Why then the sense of enlargement, of Godhood, in intelligent and active men?—for I believe that we, as well as Wilder and his Caesar, are not deceived in this leap of insight.

The answer is, I think, that these non-rational experiences differ from simple lower operations, like shivering or good digestion, because they refer to and help us integrate with an **i+1** system, a larger system than isolated man. Love, whether purely sexual or more sublimated, means biological continuity and an enlargement to include and respond to another person or a family or all mankind. Poetry or great music are creative acts that build up larger architectonic patterns for both the composer and the audience. Such acts of hierarchical growth are never rationally deducible from the smaller system-structures that precede them, as Arthur Koestler and Michael Polanyi have emphasized. Similarly, mystical experiences or a sense of destiny, as suggested for Caesar, can represent insights and identification with a larger ongoing universe in which the individual becomes a creative part.

Is this so unreasonable? When an individual’s “rational” conscious life is slipping out of harmony with deeper needs or with his relation to other people or to his environment, how else than by mobilizing these powerful sub-systems can the jump be made to a larger unity? Love and ecstatic experiences can suddenly transform lives. Sudden acts of intellectual creation and organization transform the world of words or patterns. And rather ordinary men have shaken continents when suddenly imbued with a sense of destiny or of God’s will which they communicate to millions of others. The simplification and references to a larger system, even when it is incomplete or false as with the Nazis and other fanatics, still gives such men a “power beyond themselves.”

We see that no structuring of a world system for all mankind will be satisfying or stable unless all the deep emotional orientations that direct our reason actually ratify and support this larger view of humankind at every moment and in every personal relationship. Things will break apart, “the center will not hold,” unless all the subsystems are harmonious with and supportive of the supersystem, and vice versa. The failure of this rule is what is so dangerously wrong with our economic and political systems today.

Can Hierarchical Social Restructuring be Guided?

It is not at all clear whether self-structuring hierarchical jumps of this kind can be to any appreciable degree anticipated or guided. Either “anticipation” or “guidance” would be themselves creative acts which would be part of the self-structuring. Even a man driven by the “will of God” can hardly predict how another man driven by the will of God is going to interpret and execute that will or how effective he will be in his own responsive environment. This is why Bohm regards the jumps as fundamentally as unpredictable as the quantum jumps in physics.

These questions need and deserve much more study. But a social evolutionary jump is such a large-scale process that we can at least examine its inner workings, as Kuhn did for the intellectual jumps. Once started, it has an energy and logic of its own, like the actions of a mob; but just as in that case, there is a chance that intelligent participation or intervention can help direct these energies toward creative and fruitful rather than destructive results.

We can see much of the structure and dynamics of the world transformation through which we are now passing. It is currently reaching its most acute phase, but its roots go back a long time. Atomic energy and space travel and television were not reliably predictable very much in advance, but we now see that they were nevertheless almost inevitable consequences of the earlier scientific revolution. That revolution in its turn was probably an almost inevitable consequence of printing and the Renaissance, with the rediscovery and transfer of Arabian and Greek analysis and science and scepticism to economic growth centers.

As a result, the chain of causes of our present world transformation has to be transferred back at least to the Crusades. They were what broke open the feudal mold by suddenly generating in Western Europe large-scale organizational demands, new roles and opportunities, travel and trade, and a host of new and imported products and ideas that led to the vigorous new growth of the Renaissance. The Crusades were wildly illogical, and wildly successful, in capturing for the West a sort of New Jerusalem of progress, far more priceless than the city the Crusaders thought they wanted. But at this point in backward analysis, I think we reach the unpredictable Ifs. If one or two saints and leaders had died early, or if the Moors had not come, or had come farther north, it seems possible that medieval Europe might have gone on un-Crusaded and undisturbed for many more centuries, like most of the rest of the world.

If this is so, our present transition to a new world system is the almost inevitable outcome of some very personal and unpredictable acts of creation a thousands years ago. It was downhill all the way. This is the technological imperative, the larger dialectic of history, that seems so deterministic in its onward sweep. Or, as Teilhard de Chardin might have said, our progress toward the Noosphere is like a dammed-up mountain lake, where no one can predict how soon the dam will break. But when it does break, we know the inevitable chain of results as the water carves its channel to the sea. The water in all our lakes of every shapes and size moved finally downhill to the sea of human enlargement.

This idea of a thousand-year chain of developments may seem to contradict the previous idea of the suddenness of hierarchical restructuring. But we have simply shifted to a different time scale. Against the million-year sweep of human evolution since our much earlier jump to fire and tools and speech, our whole technological transformation, even if we go back to the Greeks, is essentially instantaneous. But the present acute culmination of this transformation with order-of-magnitude technological and social jumps all over the world, concentrated into a ten to thirty year interval, is sudden even compared to a human life span.

Can we—that is, can the human race acting with its full resources of knowledge and intelligence—predict or direct the course of these vast and apparently inevitable changes in our systems? As with a flood, prediction begins to be easy and direction hard. But if direction is possible at all, it will only be possible with much more intensive analysis of these phenomena. And it will need urgent and purposive new scientific and social research and development if we are to acquire the new order-of-magnitude powers that we need to head off our crises and channel our changes before they destroy us.

For the stresses that precede hierarchical jumps, in spite of their push toward larger integration, can also be destructive and even fatal, as we see in psychotic episodes and the suicide pacts of lovers. The old structures resist, the subsystems respond in the wrong way, and stabilization mechanisms may fluctuate wildly from over-rigidity to complete collapse. Thus, our nuclear armaments today, part of the larger dissonance that precedes a world system, may be fatally unstable for the whole human race unless we introduce adequate new stabilization mechanisms before they reach the last great escalation.

In this great transformational crisis, therefore, the alternative to large scale determinism might simply be large scale instability. Our latitude for decision and control of our future may be small indeed. Can we achieve a nuclear stabilization in time? Can we mobilize the necessary intelligence and energy for self-structuring all our other great changes? Can we understand this greatest hierarchical restructuring of all time and its dynamics and scope and direction well enough to find its focal points of control?

These are the crucial questions of the next few months and years. Only if we find positive answers to them will we be able to shape the new world structures toward which we are collectively moving so that they will begin to satisfy the deepest human needs and desires of all mankind instead of destroying us all.

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