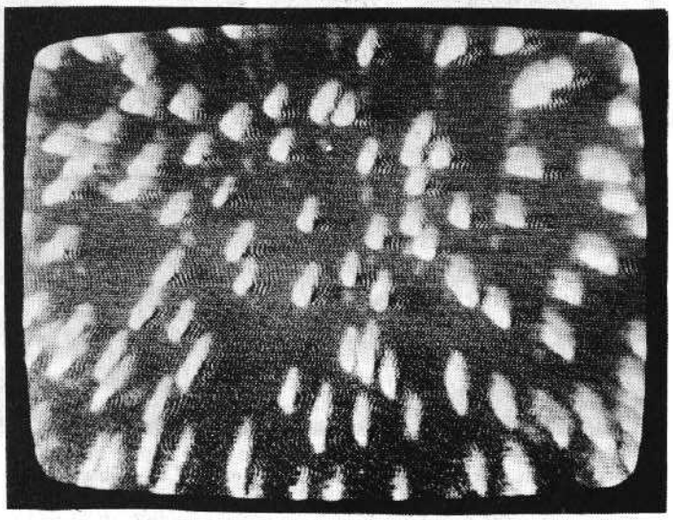
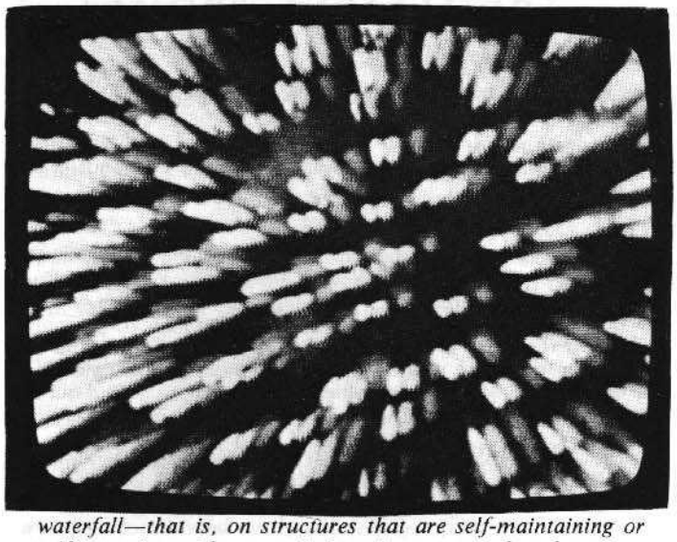
HIERARCHICAL RESTRUCTURING

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 *saltatory 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