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 ghettoes, 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, **ts**, 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, **tL**, 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, **ts**, or in its normal lifetime, **tL**. And when it occurs, the third time-constant, the transition time for the jump, **tJ**, may be as short as **ts** or shorter. This is because the old feedback loops that determine **ts** 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.