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REVOLUTIONARY CHANGE THEORIES: A MULTILEVEL EXPLORATION OF THE PUNCTUATED EQUILIBRIUM PARADIGM

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Research on how organizational systems develop and change is shaped, at every level of analysis, by traditional assumptions about how change works. New theories in several fields are challenging some of the most pervasive of these assumptions, by conceptualizing change as a punctuated equilibrium: an alternation between long periods when stable infrastructures permit only incremental adaptations, and brief periods of revolutionary upheaval. This article compares models from six domains—adult, group, and organizational development, history of science, biological evolution, and physical science—to explicate the punctuated equilibrium paradigm and show its broad applicability for organizational studies. Models are juxtaposed to generate new research questions about revolutionary change in organizational settings: how it is triggered, how systems function during such periods, and how it concludes. The article closes with implications for research and theory.

Questions about change have commanded the attention of organization theorists for many years. How do individuals, groups, organizations, and industries evolve over time? How do they adapt or fail to adapt to changing environments? How can change be planned and managed? The need to understand change processes is particularly critical now, when dramatic alterations are underway in the economic, technological, social, and political features of our environment, and people in organizations are struggling to keep pace (Deal, 1985; Kimberly & Quinn, 1984).

Our research on these questions is inevitably directed by our basic assumptions about how change works. One paradigm that has heavily influenced our thinking about change processes is Darwin's model of evolution as a slow stream of small mutations, gradually shaped by environmental selection into novel forms. This concept of incremental, cumulative change has become pervasive; it is the way people have explained everything from geological erosion to skill acquisition. Within the field of evolutionary biology, however, Darwinian gradualism has been challenged.

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Natural historians Niles Eldredge and Stephen Gould (1972) postulate a very different view of evolution as *punctuated equilibrium*. They propose that lineages exist in essentially static form (equilibrium) over most of their histories, and new species arise abruptly, through sudden, revolutionary "punctuations" of rapid change (at which point—as in the Darwinian model—environmental selection determines the fate of new variations).

Similar new, empirically derived theories in a variety of different literatures echo the punctuated equilibrium argument. Examples in the social sciences include Kuhn's (1970) distinction between normal science and scientific revolution, Abernathy and Utterback's (1982) contrast between radical and evolutionary innovation in industry, Miller and Friesen's (1984) model of momentum and revolution in organizational adaptation, and Levinson's (1978) theory of adult development as an alternation between periods of stability and transition. In the physical sciences, Prigogine's Nobel Prize-winning work on order, chaos, and change in "self-organizing systems" provides a grand theoretical perspective.

This new way of thinking has far-reaching implications for organizational practice and theory about when and how change occurs and how it can be managed. More important, it offers some promising conceptual tools for understanding the issues facing organizations in an environment where incremental adaptation increasingly appears to be unequal to the economic, social, and ecological dislocations taking place (Halberstam, 1986; Kennedy, 1987; Loye & Eisler, 1987).

The aim of this article is to explicate the punctuated equilibrium paradigm in sufficiently broad terms to indicate its general applicability and its special potential to contribute to the study of organizations. I will also suggest issues for further research. My approach is to juxtapose similar theories from different research domains and to show how each suggests questions and insights for the others. Two premises underlie the article: (1) that there are important commonalities in the way many systems, including human systems, change and (2) that we can benefit by comparing research findings from disparate areas because different facets of kindred processes may come into focus as the methodology and level of analysis vary.

The article is meant to provoke ideas, not to provide a comprehensive literature review. It is a selective exploration of one paradigm as reflected in six theories, each chosen to represent a different area and level of analysis: individual adult development (Levinson); group development (Gersick); organizational evolution (Tushman and Romanelli); history of science (Kuhn); evolutionary biology (Eldredge and Gould); and self-organizing systems (Prigogine & Stengers and the Brussels School).

KEY COMPONENTS OF THE PARADIGM—SHARED CONSTRUCTS

My argument that models from different fields have much to offer each other begins with the premise that they reflect common processes. Each theory examined here centers on the same paradigm, or basic gestalt, of evolution: relatively long periods of stability (equilibrium), punctuated by compact periods of qualitative, metamorphic change (revolution). In every model, the interrelationship of these two modes is explained through the construct of a highly durable underlying order or deep structure. This deep structure is what persists and limits change during equilibrium periods, and it is what disassembles, reconfigures, and enforces wholesale transformation during revolutionary punctuations. The tables in this section use the theorists' own words to document the degree to which these six models share the same paradigm and to show some of the specific features of each level of analysis.

The Punctuated Equilibrium Paradigm and How It Differs from Traditional Paradigms

Table 1 provides an overview of the six theories and suggests the range of fields in which the same paradigm has emerged. The statement of commonalities at the top of the table offers a summary definition of the basic paradigm, derived from all the models. A look at the excerpts below it shows the striking similarities (and some differences) across models.

Table 2 shows how each theorist differentiates his or her model from traditional counterparts and indicates the extent to which this paradigm challenges premises inherent in traditional theories. Three main distinctions emerge. First, theorists contrast their work against concepts of change as a gradual blending of one form into another. This difference is not a simple question of the pace of change, as evenly spaced versus unevenly clumped. Gradualist paradigms imply that systems can "accept" virtually any change, any time, as long as it is small enough; big changes result from the insensible accumulation of small ones. In contrast, punctuated equilibrium suggests that, for most of systems' histories, there are limits beyond which "change is *actively prevented*, rather than always potential but merely suppressed because no adaptive advantage would accrue" (Gould, 1989: 124).

These models also dispute the ideas that (1) individual systems of the same type all develop along the same path and (2) systems develop in "forward" directions, as in the universal stage theories that dominate the current literatures on group and organizational development. Punctuated equilibria are not smooth trajectories toward pre-set ends because both the specific composition of a system and the "rules" governing how its parts interact may change unpredictably during revolutionary punctuations. "The definition of the system is . . . liable to be modified by its evolution" (Prigogine & Stengers, 1984: 189).

These models suggest that conflicting theories about organizational adaptability (such as resource dependency, Pfeffer & Salancik, 1978), and organizational rigidity (such as population ecology, Hannan & Freeman, 1977, 1984) are applicable at different times, depending on whether a system is in a period of transition or equilibrium. Finally, they suggest we use caution in applying theories based on universal "drivers" such as efficiency

TABLE 1
The Overall Punctuated Equilibrium Model as Described by Six Theorists

Commonalities:
Systems evolve through the alternation of periods of equilibrium, in which persistent underlying structures permit only incremental change, and periods of revolution, in which these underlying structures are fundamentally altered.

Individuals: Levinson (1978: 49)
The life structure evolves through a relatively orderly sequence . . . [of] stable (structure-building) periods and transitional (structure-changing) periods.
Groups: Gersick (1988)
Teams progress in a pattern of "punctuated equilibrium," through alternating inertial change and revolution in the behaviors and themes through which they approach their work.
Organizations: Tushman & Romanelli (1985: 171)
Organizations evolve through convergent periods punctuated by strategic reorientations (or recreations) which demark and set bearings for the next convergent period.
Scientific Fields: Kuhn (1970: 5–6)
Most scientists . . . spend almost all their time [doing normal science, which assumes] that the scientific community knows what the world is like. . . . [Scientific revolutions, which] lead the profession . . . to a new basis for the practice of science . . . are the tradition-shattering complements to the tradition-bound activity of normal science.
Biological Species: Gould (1980: 184)
Lineages change little during most of their history, but events of rapid speciation occasionally punctuate this tranquillity. Evolution is the differential survival and deployment of these punctuations.
Grand Theory: Prigogine & Stengers (1984: 169–70)
The "historical" path along which the system evolves . . . is characterized by a succession of stable regions, where deterministic laws dominate, and of instable ones, near the bifurcation points, where the system can "choose" between or among more than one possible future.

(e.g., see Williamson, 1983: 125), by proposing that systems' basic organizing principles are varied and changeable.

Deep Structure

Tables 3, 4, and 5 display excerpted summaries of the three main components of the punctuated equilibrium paradigm: *deep structure*, *equilibrium periods*, and *revolutionary periods*. The first of these, deep structure, is the most critical for understanding the models, and it is the hardest concept to define and communicate. (Kuhn, 1970: 174–210, and Levinson, 1986, discussed some of the difficulties.)

Each theorist explains this concept in language specific to his or her own research domain; I use the term *deep structure* (Chomsky, 1966) for its general appropriateness. The six sources together suggest a general explanation of its meaning. Systems with deep structure share two characteristics: (1) they have differentiated parts and (2) the units that comprise them "work": they exchange resources with the environment in ways that maintain—and are controlled by—this differentiation (see Prigogine &

TABLE 2
How Punctuated Equilibrium Models Differ from Traditional Counterparts

Commonalities:
Systems do not evolve through a gradual blending from one state to the next. Systems' histories are unique. They do not necessarily evolve from lower to higher states, through universal hierarchies of stages, or toward pre-set ends.

Individuals: Levinson (1978: 40)

Our findings led us [away] from the idea of a steady, continuous process of development to the idea of qualitatively different *periods* in development (1978: 40). Like Erikson and Freud, I define each period primarily in terms of its developmental tasks . . . Unlike Piaget . . . I do not identify a particular structure as the . . . optimal one for a given period; the life structures generated in any period are infinitely varied. Phase 3 comes after phase 2 and to some extent builds upon it, but phase 3 is not necessarily more "advanced" (1986: 10).

Groups: Gersick (1989: 277); Gersick & Davis (1989)

Groups did not develop in uniform series of stages, nor through linear, additive building block sequences.

Project groups are all challenged to invent and generate a product, find ways to work together, deal with outside expectations and pace themselves to meet deadlines. However, there appears to be no one best way to work.

Organizations: Tushman & Romanelli (1984: 208)

Stage models [which] postulate a set of distinct and historically sequenced stages . . . dominate the literature on organizational evolution. [But] organizations do not evolve through a standard set of stages. . . . [They] may reach their respective strategic orientations through systematically different patterns of convergence and reorientation.

Scientific Fields: Kuhn (1970)

Perhaps science does not develop by the accumulation of individual discoveries and inventions (: 2). We may [also] have to relinquish the notion . . . that changes of paradigm carry scientists . . . closer and closer to the truth. . . . Nothing . . . makes it a process of evolution *toward* anything. (: 170–171)

Biological Species: Eldredge & Gould (1972: 84); Gould (1977: 36–37)

Evolution is not a stately unfolding [in which] new species arise from the slow and steady transformation of entire populations. . . . [It is] a story of homeostatic equilibria, disturbed only "rarely". . . by rapid and episodic events of speciation.

Darwin explicitly rejected the . . . equation of what we now call evolution with any notion of progress. . . . Yet most laymen still equate evolution with progress . . . [a] fallacious equation [which] continues to have unfortunate consequences.

Grand Theory: Prigogine & Stengers (1984: 207)

The way . . . biological and social evolution has traditionally been interpreted represents a particularly unfortunate use of . . . concepts . . . borrowed [unjustifiably] from physics. . . . The foremost example of this is the paradigm of optimization. Optimization models ignore both the possibility of radical transformations . . . that change the definition of a problem and thus the kind of solution sought—and the inertial constraints that may eventually force a system into a disastrous way of functioning.

Stengers, 1984: 154, 287). *Deep structure* is the set of fundamental "choices" a system has made of (1) the basic parts into which its units will be organized and (2) the basic activity patterns that will maintain its existence. Deep structures are highly stable for two general reasons. First, like a decision

TABLE 3
Concepts of Deep Structure in Six Theories

Commonalities:
Deep structure is a network of fundamental, interdependent "choices," of the basic configuration into which a system's units are organized, and the activities that maintain both this configuration and the system's resource exchange with the environment. Deep structure in human systems is largely implicit.

Individuals: Levinson (1986: 6)

Life Structure: The underlying pattern or design of a person's life at a given time. . . . The life structure [answers the questions]: "What is my life like now? What are the most important parts of my life, and how are they interrelated? Where do I invest most of my time and energy?" The primary components of a life structure are the person's relationships with various others in the external world.

Groups: Gersick (see 1988: 17, 21)

Framework: A set of givens about the group's situation and how it will behave that form a stable platform from which the group operates. Frameworks may be partly explicit but are primarily implicit. They are integrated webs of performance strategies, interaction patterns, assumptions about and approaches toward a group's task and outside context.

Organizations: Tushman & Romanelli (1985: 176)

Strategic Orientation: Answers the question: What is it that is being converged upon? While [it] may or may not be explicit, it can be described by [five facets]: (1) core beliefs and values regarding the organization, its employees and its environment; (2) products, markets, technology and competitive timing; (3) the distribution of power; (4) the organization's structure; and (5) the nature, type and pervasiveness of control systems.

Scientific Fields: Kuhn (1970)

Paradigm: Universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners. (: viii) [Paradigms indicate] what a datum [is], what instruments might be used to retrieve it, and what concepts [are] relevant to its interpretation. (: 122) [However, scientists] are little better than laymen at characterizing the established bases of their field. . . . Such abstractions show mainly through their ability to do successful research. (: 47)

Biological Species: Gould (1989); Wake, Roth, & Wake (1983: 218–219)*

Genetic Programs: Stasis is . . . an active feature of organisms and populations . . . based largely on complex epistasis in genetic programs, and the resilient and limited geometries of developmental sequences. (: 124)

[Living systems require very specific internal processes.] The . . . conditions governing each internal process are provided by preceding processes within the system, [constituting a network of] circular interaction: [the activity of each element affects all]. Each . . . change of the system must remain within the . . . limits of the process of circular production and maintenance of the elements, or the system itself will decompose. No element can interact with the environment independently . . . and no independent change (evolution) of single elements can take place. . . . The same is true for the "activity" of the genes: they never "express" themselves in a direct, linear way. Thus organisms have evolved as systems resistant to change, even genetic change.

Grand Theory: Haken (1981: 17)

Order Parameters: Collective modes . . . which define the order of the overall system. . . . Order parameters . . . may be material, such as the amplitude of a physical wave, [or] immaterial, such as ideas or symbols. . . . Once . . . established, they prescribe the actions of the subsystems . . . at the microscopic level.

* The Wake et al. excerpt is from an article recommended by S. J. Gould (personal communication). It explains and expands on the excerpt from Gould.

tree, the trail of choices made by a system rules many options *out*, at the same time as it rules mutually contingent options in. This characterization accords with organizational research on the tenacity of initial choices (Eisenhardt & Schoonhoven, 1990; Gersick, 1988; Ginnett, 1987; Stinchcombe, 1965); early steps in decision trees are the most fateful. Second, as Wake et al. explained (see Table 3, Biological Species), the activity patterns of a system's deep structure reinforce the system as a whole, through mutual feedback loops.

As Table 3 suggests, different kinds of systems face different "menus" of choices about how they will organize and run themselves. Identifying these sets of choices (which become the components of each system's deep structure) is an important part of theory building for specific punctuational models. For example, Tushman and Romanelli (1985) described five kinds of structural and performance choices that make up organizations' deep structures; Levinson (1978), Gersick (1988), and Kuhn (1970) described categories of choices for individuals, groups, and scientific disciplines, respectively (see Table 3). This approach differs critically from that of universal stage theorists, who seek commonalities in the *outcomes* of choices and dismiss individual differences as "noise" (Gersick, 1988). Punctuational models identify common choice categories, but allow for infinite variety in individual systems' particular solutions. This is the difference between saying, for example, that all project groups progress through "forming, storming, norming, and performing" (Tuckman, 1965) and saying that all project groups are challenged to choose boundaries, norms, and work methods, but they vary in the sequence and manner in which they settle those choices.

Equilibrium Periods

If deep structure may be thought of as the design of the playing field and the rules of the game, then equilibrium periods might be compared loosely to a game in play. The stable integrity of the field and the rules and, thus, of the game itself does not mean that play is uninteresting, that every match is the same, or that scores and performances are static.

Within equilibrium periods, the system's basic organization and activity patterns stay the same; the equilibrium period consists of maintaining and carrying out these choices. As implied above, what "carrying out" means is different for different types of systems. In systems without intentionality, it can be a mechanical set of activities or a series of minor adjustments to the environment. Levinson, Gersick, Tushman and Romanelli, and Kuhn described the refinements and incremental steps human systems take during equilibrium periods, as they work to achieve goals built into their deep structures (see Table 4).

Systems in equilibrium also make incremental adjustments to compensate for internal or external perturbations without changing their deep structures (see Wake, Roth, & Wake, 1983). A classic example is provided by Citibank's "back office" efforts to process increasing floods of paper-

TABLE 4
Concepts of Equilibrium Periods in Six Theories

Commonalities:
During equilibrium periods, systems maintain and carry out the choices of their deep structure. Systems make adjustments that preserve the deep structure against internal and external perturbations, and move incrementally along paths built into the deep structure. Pursuit of stable deep structure choices may result in behavior that is turbulent on the surface.

Individuals: Levinson

Structure-Building Periods: The primary task is to build a life structure: a man must make certain key choices, form a structure around them, and pursue his goals and values within this structure. To say that a period is stable in this sense is not . . . to say that it is tranquil. . . . The task of . . . building a structure is often stressful . . . and may involve many kinds of change. Each stable period . . . has distinctive tasks and character according to where it is in the life cycle. (1978: 49) [Such periods] ordinarily last 5 to 7 years, 10 at most. (1986: 7)

Groups: Gersick (1988)

Project groups' lives unfold in two main *Phases*, separated by a transition period halfway between the group's beginning and its expected deadline. Within phases, groups approach their work using stable frameworks of assumptions, premises, and behavior patterns. As frameworks vary, specific activities and efficacy vary from group to group. During a phase, groups accumulate more or less work, learning, and experience within the boundaries of their framework, but (even when hampered by it), they do not change their fundamental approach to their task.

Organizations: Tushman & Romanelli (1985)

Convergent Periods: Relatively long time spans of incremental change and adaptation which elaborate structure, systems, controls, and resources toward increased coalignment, [which] may or may not be associated with effective performance. (: 173) [They are] characterized by duration, strategic orientation, [and] turbulence. . . . (: 179) During [these] periods . . . inertia increases and competitive vigilance decreases; structure frequently drives strategy. (: 215)

Scientific Fields: Kuhn (1970)

Normal Science is directed to the articulation of those phenomena and theories that the paradigm already supplies. (: 24) Three classes of problems—determination of significant fact, matching of facts with theory, and articulation of theory—exhaust . . . the literature of normal science, both empirical and theoretical. . . . Work under that paradigm can be conducted in no other way, and to desert the paradigm is to cease practicing the science it defines. (: 34)

Biological Species: Gould (1980)

Phyletic transformation [is] minor adjustment within populations [which is] sequential and adaptive. (: 15) [It is a mode of evolution in which] an entire population changes from one state to another. [This] yields no increase in diversity, only a transformation of one thing into another. Since extinction (by extirpation, not by evolution into something else) is so common, a biota with [only this, and] no mechanism for increasing diversity would soon be wiped out. (: 180)

Grand Theory: Prigogine & Stengers (1984); Haken (1981)

In *stable regions*, deterministic laws dominate. (: 169) All individual initiative is doomed to insignificance. . . . (: 206)

Under given external conditions, the individual parts of the system have . . . stable configurations . . . or oscillations. . . . [If] small perturbations [are] imposed upon the system . . . the individual parts of the system relax to their former state once the perturbation is removed, or they change their behavior only slightly when the perturbation persists. (: 17) work—before John Reed revolutionized the system—simply by hiring more people (Seeger, Lorsch, & Gibson, 1974).

It is important to note that human systems in equilibrium may look turbulent enough to mask the stability of the underlying deep structure. For example, a young adult's life structure may include the fundamental choice to test a variety of occupational options, resulting in a pattern of job changes that appears chaotic (Levinson, 1978). A project group may choose implicitly to subvert its task, or an organization may commit to a strategy it is not well equipped to accomplish, resulting in patterns of overt conflict, vacillation, or failure. However, the deep structure of chosen goals and activities remains in place.

One of the major questions generated by the punctuated equilibrium paradigm concerns the inertia that maintains a system's equilibrium. For organization theorists, a salient form of this question is: Why is it so hard for systems to make major changes? Tushman and Romanelli (1985) reviewed the impressive organizational literature on this observation. The theorists included here discussed three barriers to radical change in human systems: cognition, motivation, and obligation.

Gersick, Tushman and Romanelli, Kuhn, Eldredge and Gould, and Prigogine and Stengers all discussed cognitive frameworks and the thoroughness with which they shape human awareness, interpretation of reality, and consideration of actions. As Kuhn stated, phenomena "that will not fit the box are often not seen at all" (1970: 24). Limits on the awareness of alternatives constrain change in behavior (Simon, 1976).

Several theorists also discussed motivational barriers to change. Levinson (1978) described the pain of loss, the uncertainty, and the fear of failure that accompany the anticipation of terminating a life structure and trying to define a new one. Gersick (1989) offered examples of groups' reluctance to take new steps in their projects, based on wishes to avoid losing opportunities, losing power struggles, or failing at more difficult tasks. Kuhn (1970: 78) described scientists' readiness to append "ad hoc modifications" to their theories, in an effort to erase contradictions which, if appreciated, could discredit their lives' work. The sunk costs incurred during a period of equilibrium, and fears of losing control over one's situation if the equilibrium ends, contribute heavily to the human motivation to avoid significant system change.

Lastly, Levinson (1978), Tushman and Romanelli (1985), and Kuhn (1970) discussed the inertial constraints of obligations among stakeholders inside and outside a system. Levinson's (1986) portrayal of the life structure as a set of relationships (see Table 3) points up how pervasively a system may be bound by others' expectations and needs. Kuhn (1970: 35) noted the inertial effects that scientific communities exert by carefully socializing students, granting legitimacy only to certain problems, and responding to research findings that fall outside the paradigm as failures that "reflect not on nature but on the scientist." As Tushman and Romanelli (1985: 177) suggested, even if a system overcomes its own cognitive and motivational barriers against realizing a need for change, the "networks of interdependent resource relationships and value commitments" generated by its structure often prevent its being *able* to change.

A final explanation for the stability of equilibrium periods is that systems benefit from this kind of persistence. For human systems, these benefits have to do with the ability to pursue goals and accomplish work. According to Kuhn (1970: 25), the practice of normal science—which prescribes what methods to use and promises that certain questions will ultimately reward pursuit—facilitates the solution of "problems that [scientists] could scarcely have imagined and would never have undertaken without commitment to the paradigm." This insight about normal science is paralleled for entrepreneurs, managers, task groups, and organizations when they respond to obstacles by inventing ways to persist with their goals, not by changing their basic direction.

Tushman and Romanelli (1985: 195), whose model defines equilibria as periods during which organizations become more internally consistent, proposed an additional reason for the adaptability of inertia. They suggested that "selection processes favor . . . organizations whose strategic orientations are consistent with internal and external environmental demands." When the environment is reasonably stable, organizations that maintain equilibrium should become more and more thoroughly adapted to carry out their missions. By sticking to a course, a system can become skilled at what it does.

Revolutionary Periods

The third major component of the punctuated equilibrium paradigm is the revolutionary period. The difference between the incremental changes of equilibrium periods and revolutionary changes is like the difference between changing the game of basketball by moving the hoops higher and changing it by taking the hoops away. The first kind of change leaves the game's deep structure intact. The second dismantles it. The definitive assertion in this paradigm is that systems do not shift from one kind of game to another through incremental steps: such transformations occur through wholesale upheaval.

The discussions in the previous two sections should help explain why incremental changes in a system's parts would not alter the whole. As long as the deep structure is intact, it generates a strong inertia, first to prevent the system from generating alternatives outside its own boundaries, then to pull any deviations that do occur back into line. According to this logic, the deep structure must first be dismantled, leaving the system temporarily disorganized, in order for any fundamental changes to be accomplished. Next, a subset of the system's old pieces, along with some new pieces, can be put back together into a new configuration, which operates according to a new set of rules.

The example of removed basketball hoops suggests how changes to the core of a system's deep structure affect the whole system. The contrast with

TABLE 5
Concepts of Revolutionary Periods in Six Theories

Commonalities:
Revolutions are relatively brief periods when a system's deep structure comes apart, leaving it in disarray until the period ends, with the "choices" around which a new deep structure forms. Revolutionary outcomes, based on interactions of systems' historical resources with current events, are not predictable; they may or may not leave a system better off. Revolutions vary in magnitude.

Individuals: Levinson (1986: 7)

Transitional Periods ordinarily last about 5 years. [They] terminate the existing life structure and create the possibility for a new one. Primary tasks . . . are to reappraise the existing structure, explore possibilities for change in the self and the world, and move toward commitment to the crucial choices that form the basis for a new life structure in the ensuing period. The choices are . . . the major product of the transition.

Groups: Gersick (1989)

The *Transition Period* provides a compact, time-limited opportunity for radical progress by interrupting the inertial movement of Phase 1. In successful transitions, groups stop the activity that has dominated the first half of their time, pull in new ideas (often involving outside contact), and reframe their accrued experience in ways that enable them to jump ahead. These transitions close with group agreement on some concrete goal that forms the basis for moving forward. The new or revised framework formed during transitions is the foundation for Phase 2 work.

Organizations: Tushman & Romanelli (1985)

Reorientations are relatively short periods of discontinuous change where strategies, power, structure, and systems are fundamentally transformed toward a new basis of alignment. (: 173) *Recreations* are reorientations that also involve discontinuous change in core values which govern decision premises. . . . [They are] the most radical form of reorientation. (: 179) During reorientations, organization inertia decreases, competitive vigilance increases; strategy drives structure. (: 215)

Scientific Fields: Kuhn (1970: 85)

Scientific Revolution: a reconstruction of the field from new fundamentals . . . that changes some of [its] most elementary theoretical generalizations. . . . When the transition is complete, the profession will have changed its view of the field, its methods, and its goals . . . "handling the same bundle of data as before, but placing them in a new system of relations . . . by giving them a different framework" (Butterfield, 1949).

Biological Species: Gould (1980: 182)

Speciation [is] the second mode [of evolution, which] replenishes the earth. New species branch off from a persisting parental stock.

Grand Theory: Haken (1981: 17); Prigogine & Stengers (1984)

Bifurcation: At critical values of external parameters . . . [the system's] stability can get lost. . . . The total system tries to find a new global configuration. . . . The way the new state is reached seems . . . universal. Because of internal fluctuations, the system tests different . . . "modes." Competition between different . . . modes sets in, and eventually one or a few kinds of modes win over. . . . The winners of this competition [can] entirely [prescribe] what the subsystems have to do.

Whenever we reach a bifurcation point, deterministic description breaks down. The type of fluctuation present in the system will lead to the choice of the branch it will follow [in a] stochastic process. . . . (: 177) the gradualist paradigm is not, again, simply a matter of many incremental changes "bunching up." According to punctuational paradigms when basic premises change, all the premises contingent on them are affected. This idea also contradicts the gradualist view of systems as never moving (or *having* to move) very far from their status quo during any one step. (Consider the fall of the Berlin Wall and the fate of initial predictions that Germany could take a very long time to reunite.) The same interdependence in deep structure that explains how it can unravel so rapidly once undermined also explains the relatively rapid close of a revolutionary period, once the basis for a new deep structure is found. As Gould (1983: 196) explained, with respect to biological organisms:

> If genetic programs were beanbags of independent genes, each responsible for building a single part of the body, then . . . any major change would have to occur slowly and sequentially as thousands of parts achieved their independent modifications. But genetic programs are hierarchies with master switches, and small genetic changes that happen to affect the switches might engender cascading effects throughout the body. Major evolutionary transitions may be instigated (although not finished all at once . . .) by small genetic changes that translate into fundamentally altered bodies.

This construction is supported by empirical findings about how systems undergo revolutionary change. Levinson, Gersick, Kuhn, and Prigogine and Stengers portrayed similar pictures of systems in transition periods, undergoing, first, a breakdown of the old equilibrium and a period of uncertainty about the future, before choosing a new basis around which to crystallize a new deep structure. In Levinson's (1978) and Gersick's (1989) terms, transition periods present two distinct tasks: terminating the old deep structure and initiating a new one.

Why should revolutions occur at all? The answers arise from the same features of deep-structured systems that generate inertia: the mutual interdependence of their parts and action patterns and the fact that deep structures determine how systems obtain resources from the environment. These features open systems' deep structures to two basic sources of disruption: (1) *internal changes* that pull parts and actions out of alignment with each other or the environment and (2) *environmental changes* that threaten the system's ability to obtain resources.

The theorists covered here offer complementary reasons why human systems generate *internal* sources of strain and misalignment. Human systems tend to outgrow the deep structures that govern their perspectives and activities. As Levinson (1978) pointed out, a life structure appropriate for the developmental tasks of a man of 20, just becoming independent of his parents and entering adulthood, cannot meet the same man's needs when he is 30 and concerned with pursuing his own career and family. A project group's framework for starting a task is seldom appropriate to carry through the entire project (Gersick, 1988). An organization's growth strains its existing structures and practices (Tushman & Romanelli, 1985). Kuhn (1970) argued that the very pursuit of normal science makes paradigms obsolete, either by answering the interesting questions (and becoming routine engineering) or by finally running up against puzzles that the paradigm was never equipped to solve. In human systems, a deep structure formed at the beginning of a period is shaped by members' inexperience, their need to get started, and their untested expectations and goals. Eventually, human systems finish their deep structures' agenda, uncover their inadequacies, and generate new needs that the old structures cannot meet.

The *external environment* presents a less orderly source of change. Levinson (1978) noted that the social environment wants different things from a person of 30 and a person of 40, even if he or she is still in the same setting. Gersick and Hackman (1990) discussed the changes that may create mismatches between a group's framework and its environment. Tushman and Romanelli (1985: 205) provided a sophisticated picture of shifts that can make organizations' strategic orientation inappropriate for their environments, including (foreseeable) maturation in product life cycles and (unforeseeable) changes in the legal and social climate, or the invention of "substitute products and/or technologies."

Such internal or external shifts do not, by themselves, cause revolutionary change; they only create the need. This point is important to pursue because it has long been proposed that failure or goal blockage triggers change (e.g., March & Simon, 1958; Weiss & Ilgen, 1985)—a proposal that is challenged by the observation that groups and organizations may rely more heavily on old routines when faced with decline (Gladstein & Reilly, 1985; Greenhalgh, 1983; Staw, Sandelands, & Dutton, 1981). Punctuated equilibrium models suggest that failures may be extremely important in setting the stage for revolutionary change. But as long as events occur against the backdrop of the same deep structure, they are treated or interpreted in ways that preserve the system's inertia and, therefore, incremental solutions are sought. The handwriting on the wall cannot be read; events do not indicate to system members what they ought to be doing differently. It may be more useful to think of certain kinds of failures—those engendered by misalignments within a system's deep structure or between its deep structure and its environment—not as sufficient causes, but as major sources of energy for revolutionary change. Revolutions themselves seem to require decisive breaks in systems' inertia.

THE DYNAMICS OF REVOLUTIONS: OPPORTUNITIES FOR SYNERGY ACROSS MODELS

Having explained punctuated equilibrium in general, I would like to suggest the potential benefits that can be gained by comparing models from diverse domains. This section of the article attempts to take a step in that direction by examining one area, the dynamics of revolutionary change processes in organizational settings. The previous outline of revolutionary periods leads directly to what are perhaps the most interesting questions raised by the paradigm: (1) What triggers the onset of revolutionary periods? (2) How do systems function during revolutionary periods? (3) How do revolutionary periods conclude? This section is necessarily speculative; it touches several levels of analysis because organized human systems (and revolutions) are multilevel phenomena.

What Triggers Revolutionary Periods?

There may be many ways in which the inertia of an equilibrium period can be broken. The models included here indicate at least two: the attraction of newcomers to crisis situations and the system's arrival at key temporal milestones. Kuhn (1970) and Tushman and Romanelli (1985) discussed the first avenue of change. Kuhn stated that crises are necessary precursors to scientific revolutions. He described how the persistence of apparently unresolvable anomalies increasingly focuses scientists' attention on trouble spots. With the stage thus set, some individuals break through by inventing a new paradigm. These revolutionary thinkers are not a field's established experts, but:

> almost always . . . either very young or very new to the field whose paradigm they change. . . . These are the men who, being little committed by prior practice to the traditional rules of normal science, are particularly likely to see that those rules no longer define a playable game and to conceive another set that can replace them. (1970: 90)

This analysis complements Tushman and Romanelli's identification of "performance pressures . . . whether anticipated or actual" (1985: 179) as the fundamental agents of organizational reorientation. Tushman, Newman, and Romanelli (1986) described as typical the scenario of an organization falling into serious trouble before responding by *replacing* its top management. They found that "externally recruited executives are more than three times more likely to initiate frame-breaking change than existing executive teams" (1986: 42).

Failures caused by inappropriate deep structures are destined to elude the (misdirected) efforts of current system members to correct them. Unless such failures kill the system, they command increasing attention and raise the likelihood that newcomers will either be attracted or recruited to help solve the problems. The newcomer has the opportunity to see the system in an entirely different context than incumbent members, and he or she may begin problem solving on a new path.

It is then the newcomer's explicit task to break the old deep structure and establish a new one. In scientific revolutions, Kuhn (1970) claimed, this is only possible when paradigm failures have caused enough crisis to generate receptivity to arguments that would otherwise be ignored; in fact, some scientists never relinquish the old paradigms and never understand the revolutionary new ones. When new executives are recruited to organizations in crisis, according to Tushman, Newman, and Romanelli (1986), it is up to them to break the grip of the old structure and reorient their organizations. One way new executives may facilitate this is by replacing their direct reports—literally removing sources of inertia.

A different trigger of change is presented in Levinson's and Gersick's models, in which system members use acute awareness of time to stop the inertia of equilibrium periods for *themselves*. Gersick found that project groups with life spans ranging from one hour to several months reliably initiated major transitions in their work precisely halfway between their start-ups and expected deadlines. Transitions were triggered by participants' (sometimes unconscious) use of the midpoint as a milestone, signifying "time to move." Although Levinson (1986: 5) proposed that transitions in adult development are stimulated by deficiencies in the current life structure, he also presented, as one of his most controversial yet robust findings, the discovery that each developmental transition "begins and ends at a well-defined modal age, with a range of about two years above and below this average." His report of the feelings men experience near age 30, and again near age 40, closely parallel Gersick's findings about group members' sense of time at project midpoints, albeit on a different scale:

> At age 28 . . . a voice within the self says: "If I am to change my life . . . I must now make a start, for soon it will be too late" (1978: 58).
>
> [Near age 40, a man's] need to reconsider the past arises in part from a heightened awareness of his mortality and a desire to use the remaining time more wisely. (1978: 192)

These theorists propose that events "do not in themselves cause the start or end of a period" (Levinson, 1978: 55). Instead, the timing of the event determines its perceived significance and its potential to influence deep structure change. When people reach temporal milestones that are important to them, they change their views of their own situations, seeing a meaningful portion of their time as closed, and the next portion as imminent. Equilibrium periods are thus interrupted by strong, self-imposed signals.

This view is supported by research on the Einstellung effect: people's tendency to persist with the same approach to a problem or series of problems whether or not that approach is productive (Luchins, 1940). Ericsson and Simon reported (1984: 129) that such persistence is not inadvertent, but a deliberate choice to continue a strategy as long as the task appears to be the same. They found that "a number of experiments have reduced the Einstellung effect by marking the test problems as separate problems rather than a continuation of the sequence of problems presented before." Persistence as well as its converse are thus explained. When people feel that a temporal era has ended, they may consciously decide that the approaches they chose for that era are no longer valid. When individuals and groups are reminded, by temporal milestones, that their time is finite, they feel a sense of urgency to reevaluate past choices, pursue aspirations they have put off, and take new steps.

To date, people's attention to time has not been considered a factor in organizational reorientations. Organizations are not mortal like individuals, and they usually are not temporary in the same way as project groups. Nonetheless, there are reasons to consider the role of timing. Deadlines have been recognized as stimulators of organizational activity for many years (March & Simon, 1958). Certainly some organizations, such as start-ups backed by venture capital, are run much like time-limited projects. They have long-term goals (e.g., of 5 to 10 years) by which they are expected to yield returns on investments; backers regularly evaluate such organizations' progress against time-linked targets.

Preliminary data from a field study by the author suggest that CEOs in start-up businesses do use temporal milestones in ways similar to project groups. Interviewed executives described being aware of problems for months without considering basic strategy changes—either as a conscious choice (as with Einstellung effects), or because their assumptions about their business kept them from realizing what was needed. For example, one executive said, "You'll do [strategic planning] as often as you need it," but immediately added that he sets a half-year time period within which he will not change directions. The excerpt which follows is from his description of his company's decision to shift its identity to a new product area, in order to improve its market valuation:

> Q: Did you decide that as soon as you talked to the financial analysts?
>
> No—it doesn't *happen* that way! (laughs). . . . After . . . collecting this data for the *first* half of the year, [we had] strategic review meetings [in the summer. That's when we said] well, let's—reset the direction for the business. . . . Just *shift* the direction of the company. . . . You'll do [strategic planning] I guess, as frequently as you need it, but—once you change the direction, you've got to give it six months or more before you can say, well, you know—"that didn't work, I've gotta try something else."

A second CEO's description of his company's response to a series of product failures illustrates that even serious, repeated problems can be persistently misdiagnosed for long periods of time. Until a temporal milestone gave this company the opportunity to redefine its product at a deep-structure level, the problems were seen as peripheral to the business:

> Six months ago, we had "tacky engineering problems," and we treated 'em [as such], not as a concept change. And we made a couple of bad errors. . . . We *patched* it. . . . [Our yearly] offsite session was almost all strategy . . . and in that session I think we came to grips with . . . these issues. . . . We all *understood* [that the product must include linkage systems]. Now we have strategic statements and technical statements and cost quotes . . . we can put it into effect. . . . We're in a different business today than we were six months ago.

Most likely, as Tushman and Romanelli (1985) suggested, the older the organization and the longer the executive team's tenure, the less often such milestones can break equilibrium and allow for changes of this magnitude. However, Levinson's research does show that individuals, at least, make far-reaching changes within time scales much grander than those of project groups or start-up organizations. The mid-life transition, for example, is an often deeply wrenching shift, made near age 40, at the halfway point within the temporal context of an individual's whole expected life span.

Tushman and his associates (Tushman & Romanelli, 1985; Tushman et al., 1986) have stressed the importance of organizational leaders in managing reorientations. They reported that a small percentage of top executives do initiate reorientations without waiting for serious decline, without having to be replaced, and most important, with better results than executives hired in from outside. It is conceivable that, for some of those leaders, critical milestones in adult development, or in their long-range plans for their companies, coincide with important environmental shifts, thus priming them for revolutionary change in ways that elude others.

This section of the article has dealt with triggers of revolutionary periods: conditions that break a system's inertia and thereby allow revolutions to begin. According to Kuhn and Tushman and Romanelli, a system's members usually are unable to do this. When internal and/or external events make a system's deep structure obsolete, it usually takes a crisis, and the subsequent attraction of newcomers, to intervene and end equilibrium periods. In contrast, Levinson and Gersick suggested that when system members feel they have time limits, they set temporal boundaries determining when equilibrium periods will end, at which points they initiate their own transitions.

The contrast between these scenarios suggests the value of research to explore (1) whether temporal mechanisms are involved in the few cases where incumbents in organizations initiate their own reorientations and (2) whether there are ways, besides waiting for temporal milestones or replacing executives, to help organizational systems close equilibrium periods when revolutionary change is needed.

How Do Systems Function During Revolutionary Periods?

During equilibrium periods, organizational systems may make incremental changes because members want to try something new. This is not the case for change of revolutionary dimensions. System members do not begin revolutionary periods because they have a specific new idea to try, but because their equilibrium has been broken. Since they are no longer directed by their old deep structures, and do not yet have future directions, system members experience uncertainty, often accompanied by powerful feelings. This section of the article begins with the role of emotion in transition dynamics and moves to the related issues of environmental contact, cognition, and the dispersal of transitional changes throughout the system. Although transitions' outcomes are inherently unpredictable, the following points suggest some ways that future research might increase our chances to manage them well.

The role of emotion. Even in project groups of one hour's duration, the perception that a transition is imminent can pack a punch: "Once it passes the halfway point, that's when the panic sets in" (group member, quoted in Gersick, 1989: 287). Levinson (1978: 86) discovered that transitions in adults' lives are often profound crises. Feeling suspended and directionless, people fear "chaos, dissolution, [and] loss." Yet, he reported, transitions are also occasions for hope and anticipation of a better future. Tushman et al. (1986: 32) described organizational reorientations as inescapably risky and "painful to participants," yet potentially exhilarating, too. Evidence from the theories examined here suggests that emotion is more than an incidental by-product of transition dynamics; it often plays an important motivational role.

For example, the direct observation of project groups reveals a particular interplay of emotions and actions during successful transitions. In groups that move ahead at their transitions, the jolt of urgency registered at the midpoint usually includes enough fear of not finishing to help members complete agendas that have been productive, drop agendas that have not, and, at least temporarily, suspend power struggles. Although the choice of the midpoint (or some other milestone) may be calculated, part of its power to stop a group's equilibrium may well lie in the emotions people feel upon reaching it: research shows that strong negative emotion "interrupts . . . the normal program of behavior" (Isen, 1984: 180).

At the same time, such groups appear to feel enough optimism to initiate fresh search activities and to move forward on the basis of new ideas. Optimism is important because, as Kuhn (1970) and Tushman and Romanelli (1985) stressed, there is no way to prove, during a revolutionary period, that an idea will succeed. At inception, the central premises of a new paradigm or new strategic configuration are necessarily untested; their merit can only be demonstrated as the system rebuilds around them in the equilibrium period to come.

Kuhn further proposed that, among ideas competing to provide new scientific paradigms, the choice may ultimately rest on aesthetic appeal; an idea must feel right, at least to a small group, who will then risk investing the energy to pursue it. Tushman et al. (1986) discussed the importance of top executives' abilities to inspire confidence and enthusiasm for the new direction. Without an adequate combination of urgency and optimism, organizational systems at transition points may cling to old patterns, even while they clearly recognize the need to change, or they may simply quit. This hypothesis suggests the value of research on the effects of combined negative and positive emotions on performance, in situations calling for punctuational changes or turnarounds.

Environmental contact. Urgency and optimism may also be important to another phenomenon that is often critical to transition dynamics: the influence of outsiders. Levinson (1978: 109) discussed important roles played by "transitional figures." These are people with whom adults in transition form special relationships, from whom they gain encouragement and learn new ways to live and work. Gersick (1988) found a similar occurrence of special interaction between project groups in transition and their external supervisors. Over half of the naturally occurring teams observed actively sought outside assistance during transition periods, partly to get help making choices and moving forward, and partly to check external requirements and increase the chances that their products would succeed in their environments. Previously this article reviewed the key role played by outsiders who are attracted or recruited to solve revolutionary crises in scientific disciplines and in organizations. Eisenhardt's (1989) research, showing the importance of a "trusted advisor" in helping organizations make major decisions fast and effectively, suggests transitional figures may also be critical in organizational reorientations where top executives remain in place.

The cognitive confusion and emotional distress of revolutionary periods may propel systems to seek outside help or to be especially receptive to outside influence at that time. The benefits provided by outsiders may include new cognitive perspectives, fresh awareness about the environment, and an energizing reassurance. Research on the role of outside advisors, and the effects of contrasting emotions in both help-seeking and help-providing behavior, may have important implications for the management of organizational transitions.

Cognition and the dynamics of insight. There is a moment that can be directly observed in project groups (Gersick, 1989), and occasionally documented in scientific disciplines (e.g., Gould, 1977), when a system in transition turns from confusion toward clarity. The system pivots on the insight around which a new deep structure will crystallize. It is clear that the articulation of a new vision is also central to organizational reorientation (Tushman & Romanelli, 1985). The six models examined here suggest several facets of this complex phenomenon.

Kuhn and Prigogine and his colleagues emphasize the unpredictability of a system in transition. Kuhn (1970) noted that perception is a subjective phenomenon: there is always more than one plausible way to interpret reality. Prigogine and Stengers (1984: 176) pointed to the objective unpredictability of the transition system itself, stating that it may follow "a number of equally possible paths," the choice of which will depend on a random fluctuation. In marked contrast to the relative predictability of equilibrium conditions, neither the mechanics of human cognition nor the system itself absolutely "dictates" the outcome of a transition.

The situation, in line with the thinking of these theorists, is something like an Escher print: it incorporates several pictures simultaneously, none of which system members can distinguish as the transition begins. Prigogine's colleague Haken referred to this as *symmetry*, and he referred to the event that resolves it as *symmetry breaking:*

> Symmetry breaking is a wide-spread . . . behavior of complex systems, including the human brain. [For example] taking the black features [of an Escher graphic] as foreground, we recognize devils, whereas the white features as foreground let us see

> angels. . . . Pattern recognition can often be viewed as a sequence of symmetry-breaking events, in which at each branching point new information is needed to break the symmetry [and] make a unique decision possible. (Haken, 1981: 19)

The construct of symmetry breaking helps researchers to understand the dawn of insight during transitions. Given a piece of information that provides a new way to look at it, a confusing puzzle can resolve into a coherent picture seemingly instantly. During the very swift transitions that can occur in project groups, this metaphor fits people's experience of things "falling into place." In more complex transitions, Kuhn and Gould offered intriguingly similar descriptions of the revolutionary turn toward a new structure beginning with a "keystone" (Kuhn, 1970: 56) or "key adaptation" (Gould, 1980: 191). In these cases, the new direction does not emerge all at once; instead, a catalytic change opens the door to it. Kuhn described critical insights that sometimes show the way to novel paths of investigation, leading to new paradigms. Gould described initial mutations that thrust a group of organisms into a new mode of life, thereby subjecting them to novel selective pressures, which then work toward full emergence of the new species.

Note that this model of insight formation illuminates some critical differences between the punctuated equilibrium paradigm and traditional universal-stage models of system evolution. First, systems' particular histories matter, because histories determine the unique array of information and conditions from which system members can select their new direction—the jumping-off place for the transition (Prigogine & Stengers, 1984). Second, systems' futures are unpredictable: the information used to "break the symmetry" of the transition period may come from a random environmental event or circumstance. These aspects of transitions both inject chance into the development process and explain how systems can adapt to entirely new features in their environments, rather than merely following their own teleology.

In the first section of the article, I described the relative speed with which transitions unfold and offered some general explanations for it. Why should people find insight quickly during transitions? The sheer urgency and discomfort of being without a functioning structure lend intensity to the search for new solutions. The dismantling of the old deep structure frees system members to search for symmetry-breaking information in new fields and to perceive material that they already knew in new ways. Further, as Tushman and his colleagues (1986) pointed out, an organization in transition is unstable on a number of fronts. If a new order does not take control relatively quickly, numerous vested interests may pull it toward its old structure; transition periods may end quickly by default.

A final contributor to the swift development of insight during transitions may have to do with the effects of time-awareness on perception. In their article on managerial problem solving and social cognition, Kiesler and Sproull (1982) noted that individuals automatically and continuously notice time and segment streams of stimuli into coherent units. The fineness of this segmentation and, thus, the level of abstraction and detail that is perceived, changes automatically, in predictable ways. For example, experts segment events less finely and, thus, see "whole pictures"; conditions of uncertainty lead people to segment events much more finely, as they comb their surroundings for information.

Automatic changes in segmentation may be very important in the development of insight during transitions, especially transitions stimulated by temporal milestones. As system members perceive one era of their time to have closed and another era to have opened before them, their segmentation of the past and distant future should broaden. As those periods resolve into coherent blocks, system members' vision may shift suddenly from the trees to the forest. In project teams, this can be seen in members' characteristic transition summaries of what they have been doing and what is most important about where they need to go (Gersick, 1989). Simultaneously, the uncertainty of the transition may cause system members to segment the information that is *immediately* before them more finely. With that kind of search, according to Kiesler and Sproull, choices are made more rapidly.

The formation of insight is an important part of revolutionary periods in human systems. The dynamics of this process should be fertile soil for research on how to understand and foster the kind of divergent thinking that is critical for creative problem solving in general.

The dispersal of revolutionary change through the system. As Prigogine and Stengers noted (1984: 187), no one change can convert an entire system instantaneously. They portray reorganizations as beginning with a "nucleus," where the change must first become established firmly before it can take over the rest of the system. Furthermore, they reported that the more efficient a system's communication mechanisms are, the stronger and larger the nucleus must be if it is to result in a systemwide change, instead of being damped by its surroundings. Eldredge and Gould (1972) hypothesized similarly that speciation must begin rapidly and in populations that are small enough and isolated enough for the change to take hold, in order to avoid being diluted by the parent population.

It is intriguing to compare these ideas with the importance accorded top-executive teams in the work of Tushman and his colleagues. They proposed that, although convergent change during equilibrium periods can be managed through broad participation, top teams are the only instigators strong enough to mount successful reorientations (Tushman et al., 1986). It may be fruitful to explore whether executive teams who lead reorientations experience or seek isolation (either physical or social) from their own organizations, so that they can formulate changes and develop commitment to new directions.

How Do Revolutionary Periods Conclude?

It is essential to distinguish firmly between the *processes* of change in revolutionary periods and their *outcomes*—the new deep structures they bring about. One reason for this separation is that the substantive changes with which revolutionary periods conclude may differ widely in type, success, and scope. For example, Tushman and Romanelli (1985: 173, 179) found that *reorientations*, where "strategies, power, structure and systems" change, are less radical than *recreations*, where the "core values which govern decision premises" are also transformed. Levinson (1978) reported that transitions from one great era in life to the next (e.g., the age 40 transition, between the eras of early and middle adulthood) are broader in magnitude than within-era transitions (e.g., at ages 30 and 50). The group transitions that Gersick observed correspond to the milder kind of revolutions because they were contained within projects; more difficult revolutions must bridge wider gaps, as when one major project ends and another must be initiated.

Revolutionary periods may also vary in how much they benefit or harm a system. Levinson, Gersick, and Tushman and his colleagues all observed that a system may change significantly for the worse during a transition. This is consistent with the punctuated equilibrium paradigm's implication that systems do not inevitably evolve toward improvement.

Apart from the issues noted above, findings in two of the models examined here suggest that there are good reasons to keep revolutionary periods conceptually separate from revolutionary changes themselves. Levinson and Gersick have observed that a system may go through a clear, time-limited transition period, experiencing many of the unsettling processes described earlier, yet it can emerge at the end without having accomplished revisions in its deep structure. Both authors suggested that systems may undergo only mild change if their deep structures need little adjustment at the time the transition occurs. However, when system members back away from change "because of resignation, inertia, passivity, or despair" (Levinson, 1978: 52), the closing of the transitional opportunity often brings a sense of failure or stagnation. This emotional tone, and the absence of needed alterations, are likely to result in a period of persisting decline, lasting until the next transition or beyond (Gersick, 1989; Levinson, 1978).

These two models differ from that of Tushman and his colleagues, who define reorientations in terms of the changes themselves. According to Gersick's and Levinson's findings, systems that have undergone unsuccessful or abortive transitions are, indeed, different after revolutionary periods because they are weakened; however, such transitions would be invisible to researchers who are looking for new strategies or structures. The difference in Tushman and his colleague's definition of the construct may be a methodological artifact. Their use of historical archives to identify organizational reorientations, although offering the considerable advantage of access to larger samples, would seldom permit researchers a view of transition *processes* or of abortive transitions.

This issue has implications for practice and research and suggests the value of identifying organizational-level indicators that transition periods are underway. Only by separating the construct of a revolutionary period from accomplished changes is it possible to locate and study systems as they undergo transitions, when intervention may be most important, rather than waiting until the changes are complete.

DISCUSSION

The punctuated equilibrium paradigm offers a new lens through which theorists can make fresh discoveries about how managers, work groups, organizations, and industries both develop over time and react to changes in their environments. The construct of a deep structure that keeps systems basically stable during equilibrium periods offers a new way to understand systems' resistance to change. The idea that major change occurs through difficult, compact revolutions provokes interesting research questions and indicates the practical demands of adaptation to severe alterations in a system's environment or in its own growth. The emergence of the same paradigm in diverse fields has implications for theory and research methodology.

Methodological Implications

Methodological differences may account for some of the variety in different theorists' findings, and different methods may be needed to answer different questions. Levinson used intensive biographical interviews, which afforded him (1) the panoramic views of men's lives needed to place specific events within broad eras of continuity and change and (2) the intimate detail needed to create a rich portrait of the human experience of building structures and undergoing transitions. Turnover would present obstacles to using this technique at the organizational level. However, in those key organizations that kept their executive teams through reorientation periods, this type of interviewing would be invaluable for understanding the dynamics involved.

Gersick worked with more short-lived systems than individuals or organizations. The observation of project groups' entire life spans offered opportunities to study equilibrium and transition processes directly. The finding that transitions can be observed in brief laboratory simulations means that controlled hypothesis testing about these processes is possible (Gersick, 1989). It is difficult to establish naturalistic conditions in the laboratory, but good organizational simulations do exist (e.g., "Looking Glass", McCall & Lombardo, 1978). Laboratory studies could be especially useful for testing hypotheses on organizational stability and change and for trying intervention strategies.

The collection of documentary histories over very long time periods and for large, diverse samples by Kuhn and Tushman and his colleagues—similar to the study of fossil records by Eldredge and Gould—offers opportunities for insight about the structural conditions under which revolutionary change occurs and succeeds or fails. It affords a view of how revolutionary changes may spread to their surroundings or, in the case of defunct systems, of how they die out. Even though documentary data may be less available for individual and group histories, the work of these researchers suggests the rewards of using archives to study broad sets of structural variables among large samples.

Finally, the complementarity of these six models suggests the need and possibilities for multilevel research. Revolutionary change in large systems ultimately depends on comparably radical change among individuals and groups; conversely, individuals and groups attempting to make radical changes must be affected by the deep structures of the systems in which they are embedded.

Limitations of the Paradigm

There are at least two fundamental cautions to follow in applying the punctuated equilibrium paradigm. The first is to avoid assuming it is the only way systems change. Gould and Eldredge (1977: 19) themselves "never claimed either that gradualism could not occur in theory or did not occur in fact. Nature is far too varied and complex for such absolutes." Wake and his associates (1983) proposed that behavioral plasticity allows organisms to compensate for environmental changes without changing morphologically. In organizations, punctuational patterns may be most evident in systems that have confining deep structures; they may be least evident in highly flexible systems. Existing theory provides us with a ready-made map of how organizational structures vary on this dimension, from bureaucracies (Burns & Stalker, 1961) to clans (Ouchi & Price, 1978) and to "commitment strategy organizations" (Walton & Hackman, 1986). Weick's (1976) "loosely coupled systems," with their low internal interdependence, may be the least likely to fit the punctuated equilibrium paradigm.

The second caution is to avoid applying models from one research domain to another too freely or literally. Human systems, self-aware and goal-directed, have the capacity to "schedule" their own opportunities for revolutionary change (as with time-triggered transitions), to solicit outside perspectives, and to manage their histories in ways that are inconceivable for nonconscious systems. Much as theories from different domains have to offer each other, it would be a mistake to import constructs uncritically, rather than to use them to provoke questions about how they might apply in other settings.

Grand Theory

I have suggested specific research implications of each model examined here for the others. However, the most important implications of the punctuated equilibrium paradigm are suggested by the very diversity of the fields that have been affected by it. Scientists' assumptions about what change is and how it works must fundamentally influence how research is designed and how findings are interpreted. The punctuated equilibrium paradigm suggests three basic questions that can be asked of almost any model or set of findings: Do these data reflect a system in equilibrium or in transition? Do they depend on characteristics inherent in the system's parts, or in the deep structure that organizes them? How far can these conclusions be expected to hold, should the system undergo radical change?

Prigogine and Stengers (1984: 207) (see Table 2), writing from the vantage point of physics, have argued that traditional deterministic paradigms have had "particularly unfortunate" effects on the social sciences. According to these authors, the search for optimizing, predictive trajectories that can be extrapolated to infinity is misguided because such approaches account neither for the extremes to which inertia may drive a system nor for the unpredictability of radical changes that rewrite the rules of the game. Finally, as Gould (1985) noted, efforts to unravel a system's workings by minutely dissecting its parts miss the point when the parts' behavior is determined by the deep structure that organizes them.

For organizational researchers and practitioners, there is the added challenge to the beliefs about how organizational systems can accomplish (or be helped to accomplish) change. On the one hand, the punctuated equilibrium paradigm proposes that fundamental change cannot be accomplished piecemeal, slowly, gradually, and comfortably. On the other hand, it holds promise that we may someday create new organizational forms that have not yet been imagined.

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