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ORGANIZATIONAL TRANSFORMATION AS PUNCTUATED EQUILIBRIUM: AN EMPIRICAL TEST

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The punctuated equilibrium model of organizational transformation has emerged as a prominent theoretical framework for explaining fundamental changes in patterns of organizational activity. To date, however, few aspects of the model have been tested formally. We tested three basic arguments of the model using data on U.S. minicomputer producers. Supportive results showed that (1) a large majority of organizational transformations were accomplished via rapid and discontinuous change over most or all domains of organizational activity, (2) small changes in strategies, structures, and power distributions did not accumulate to produce fundamental transformations, and (3) major environmental changes and chief executive officer succession influenced transformations.

The punctuated equilibrium model of organizational transformation (e.g., Gersick, 1991; Miller & Friesen, 1980a, 1984; Tushman & Romanelli, 1985) has recently emerged as a prominent theoretical framework for characterizing and investigating fundamental organizational change. As described by its proponents, punctuated equilibrium theory depicts organizations as evolving through relatively long periods of stability (equilibrium periods) in their basic patterns of activity that are punctuated by relatively short bursts of fundamental change (revolutionary periods). Revolutionary periods substantively disrupt established activity patterns and install the basis for new equilibrium periods. Gersick (1991) described the largely independent emergence of punctuated equilibrium models over a number of social and physical science disciplines, including biology (e.g., Gould, 1989), sociology (Kuhn, 1970), and psychology (Levinson, 1986), and at several levels of analysis in organizational theory, such as groups (Gersick,

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1988, 1989) and organizations (Miller & Friesen, 1980a, 1984; Tushman & Romanelli, 1985).

Despite the growing prominence and pervasiveness of punctuated equilibrium theory, little research has explored the empirical validity of the model's basic arguments. A few case histories have supported the idea that fundamental transformations occur according to patterns predicted by the model. For example, Tushman, Newman, and Romanelli (1986) examined the life histories of four organizations, AT&T, General Radio, Citibank, and Prime Computers, and described a progression of equilibrium periods during which organizational systems, structures, and strategies were consistently reinforced toward increasing coherence with the organizations' basic missions. The equilibrium periods were punctuated by very brief periods of intense and pervasive change, culminating in the formulation of new missions and the initiation of new equilibrium periods. Bartunek (1984) described repeated failures of a religious order to accomplish fundamental transformation until both the structure and the interpretive schemes of the organization were rapidly and dramatically revised.

Other studies have explored some of the correlates and consequences of revolutionary transformation. For example, Lant and Mezias (1992) linked the punctuated equilibrium model to processes of organizational learning that accounted for tensions between the forces for stability and change that generate revolutionary transformations. Miller and Friesen (1982, 1984) showed that organizations that radically and quickly altered their formal structures, decision-making routines, and information-processing devices performed better over their lives than organizations that changed gradually or incrementally. Similarly, Virany, Tushman, and Romanelli (1992) showed that organizations that accomplished transformations discontinuously and in response to basic changes in their environments performed better over their lives than organizations that were either never transformed or were transformed excessively without the clear stimulus of environmental change.

Although case histories have supported the descriptive validity of the punctuated equilibrium theory, and though tests of the antecedents and consequences of fundamental transformation have offered important insights into its processes and practical outcomes, no study has tested the model directly. At its heart, punctuated equilibrium is a theoretical explanation for how organizations will typically accomplish fundamental transformation. Critical empirical questions regarding the frequency with which organizations undergo fundamental transformations according to patterns predicted by the punctuated equilibrium model remain unanswered. In this study, we sought to fill that empirical gap.

THEORY AND HYPOTHESES

Punctuated equilibrium models first and foremost enable predictions about patterns of fundamental organizational transformation. Proponents of

the general theory argue that the common state of organizational activity is one of stability or equilibrium. Organizations establish an initial pattern of activity (Boeker, 1988; Eisenhardt & Schoonhoven, 1990; Selznick, 1949; Stinchcombe, 1965), based on the environmental conditions prevailing and the managerial decisions made during their time of founding. Then, as a result of inertia (Hannan & Freeman, 1984) and institutionalization (Meyer & Rowan, 1977; Scott, 1987; Zucker, 1988), organizations develop coherent systems of shared understandings that support continuation of the established patterns. According to the punctuated equilibrium model, radical and discontinuous change of all or most organizational activities is necessary to break the grip of strong inertia. Thus, the first and principal hypothesis of the punctuated equilibrium model is that the pattern of fundamental organizational transformation is one of radical, brief, and pervasive change.

> *Hypothesis 1: Organizational transformations will most frequently occur in short, discontinuous bursts of change involving most or all key domains of organizational activity.*

As Gersick (1991) discussed, punctuated equilibrium theorists typically contrast their prediction of discontinuous and pervasive transformation with a view of nonrevolutionary, or gradual, incremental transformation. For example, Miller and Friesen, following Cyert and March (1963), characterized the nonrevolutionary view as depicting "individual subunits of organizations dealing incrementally and disjointedly with one problem and one goal at a time while emphasizing short-run reaction to short-run feedback" (1984: 222). Nonrevolutionary views of organizational transformation thus emphasize the relative independence of organizational subunits as managers seek to adapt to changes in their local internal and external environments. Over time, as subunits repeatedly alter their goals and relationships to local environments, the organization as a whole becomes transformed. Nonrevolutionary views suggest that fundamental organizational transformations can be observed by comparing organizational activity patterns over distant points in time, though no specific transforming event may be identifiable. Miller and Friesen associated the gradual transformation perspective with familiar arguments from policy theorists (e.g., Lindblom, 1959; Hedberg, Nystrom, & Starbuck, 1976; Quinn, 1980) about the potential efficacy of incremental change but noted that such arguments merely assume the prevalence of incremental change processes.

Punctuated equilibrium theorists, by contrast, stress the interdependence of organizational subunits. Following Khandwalla (1973) and Mintzberg (1979), Miller and Friesen argued that organizations "must be constructed so as to ensure a complementary alignment among structural variables" (1982: 870). Similarly, building on arguments from population ecology (e.g., Hannan & Freeman, 1984) and institutional theory (e.g., Tolbert & Zucker, 1983; Zucker, 1988), we concluded in an earlier work that

organizations develop "webs of interdependent relationships with buyers, suppliers, and financial backers . . . and patterns of culture, norms, and ideology" (Tushman & Romanelli, 1985: 177) that legally and normatively constrain organizations to an ongoing commitment to established activities and relationships. Finally, Gersick described "organizational deep structure" (1991: 14) as a system of interrelated organizational parts that is maintained by mutual dependencies among the parts and with competitive, regulatory, and technological systems outside the organization that reinforce the legitimacy of managerial choices that produced the parts.

According to this view, the result of interdependence is not cascading adaptation over related organizational subunits, but rather resistance to change as subunit managers seek to maintain a complex network of commitments and relationships. Resistance to change is critical to punctuated equilibrium theory in that it establishes the key condition that supports revolutionary transformation as the principal means by which organizations can accomplish transformation. Resistance to change prevents small changes in organizational subunits from taking hold or substantially influencing activities in related subunits. Thus,

> *Hypothesis 2: Small changes in individual domains of organizational activity will not accumulate incrementally to yield a fundamental transformation.*

Finally, punctuated equilibrium theorists have addressed the question of how organizational transformation can be stimulated. Especially since the theory posits strong inertia as the common state of organizational affairs, consideration of how such inertia can be broken or disrupted is critical. Severe crisis in the performance of an organization, major changes in its environment, and succession of its chief executive officer have been posited as forces potentially strong enough to overcome inertia and to stimulate fundamental organizational transformation.

Numerous studies have explored the influence of organizational performance on fundamental transformation. For example, Oster (1982) and Boeker (1989) showed that organizations tend to persist in established activity patterns when performance is good or improving. Harrigan (1980) and D'Aveni (1989) showed that organizations tend to alter their activities principally when performance is poor or declining. Although declines in organizational performance may challenge the legitimacy of established courses of action, several authors (e.g., Hambrick & D'Aveni, 1988; Staw, Sandelands, & Dutton, 1981) have noted that incumbent management teams may tend to minimize the importance of performance declines or seek to explain them optimistically in terms of a need for greater commitment of resources. We have thus previously argued (Tushman & Romanelli, 1985) that only large or long-sustained declines in performance are likely to trigger fundamental organizational transformations.

Hypothesis 3: Major declines in the short-term performance of an organization or sustained declines over several years will substantially increase the likelihood of revolutionary transformation.

Much attention has been paid to the influence of major environmental change on the likelihood of organizational transformation. Indeed, the literature on the effects of changes in the demand for an organization's product (e.g., Delacroix & Swaminathan, 1991; Miles & Cameron, 1982), technological innovation (e.g., Abernathy & Utterback, 1978), changes in environmental uncertainty, complexity, and turbulence (Keats & Hitt, 1988; Meyer, 1982; Meyer, Brooks, & Goes, 1990; Miner, Amburgey, & Stearns, 1990), and changes in institutional conditions (Mezias, 1990; Oliver, 1991; Tolbert & Zucker, 1983) is one of the richest in organization theory. Although most of these studies have not distinguished among degrees or types of organizational transformation, all have generally predicted a positive relationship between changes in environmental conditions and organizational change. Studies by Meyer and his colleagues (Meyer, 1982; Meyer et al., 1990) have directly explored the influence on revolutionary change of "environmental jolts," discontinuous changes that dramatically alter the competitive and operating conditions of an environment. Through longitudinal analysis of the hospital industry, these researchers concluded that environmental jolts do tend to provoke crises in organizations that facilitate revolutionary transformation.

Hypothesis 4: Major changes in environmental conditions will significantly increase the likelihood of revolutionary transformation.

Finally, chief executive officer (CEO) succession, even in the absence of performance declines or major environmental change, should increase the likelihood of organizational transformation (Tushman & Romanelli, 1985). Fundamental organizational transformation requires not only a vision of the type of transformation that will promote organizational interests but also an opportunity for instigating transformations. New chief executive officers, especially those who come from outside organizations (Helmich & Brown, 1972), stand uncommitted to the strategies and policies established by their predecessors. Moreover, their information and experience may lead them to have different understandings of effective or appropriate organizational actions than their predecessors had (Dearborn & Simon, 1985). Finally, new CEOs often begin work in an atmosphere of expectancy about change. The periods closely following their installation provide the best opportunity for signaling that new regimes are in place (Gabarro, 1987).

Hypothesis 5: Installation of a new chief executive officer will significantly increase the likelihood of revolutionary transformation.

METHODS

Data and Setting

This study examined the life histories of 25 minicomputer producers that were founded in the United States over a three-year period, 1967 through 1969. The firms studied represent 54.4 percent of the 46 minicomputer producers that were founded during this period, which covers the peak of founding activities in the minicomputer segment of the computer industry. The group of firms was selected to maximize organizational similarities on dimensions of organizational age and the environmental characteristics that the organizations faced both during founding and later in their lives. We considered such similarity to be critical for ruling out alternative explanations for patterns in organizational transformation that might be observed. All 46 companies were founded as single-product manufacturers of minicomputers with initial market and distribution targets restricted to the United States. We chose the 25 companies on the basis of the availability of data regarding their products, markets, strategies, structures, and the composition of their executive teams over their lives. Since all 25 companies were publicly traded early in their lives, substantial information about their activities was available from public documents. Detailed, longitudinal data about organizations' activities were critical to ensuring that we would discover all transformations, whether revolutionary or nonrevolutionary.

These sampling procedures may have limited the generalizability of our findings to firms founded during the high-growth period of technology-based industries and acquiring early public funding. For this study, however, we were principally concerned that enough data be available on a large enough number of firms competing over time in the same general environment to ensure the discovery of fundamental transformations, whether revolutionary or nonrevolutionary. Threats to generalizability are considered in the discussion section of this article.

Domains of Organizational Activity

Investigation of organizational transformation as a discontinuous event involving most or all domains of organizational activity requires measuring organizational characteristics over several different domains. As McKelvey (1982) and Freeman (1982) noted, domains should also be selected on the basis of their importance to organizational survival and centrality to an organization's core competencies (Prahalad & Hamel, 1990). We take it as axiomatic that organizations are changing in some ways virtually every day. The study of organizational transformation as a process or outcome that is distinct from routine replacements of personnel, normal improvements of equipment and control processes, and regular changes in customer composition requires that we explore domains in which substantial change can systematically alter the overall pattern of organizational activity.

In our earlier work on organizational transformation (Tushman & Romanelli, 1985), we identified five domains of organizational activity—

organizational culture, strategy, structure, power distributions, and control systems—that met the criteria of being important to organizational survival and central to organizational activities. In developing these domains we drew on Zald's (1970) matrix of organizational activities, framed by internal and external orientations and by social and economic objectives. These domains are highly similar to other characterizations of core organizational activities that have appeared in the literature. For example, Hannan and Freeman (1984) defined organizational forms in terms of stated goals, forms of authority, core technology, and marketing strategy, including both product characteristics and types of markets targeted. Mintzberg (1979) described five basic parts of organizations: the strategic apex, the technostructure, the middle line, the support staff, and the operating core. Thus, as these domains appear generally in the literature as characteristic of organizations' fundamental activity patterns, we think they are appropriate for studying organizational transformation.

The study of organizational transformation also demands that measures of organizational activities be taken frequently over organizations' lives. We collected data on organizational cultures, strategies, structures, power distributions, and control systems for all years of the organizations' lives from a variety of sources, including 10-K forms required by the Securities and Exchange Commission, annual reports, prospectuses, and industry and business press reports. Detailed information about strategies, structures, and power distributions was available for all organizations in the study group throughout their lives. However, the organizations reported information about cultures and control systems infrequently and inconsistently. Thus, we dropped the culture and control system domains of activity from further analysis.

Because some of our information about organizational strategies, structures, and power distributions came from stories reported in the industry and business press and other information came from descriptions and interpretations of events described in company documents, some of the information was more objective than the rest. Accordingly, we used different methods to characterize activities occurring over the organizations' lives and to identify important changes. In the following sections, we discuss the qualitative and objective methods used for identifying substantial change in the strategies, structures, and power distributions of the organizations. Examination of the similarity of findings derived by these two methods provides a basis for ensuring the validity of measures of change by either method.

Qualitative Measures of Changes in Activity Domains

A rich base of "stories" about organizational activities was available from business press articles, 10-K forms, annual reports, and prospectuses. Two independent coding teams developed company histories from these sources. One coding team (four individuals) mined documents prepared by the firms themselves. The other coding team (two individuals) considered information from business press articles and other noncompany publica-

tions. We divided the information sources in this way because we were concerned about biases in information, particularly from firm-generated documents.

Each coder was instructed to organize materials in chronological order and to write objective, year-by-year event histories of the firms. For this portion of the coding, we did not specify any precise meanings of strategy, structure, or power distribution. Coders were simply told to record, as fully and objectively as possible, everything that happened to or that was discussed by the firms. For a few of the firms, coders exchanged documents and wrote independent histories. No differences in the event histories were observed, either between coders or between different document sources.

Only when the objective histories were completed was any attempt made to organize and interpret the information. Three individuals, who were coders of only some of the objective histories, reviewed the event histories and noted all changes in strategies, structures, and power distributions that appeared to represent substantial changes in organizational activities. For this phase of the research, we employed specific definitions.

Strategy changes. Changes in strategy were coded whenever companies introduced or abandoned either major new lines of minicomputers or nonminicomputer product lines such as software systems, peripherals, mainframes, or microcomputers. A strategy change was also coded if a company entered or abandoned an important market segment, shifting, for instance, from original equipment manufacturers as principal customers to end users. For example, Data General began marketing minicomputers directly to end users in 1972, an activity that substantially deviated from its prior and publicly stated emphasis on sales to original equipment manufacturers. Rolm Corporation initiated a major product reorientation in 1976 when it began marketing computerized telephone switching equipment in addition to its traditional "ruggedized" minicomputers for severe environments. We considered movements into or out of major product lines and changes in principal customer targets to be important strategic changes on the basis of companies' own discussions of such movements as representing substantial shifts in market targets and activities.

Structure changes. Changes in structure were coded whenever business press articles or company documents reported a general reorganization of a firm, from, for instance, a functional to a divisional structure, or major changes in centralization or decentralization. For example, Datapoint decentralized its sales and research operations in 1976 by establishing a network of sales offices and research laboratories throughout the United States. In 1974, Computer Automation abandoned its traditional, engineering-dominated functional structure in favor of a product divisional structure supporting its diversifying product line.

Power distribution changes. Changes in power distributions were coded whenever an organization experienced a high turnover of senior executives or when additions to an executive team reflected a shift in the functional orientation of a firm—for instance, from emphasis on research

and development to emphasis on sales and marketing. For example, when Microdata began manufacturing, as opposed to licensing, its minicomputer designs in 1970, a number of new executives were installed to handle not only the production function but also the new requirement for marketing expertise. Additions to the executive team were accompanied by exits of other executives whose expertise had addressed R&D almost exclusively. The new executives publicly discussed these changes as indicative of a major new strategic orientation.

It should be noted that we did not code CEO successions as indicators of major shifts in power distributions. This decision was made for two reasons. First, as numerous succession studies (e.g., Carlson, 1962; Helmich & Brown, 1972; Gabarro, 1987) have shown, CEO succession often precedes changes in the composition of the executive team as well as the balance of power over various functional and divisional domains of activity. Hypothesis 5 in this research explicitly predicts that CEO succession can be an important triggering event for organizational transformation. Second, as Mintzberg and Waters (1982) described, major changes in power distributions can occur even in the absence of a CEO change. Thus, we considered that shifts in power distributions should be counted toward organizational transformations only when an executive team, minus the CEO, and its collective expertise were substantially altered.

For any year in which a substantial change on any of these dimensions was observed, a 1 was coded in the appropriate category for the particular year; otherwise, a 0 was coded. Coders agreed on the majority (87%) of classifications. Disagreements were usually resolved in favor of coding a change since no objective criterion existed for determining substantialness. Changes and nonchanges in the strategy, structure, and power distribution domains were coded for all years of the organizations' lives except for their first years of existence and the last years of acquired or failed firms. No substantial change or transformation can reasonably occur during the first year of an organization's life. And significant changes during the last year of a failed or acquired firm's existence probably reflect closing out operations or transferring assets more than they reflect substantial change in activities.

On the basis of these data, a total of 149 substantial changes were identified out of a possible 669 over all 25 organizations. We calculated the total number of possible changes by multiplying the number of years of a firm's life (minus the first and last years) by three, the number of core activity domains being considered. Over all companies, the average number of substantial changes per year was .223 (s.d. = .416). The minimum number of substantial changes exhibited by a firm was 0; the maximum was 17.

Objective Measures of Changes in Activity Domains

Qualitative measures of organizational changes yield a rich picture of organizational histories, but we were concerned that all significant changes might not have been observed for all companies. Some companies (e.g., Microdata, Viatron) were written about often and at length in the business

press; other companies were mentioned only infrequently or very briefly. It was possible the qualitative data indicated that some firms exhibited few or no changes on the different dimensions of organizational activity simply because less information was available. Thus, we developed objective measurements of the firms' strategies, structures, and power distributions from information consistently available for all companies and used these measurements separately to identify substantial changes.

Strategy changes. Four measures of substantial change in organizational strategy were defined. First, consistent with the qualitative measures, strategy change was coded whenever a company entered or exited a nonminicomputer product line, such as peripherals or microcomputers. Major product line listings for all companies were reported annually in the *Computer Directory and Buyers' Guide*. For the years 1957 through 1981, entries and exits were coded (0 = no entry or exit, 1 = entry or exit) for the year in which a line first appeared or disappeared from the lists. Second, substantial change was coded whenever a company shifted its basic market orientation from original equipment manufacturers (OEMs) to end users, or vice versa. Companies formally reported categories of customer segments, which included OEMs as a separate category, to describe the range of their customer markets. Shifts into or out of an OEM customer segment were coded (0 = no shift, 1 = shift) for the year in which the original equipment manufacturer category was either first indicated or was eliminated.

Although these measures capture the basic product and market orientations of the minicomputer producers, they do not indicate variation in the organizations' strategies for designing and marketing minicomputers themselves. Thus, following procedures described in Romanelli (1989), we also coded changes in the market breadth and market aggressiveness of the organizations' minicomputer strategies. Market breadth was measured as the number of distinct applications segments in which a company competed. The companies competed in six segments—scientific and engineering laboratories, industrial automation and process control, communications, distributed data processing, small business, and severe environments—over the period of the study. Market aggressiveness was measured as the number of distinct product lines offered, independent of the number of markets addressed. Minicomputer product lines were differentiated on the basis of fundamental system architecture as indicated in documents prepared by International Data Corporation. No significant correlation was found between measures of market aggressiveness and breadth; minicomputer producers varied widely in their tendencies to offer many different product lines to a single market segment or to offer a single product line to many segments. Change in market breadth was coded as the number of markets entered plus the number of markets exited over the total remaining number of markets in which a company operated. Change in market aggressiveness was coded as the number of product lines added plus the number of lines eliminated over the remaining number of product lines offered. For both

variables, we considered additions and deletions to be representative of change since both clearly necessitate substantial reallocations of resources.

Structure changes. Changes in organizational structure were measured using titles of senior executives as basic indicators. Titles were classified as general management where no specific functional or divisional responsibilities were indicated (for instance, president, treasurer, comptroller); as functional where no product- or geographic-specific responsibilities were attached (e.g., vice president of research and development, sales manager); and as divisional if a product or geographical division was indicated (e.g., vice president, Western United States, or vice president, airlines reservations systems). We used two measures of organizational structure based on yearly data on ratios of executive titles: (1) the number of general management titles relative to the total number of executives and (2) the number of functional titles relative to the number of functional and divisional titles. These measures reflect the extent to which organizations organized on a functional or a divisional basis and, given some emphasis on one or the other type, the extent to which functional or divisional concerns were dominant. Changes in organizational structure were measured as the absolute value of percentage increases or decreases in the executive title ratios.

Power distribution changes. Changes in power distributions were coded in three ways. First, turnover in a company's executive team was measured as the number of new executives plus the number of executives eliminated over the total number of executives remaining. We considered both additions and deletions to an executive team to represent change since remaining executives will be aware of, and presumably respond to, both the presence of new members and the absence of old. Second, to assess the relative power of research and development concerns over marketing and sales concerns, or vice versa, we calculated percentage changes in the ratio between research expenditures and the total of research expenditures and marketing and sales expenditures. Finally, we calculated changes in the ratio between the number of research executive titles and the total number of titles in research plus titles in marketing and sales. Minicomputer organizations, like companies in many other technology-based industries, struggle routinely with the relative sways that R&D and marketing and sales should hold over strategic decisions. Thus, shifts in the proportion of expenditures and executive titles over these domains seemed to offer good measures of shifts in organizational power distributions.

Table 1 presents descriptive statistics for all the strategy, structure, and power distribution variables that were measured objectively. As described above, some of the measures used to identify substantial change were categorical, such as entry into or exit from a non-minicomputer product line. For these measures, substantial change was coded whenever the indicated event occurred. Other measures, however, such as minicomputer product line change and executive team turnover, are continuous, and no objective criterion could be established to determine how substantial a change was. To

TABLE 1
Descriptive Statistics and Pearson Correlations, Objective Measures[a]

Variables	Means	s.d.	1	2	3	4	5	6	7	8
Measures of strategic change										
1. Entries/exits: Non-minicomputer products	.18	.39								
2. OEM–end user shifts[b]	.06	.23	.15							
3. Percent change in market aggressiveness	.15	.27	.15	.04						
4. Percent change in market breadth	.08	.24	.21	.22	.33					
Measures of structure change										
5. Percent change in general management titles	.19	.23	.05	−.01	.09	−.03				
6. Percent change in functional titles	.12	.26	.15	−.03	.02	−.05	.03			
Measures of change in power distributions										
7. Executive team turnover	.33	.44	.10	.04	.03	.11	.07	.01		
8. Percent change in R&D expenditures	.18	.25	−.04	−.05	−.01	−.06	−.01	−.07	−.03	
9. Percent change in R&D titles	.19	.33	.09	.08	.04	.01	.28	−.01	−.11	.15

[a] Ns vary between 156 and 225 according to data availability—some companies, for example, did not always separate R&D and other expenditures.

[b] OEM is "original equipment manufacturer."

obtain a first estimate of substantial change, we simply classified all year-to-year changes at four levels of percentage change (30, 40, 50, and 60 percent). Results regarding the number of substantial changes over the three activity domains and patterns in organizational transformation, which rely

on these data, will be presented for all criterion levels. This approach supports analysis of the sensitivity of our findings to different assumptions about substantial change. Table 2 shows the number of substantial changes identified by both qualitative and objective methods, the latter at each of the four change-criterion levels.

Table 2 also shows the mean number of substantial changes observed over all activity domains for each of the measurement types. Not surprisingly, the mean number of changes per year was highest for changes measured objectively at the 30 percent criterion level. Even at this level, however, change in any domain occurred relatively rarely, at the rate of .390 changes per year. As discussed above, theoretical interest in the topic of organizational transformation hinges conceptually on a distinction between routine and revolutionary organizational changes. This finding suggests that our measures captured relatively major changes in the strategies, structures, and power distributions of the organizations.

We noted earlier that one advantage of using both qualitative and objective measures is the opportunity that is gained for assessing their agreement. Since the two procedures were almost completely independent in terms of the coders and kinds of data used, substantial agreement between qualitative and objective measures would indicate that important organizational changes were being measured reliably. To assess the degree of agreement between qualitative and objective measures, we simply counted the number of times that the measures agreed for each year of a company's existence. Agreements were counted separately for each of the four criterion levels and then calculated as proportions of the total number of possible agreements for each company. We then averaged these proportions over all the companies studied to arrive at the average proportion of agreements shown in Table 3.

As Table 3 shows, agreement between qualitative and objective measures was quite high for all four criterion levels, ranging from an average proportion of .808 (s.d. = .119) at the 30 percent criterion level to .872 (s.d. = .103) at the 60 percent criterion level. Apparently, the qualitative and objective measures of substantial change in domain activities largely captured the same information. Thus, we were confident that our procedures for measuring organizational transformations were based on reliable indicators of substantial change in domain activities.

Identifying Organizational Transformations

Fundamental organizational transformations were coded as occurring whenever substantial changes were observed in the strategy, structure, and power distribution domains of organizational activity. No restriction was imposed for the length of time over which substantial changes had to be observed over all three domains. For example, if a company exhibited a significant change in strategy during year 3 of its existence, a structure change in year 9, and a power distribution change in year 12, we counted the firm as having completed a transformation in its 12th year. Whenever a

TABLE 2
Frequencies of Substantive Change by Domain and Type of Measure

Variables	Qualitative Measures	Objective Criterion Levels			
		60%	50%	40%	30%
Strategy changes	61	57	74	75	90
Structure changes	35	17	37	39	61
Power distribution changes	53	53	69	86	110
Total number of changes	149	127	180	200	261
Mean number of changes annually	.223	.190	.269	.299	.390
Standard deviation	.416	.392	.444	.458	.488

TABLE 3
Average Proportion of Agreement Between Qualitative and Objective Measures

Agreement	Objective Criterion Levels			
	60%	50%	40%	30%
Mean	.872	.869	.868	.808
Standard deviation	.10	.10	.10	.12

transformation was identified in this manner, we restarted the count of substantial changes.

A revolutionary transformation was coded as occurring whenever changes in all three strategy, structure, and power distributions occurred within any two-year time period. A more stringent criterion for classifying transformations would require that changes occur in all three domains in a single year. The majority of the revolutionary transformations observed, defined by either qualitative or objective measures, in fact did occur within single years. However, because some of the data were presented for corporate fiscal years and some for calendar years, the two-year criterion seemed best.

Nonrevolutionary transformations were identified in two ways. First, following the procedures described above, we coded a nonrevolutionary transformation as having occurred whenever there were substantial changes over a period longer than two years. This measure permitted direct examination of the frequency of revolutionary and nonrevolutionary transformations in which the components of change were entirely comparable except in the timing of their occurrence. We also wished to examine, however, whether nonrevolutionary transformations might be observed through the accumulation over time of even very small changes in the activity domains. Thus, we also coded a nonrevolutionary transformation whenever changes in each of the three activity domains accumulated to 30 percent through addition of multiple small annual changes and when all three domains exhibited this level of change. For this approach, the count of small annual changes was halted whenever a one-year change of at least 30 percent was encountered.

Counting toward accumulation was begun again immediately after the occurrence of a large annual change.

Measures of Extrasystemic Pressures for Transformation

We coded three measures of extrasystemic pressure to investigate the possibility that organizational transformations typically occur when organizations are facing crises resulting from declines in performance or major changes in environmental conditions, or when a CEO succession has recently occurred.

Performance crisis. Organizational performance was measured as the percentage change in a firm's market share over successive annual periods. Crisis was coded whenever the market share percentage change was $-.42$ or lower, a level representing the lowest 10th percentile of market share changes over all firms for all years. The data were coded as a dummy variable (0 = crisis, 1 = no crisis). Market share data were available for all firms for all years of their lives from information compiled in the *EDP Industry Report*, published by International Data Corporation. This publication supplies monthly information on the number and prices of all minicomputer models marketed by all producers. We calculated market share by contrasting each firm's minicomputer sales with the total number of minicomputers sold by all competitors. Although market share does not directly specify profitability, it does indicate the relative strengths and ongoing viability of organizations' competitive positions. Thus, we considered a substantial decline in market share to constitute an organizational crisis.

Major environmental changes. Major changes in environmental conditions were coded as dummy variables (1 = major change, 0 = no major change) to test the effect of environmental change on the likelihood of organizational transformation. Three major shifts, occurring during 1971, 1976, and 1980, seemed severe enough to pose a crisis for competing organizations. Previous research (Romanelli & Tushman, 1986; Tushman & Anderson, 1986) contains detailed discussions of the major environmental changes that occurred in the minicomputer industry during those years. Thus, we only briefly characterize the periods here. The year 1971 presented the first serious challenge to minicomputer producers since the industry's inception in 1957. Previous steep increases in the rate of organizational foundings, rapid changes in basic minicomputer technology, and steep declines in competitive concentration gave way to a stable technological design, a dramatic decline in the organizational birth rate, and a stabilization of competitive concentration. Perhaps most important, venture capital dried up and public markets for funds tightened severely. We have described (Romanelli & Tushman, 1986) 1971 as the first period of shakeout and consolidation experienced in this industry. The year 1976 showed a sharp increase in both the failure rates of minicomputer producers and four- and eight-firm concentration ratios. This was the first year in which sales of desktop computers made a dent in overall computer sales. Traditional minicomputer markets were also beginning to be squeezed by the introduction of superminis, 32-bit

minicomputers; the previous standard had been the 16-bit minicomputer. Demand for minicomputers continued to increase throughout the mid-1970s, but the rate of increase began to slow substantially in 1976. Finally, 1980 exhibited the first absolute decline ever in the sales of minicomputers. Only one new firm was founded in 1980. Four-firm concentration ratios increased to almost 75 percent of minicomputer sales. Industry analysts and executives alike began to hail the end of the traditional minicomputer market.

CEO succession. Succession of a CEO was coded as a dummy variable (1 = a year in which a CEO was replaced, 0 = otherwise) to test the effect of succession on the likelihood of organizational transformation.

RESULTS

Hypothesis 1 predicts that organizational transformations most frequently follow the patterns described in the punctuated equilibrium model, occurring as short, discontinuous bursts of change over most or all domains of organizational activity. Table 4 shows the number of transformations identified and classified as revolutionary and nonrevolutionary according to the methods described above. As shown, whether measured qualitatively or objectively and calculated at any level of percentage change, revolutionary transformations outnumbered nonrevolutionary transformations by at least six to one. Hypothesis 1 is clearly supported. Organizational transformations occurred most frequently according to the patterns described by the punctuated equilibrium model.

Although these results were striking in the overwhelming preponderance of revolutionary transformations over nonrevolutionary transformations, a question remains as to whether our observation of revolutionary transformations was simply a function of chance. Chance observation would be especially likely to occur for organizations with high base rates of sub-

TABLE 4
Frequencies and Average Durations of Transformations

Variables	Qualitative Measures	Objective Criterion Levels			
		60%	50%	40%	30%
Frequencies					
Revolutionary transformations	23	10	26	29	40
Nonrevolutionary transformations	3	2	4	6	7
Total	26	12	30	35	47
Average durations					
Revolutionary transformations					
Means	1.17	1.30	1.39	1.38	1.28
s.d.	.38	.48	.50	.49	.45
Nonrevolutionary transformations					
Means	4.67	3.00	3.25	3.33	3.29
s.d.	2.08	1.00	.50	.58	.49

stantial change over the three activity domains. The firms studied were heterogeneous with respect to base rates of change. A more direct test of Hypothesis 1 would involve examination of the frequency of revolutionary transformations for each organization relative to its particular base rate of substantial change. The arguments of punctuated equilibrium theory would be more strongly supported if revolutionary transformations were observed even where base rates of change were low.

To explore this possibility, we calculated expected numbers of revolutionary transformations by computing, for each company, the expected number of substantial changes over any two-year period for each of the three activity domains. We then computed the intersection of these expected values for each company to obtain an expected number of revolutionary transformations for each company. For example, Digital Computer Controls, which was founded in 1969 and acquired and disbanded by Data General in 1977, exhibited two substantial changes in strategy, one substantial change in structure, and four substantial changes in power distributions using the 50 percent change criterion. This computation yielded an expected value of substantial change per year of .33, .17, and .67 for each of the three domains. Multiplying these figures together yields an expected number of .037 revolutionary transformations per year for Digital Computer Controls, which translates to an expectation of .222 revolutionary transformations over the life of the company. We observed 1 revolutionary transformation over the life of the company. We followed this procedure for each company studied, calculating observed rates of revolutionary transformation using both qualitative and objective data, entering the latter at each of the four levels of percentage change. Chi-square tests for independence between observed and expected frequencies showed that, for both the qualitative and objective measures, the observed frequencies of revolutionary transformation significantly outnumbered the expected rates even when organizations' individual base rates of substantial change were taken into account. For example, the observed frequency of revolutionary transformations at the 50 percent change criterion level was significantly greater than the expected frequency ($\chi^2 = 178.64_{15}$, $p < .01$). Chi-square values were of similar magnitude and significance for all qualitative and objective measures of substantial change.

Hypothesis 1 is thus directly supported. Regardless of differences in the base rates of substantial change over the three activity domains, the organizations tended to accomplish fundamental organizational transformations according to patterns predicted by the punctuated equilibrium model.

Hypothesis 2 predicts that small changes in individual domains of organizational activity will not accumulate incrementally to yield a fundamental transformation. To explore this hypothesis, we arrayed all objective measures of change for each of the three domains over all years of all organizations' lives. We then summed annual percentage changes for each variable over successive years. Incremental accumulation of small changes toward large differences—30 percent or greater—would disconfirm one of the main arguments of punctuated equilibrium. The striking result of these anal-

yses was that in not one single case did accumulated changes total more than 18 percent before a one-year increase of at least 30 percent occurred. Apparently, small organizational changes do not accumulate to produce nonrevolutionary transformations. These findings provide additional evidence that fundamental organizational transformations tend to occur in short, discontinuous bursts.

Finally, punctuated equilibrium theories contain predictions about when organizations will be likely to undergo revolutionary transformations. Hypotheses 3 through 5 predict that revolutionary transformations will typically occur in the presence of some external stimulus for change. Specifically, we hypothesized that major declines in an organization's performance, major changes in its environmental conditions, and succession of its chief executive officer would increase the likelihood of fundamental, revolutionary transformation. We tested these hypotheses using "logit" regression analysis, which Yamaguchi (1991) noted as an appropriate procedure to use when time-dependent processes, such as organizational age, are not specified theoretically. Table 5 shows results of these analyses.

As Table 5 shows, major changes in environmental conditions and succession of a CEO significantly and positively influence revolutionary transformations. Thus findings support Hypotheses 4 and 5. Hypothesis 3, however, which predicts a negative relationship between performance crisis and the occurrence of revolutionary transformation, was not supported. The coefficient was insignificant. We examined whether lags in the performance change variable might improve the results, but the coefficient was again insignificant (results are not shown).

DISCUSSION

We began this research with the simple idea that research was needed to verify the basic arguments of the punctuated equilibrium model before reliable insights about the antecedents and consequences of revolutionary transformation could be established. Results of this study demonstrate that

TABLE 5
Results of Regression Analyses: Effects of External Pressures on Revolutionary Transformation

Variables	Means	s.d.	*b*	s.e.
Constant			−2.427**	.505
Performance crisis	.785	.412	−0.593	.495
Major environmental change	.238	.427	1.513**	.466
CEO succession	.112	.316	1.684**	.544
χ^2			21.853[a]	
df			3	
pseudo R^2			.140	

[a] $\alpha \leq .001$
** $p < .01$

revolutionary transformation, as predicted by the punctuated equilibrium model, is a principal means by which organizations fundamentally alter their systems, strategies, and structures. The organizations studied overwhelmingly accomplished fundamental transformations within two-year periods. The few transformations that occurred over a period longer than 2 years averaged between 3 and 4.67 years, depending on whether we were looking at qualitative or objective measures. No evidence was found to support an argument that very small changes accumulated over longer periods to accomplish fundamental transformation. This result supports a key argument of punctuated equilibrium theory regarding the likely inability of organizations to instigate or conclude a fundamental transformation via incremental or gradual changes in organizational characteristics. Finally, the results support hypotheses regarding the ability of extrasystemic pressure to initiate fundamental transformation. Revolutionary transformations were shown to be positively and significantly influenced by major changes in environmental conditions and successions of chief executive officers.

Although these results provide good support for the arguments of the punctuated equilibrium model, we do not suggest that debate about either the descriptive validity or prescriptive consequences of revolutionary transformation can or should be laid to rest. Questions about the processes and outcomes of fundamental organizational transformation remain important, both theoretically and practically. We close this study by offering a few thoughts about directions for future research that should both improve the quality of debate about the modes of fundamental transformation (revolutionary versus nonrevolutionary) and extend investigation of the punctuated equilibrium model.

Replications and Extensions of the Research

Several aspects of this research merit future investigation using different samples of organizations and data that are different in certain respects. First, results of this study must be considered limited in their generalizability in that the activities of the minicomputer producers were examined during a period of high turbulence in technology and competition. We chose this setting precisely because such conditions should generate a high number of fundamental transformations. This density of incident was crucial to testing the null hypothesis that revolutionary transformations do not occur more frequently than nonrevolutionary transformations. It is possible, however, that the high degree of environmental turbulence in this industry actually led to faster and more dramatic transformations. Future studies should explore whether organizations competing in more stable environments exhibit similar patterns of fundamental transformation.

Second, the punctuated equilibrium argument that resistance to change, or deep structure, is the mechanism that accounts for the rarity of nonrevolutionary transformations needs to be tested more directly. Because we used archival data, we were only able to show here that small changes in

individual activity domains tended not to accumulate toward fundamental transformation. This finding is consistent with a resistance-to-change argument, but it does not directly demonstrate the mechanism. Future research will need to examine finer-grained data on the attempts at change that subunits try and on the responses, whether adaptation or rejection, of related subunits.

A related issue concerns our procedure for classifying nonrevolutionary transformations. As was described, we simply coded a nonrevolutionary transformation as occurring whenever substantial changes in all three activity domains occurred over a period of longer than two years. This procedure raises the possibility, when the period of nonrevolutionary transformation is very long, that the substantial changes observed over the three domains were unrelated. Archival data unfortunately make investigating such a possibility difficult. Our purpose for this research, however, was to explore whether organizational transformations fit the pattern predicted in the punctuated equilibrium model. Possible relationships among changes are not directly germane to this research question. Future research should certainly explore patterns of influence among substantial changes over different domains for both revolutionary and nonrevolutionary transformations.

Finally, findings did not support our hypothesis regarding the influence of performance declines on revolutionary transformations. Perhaps the measure of performance used in this study, change in market share, is inappropriate as a signal of performance declines. As noted, market share for any one organization is directly affected by the activities of other organizations. Organizations can experience an inverse relationship between profitability and market share, especially in a high-growth market. Our experience with this data set suggests that this is not the case, however; organizations that did not increase or at least maintain steady levels of market share failed earlier and more frequently than other organizations (Romanelli, 1989). Nevertheless, future studies should explore the impact of changes in profitability directly.

Future Directions

In its strong finding that revolutionary transformation was the principal means by which these organizations fundamentally altered their activity patterns, this research also sets the stage for the examination of related questions regarding the consequences and temporal patterns of revolutionary transformations. Even as research proceeds to verify our findings, it is important to the development of the punctuated equilibrium paradigm (Gersick, 1991) to elaborate and test the full implications of the model.

Performance consequences. Researchers have examined whether revolutionary transformation improves the performance of organizations more than nonrevolutionary transformation. Studies by Miller and Friesen (1984) and by Virany and colleagues (1992) have showed that organizations that have accomplished revolutionary transformation outperformed organizations pursuing more gradual, incremental approaches to transformation.

These results suggest that, when transformation occurs, revolutionary change confers a performance benefit.

In earlier work, however (Tushman & Romanelli, 1985), we have argued that revolutionary transformation nonetheless constitutes a dangerous endeavor for organizations, increasing their risk of short-term failure. Revolutionary transformation fundamentally disrupts established activities and understandings, and nothing guarantees that the resulting configuration of activities will be better than the previous configuration. Hambrick and D'Aveni (1988) described a dangerous "downward spiral" of decline that is characterized by increasingly frequent and more radical changes as an organization seeks to reestablish some basic alignment with environmental conditions. Miner and colleagues (1990) also found support for the dangers of transformation in their study of Finnish newspapers from 1771 to 1963; transformations significantly increased the probability of failure for all these organizations.

A few studies have examined organizational and environmental conditions that tend to increase the likelihood of successful revolutionary transformation. Miner and colleagues also found that newspaper organizations that were protected by interorganizational linkages showed a significantly lower probability of failure following transformation than organizations without such protection. Haveman (1992) argued that the timing of fundamental transformations and the relationship of changes to established routines and competencies also influenced post-transformation performance and survival chances. In her study of California savings and loan institutions, Haveman showed that transformations accomplished in close temporal proximity with major environmental changes improved both the short-term financial performance of the organizations and their long-term survival likelihood. Among these organizations, financial performance was also improved when changes were related in some fashion to previous organizational competencies. In an interesting reinforcement of this finding, Virany and colleagues (1992) found that although the majority of the transformations they observed occurred immediately following the succession of a CEO, organizations that accomplished revolutionary transformations without change in CEO performed better over the long term than organizations that coupled transformation with CEO succession.

Post-transformation performance was not examined here, but it is interesting to consider how findings from studies of the consequences of transformation compare with our results about the triggers of transformation. Our findings showed that an organization is significantly more likely to undergo a revolutionary transformation when environmental conditions are changing dramatically and its CEO has been replaced. Apparently, the occurrence of transformation when environments are changing improves an organization's performance and survival likelihood. New CEOs, however, although they demonstrate a clear tendency to radically alter their organizations following the assumption of power, might do better to avoid or delay transformation. Virany and colleagues argued that new CEOs, especially outsiders, may not

understand established competencies and important interorganizational relationships well enough to determine successful post-transformation activity patterns.

Paths of revolutionary transformation. Punctuated equilibrium theorists have also begun to consider questions about longer-term relationships among activity patterns over equilibrium periods. If organizations are most effectively transformed when links to prior equilibrium periods are maintained, a real chance is gained for examining the paths or directions of transformational development. Rather than merely theorizing about organizational life cycles, researchers can begin to consider whether organizations develop according to regular, and thus ultimately predictable, sequences of equilibrium periods, or follow their own idiosyncratic paths.

Miller and Friesen (1980b, 1984) have argued in favor of the first view, suggesting that organizational configurations cluster over a few basic types. Each type, they stated, presents basic constraints on the transformation that will likely occur. In contrast, we have suggested (Tushman & Romanelli, 1985) that there may be great variety in the temporal patterns of configuration over organizations' lives. Given the radical nature of revolutionary transformation, organizations, even very similar organizations facing similar changes in their environments, may emphasize different competencies as links over successive transformational periods. Prior activity patterns probably constrain subsequent patterns to some extent; the nature and direction of change, however, is left open in our model.

It would be premature at this stage of investigation to draw conclusions about the degree of constraint that may characterize longitudinal patterns in organizational transformation. Punctuated equilibrium theory, however, as it specifies periods of stable organizational activity, presents a clear basis for conducting research on this question. Periods could be investigated across organizations, with researchers looking for similarities in pattern and temporal sequencing. More generally, we might explore, within organizations, whether characteristics of earlier periods systematically influence the degrees or directions of future change. The punctuated equilibrium model thus establishes a basis for exploring path dependencies in long-term patterns of organizational transformation.

CONCLUSIONS

This article has addressed the question of whether organizations are typically transformed via the discontinuous change processes predicted in the punctuated equilibrium model. Our findings strongly support the conclusion that revolutionary transformation is the most common mode of fundamental transformation. Researchers may thus proceed with further investigation of the processes and outcomes of revolutionary transformation with greater assurance that organizations do frequently alter their systems, strategies, and structures through short, discontinuous bursts of change over most or all domains of organizational activity.

At the same time, we suggest that this study should serve as the starting point for more systematic debate among proponents of revolutionary and nonrevolutionary theories of fundamental organizational transformation. Competing theories of fundamental transformation appear to embody systematically different assumptions about organizational capacities for change at the subunit level and about the degree of interconnectedness among subunits. These issues address the most basic understandings about organizations. At the same time as researchers explore the performance consequences of alternative modes of transformation, they should continue to examine both the frequencies of revolutionary and nonrevolutionary transformations and the underlying organizational systems and conditions that may give rise to the different modes.

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