The Art of Continuous Change: Linking Complexity Theory and Time-paced Evolution in Relentlessly Shifting Organizations

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In contrast to the punctuated equilibrium model of change, this inductive study of multiple-product innovation in six firms in the computer industry examines how organizations engage in continuous change. Comparisons of successful and less-successful firms show, first, that successful multiple-product innovation blends limited structure around responsibilities and priorities with extensive communication and design freedom to create improvisation within current projects. This combination is neither so structured that change cannot occur nor so unstructured that chaos ensues. Second, successful firms rely on a wide variety of low-cost probes into the future, including experimental products, futurists, and strategic alliances. Neither planning nor reacting is as effective. Third, successful firms link the present and future together through rhythmic, time-paced transition processes. We develop the ideas of "semistructures," "links in time," and "sequenced steps" to crystallize the key properties of these continuously changing organizations and to extend thinking about complexity theory, time-paced evolution, and the nature of core capabilities.

The punctuated equilibrium model of change assumes that long periods of small, incremental change are interrupted by brief periods of discontinuous, radical change (Abernathy and Utterback, 1978; Tushman and Anderson, 1986; Rosenkopf and Tushman, 1995). Fundamental breakthroughs such as DNA cloning, the automobile, jet aircraft, and xerography are examples of radical change. The central argument of the punctuated equilibrium model is that change oscillates between long periods of stability and short bursts of radical change that fundamentally alter an industry (Gersick, 1991). Although incremental change is assumed to occur, radical change is the focus of interest in the punctuated equilibrium model (e.g., Tushman and Anderson, 1986; Romanelli and Tushman, 1994; Utterback, 1994).

While the punctuated equilibrium model is in the foreground of academic interest, it is in the background of the experience of many firms. Many firms compete by changing continuously. For example, Sears' president, Arthur Martinez, recently claimed, "If you look at the best retailers out there, they are constantly reinventing themselves" (Greenwald, 1996: 54). For firms such as Intel, Wal-Mart, 3M, Hewlett-Packard, and Gillette, the ability to change rapidly and continuously, especially by developing new products, is not only a core competence, it is also at the heart of their cultures. For these firms, change is not the rare, episodic phenomenon described by the punctuated equilibrium model but, rather, it is endemic to the way these organizations compete. Moreover, in high-velocity industries with short product cycles and rapidly shifting competitive landscapes, the ability to engage in rapid and relentless continuous change is a crucial capability for survival (Eisenhardt, 1989b; D'Aveni, 1994).

Several authors have begun to explore the implications of continous change, notably in pricing and routes within the airline industry (Miller and Chen, 1994), in charter shifts to

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capture constantly shifting market opportunities in the electronics industry (Galunic and Eisenhardt, 1996), and in market moves and countermoves (D'Aveni, 1994; Eisenhardt and Tabrizi, 1995). In these industries, the ability to change continuously is a critical factor in the success of firms. In addition, what is also becoming apparent is that this continuous change is often played out through product innovation as firms change and ultimately even transform through continuously altering their products (Burgelman, 1991; Chakravarthy, 1997). A classic case is Hewlett-Packard, which changed from an instruments company to a computer firm through rapid, continuous product innovation, rather than through an abrupt, punctuated change. In firms undergoing continuous change, innovation is intimately related to broader organization change. Yet research to date has revealed very little about the underlying structures and processes by which firms actually achieve continuous innovation and, ultimately, change.

The purpose of this paper is to explore how organizations continuously change and thereby to extend thinking beyond the traditional punctuated equilibrium view, in which change is primarily seen as rare, risky, and episodic, to one in which change is frequent, relentless, and even endemic to the firm. In particular, we explore continuous change in the context of multiple-product innovation.

The setting is the high-velocity computer industry. This industry is an attractive one for this study because of its extraordinary rate of change. During the 1993–1995 period of this study, there was a growing convergence with telecommunications and consumer electronics, a rise in multimedia applications, assaults on standards, and the emergence of the Internet, all of which put a premium on the ability to change continuously, especially through multiple-product innovation. Moreover, this pace of change has gone on for many years within the industry, and coping with this change is a key to competitive success (e.g., Bourgeois and Eisenhardt, 1988). As Michael Dell, founder of a major computer firm, explained, ''The only constant thing about our business is that everything is changing. We have to take advantage of change. . . . We have to be ahead of the game'' (Narayandas and Rangan, 1996: 1).

The underlying logic of the research presented here is grounded theory building, which involves inducting insights from field-based, case data. We chose grounded theory building because of our interest in looking at a rarely explored phenomenon for which extant theory did not appear to be useful. In such situations, a grounded theory-building approach is more likely to generate novel and accurate insights into the phenomenon under study than reliance on either past research or office-bound thought experiments (Glaser and Strauss, 1967).

The major results from the study were theoretical insights concerning the organizational structures and processes that characterize successful multiple-product innovation and, more broadly, continuously changing organizations. First, we found that, rather than just communicate, successful managers combine limited structure (e.g., priorities, respon-

sibilities) with extensive interaction and freedom to improvise current products. This combination is neither so rigid as to control the process nor so chaotic that the process falls apart. Second, successful managers explore the future by experimenting with a wide variety of low-cost probes. They neither rely on a single plan for the future nor are they are completely reactive. Third, rather than ignoring change or never changing, they link products together over time through rhythmic transition processes from present projects to future ones, creating a relentless pace of change. All of these insights are empirically grounded.

A primary contribution of the paper is a sketch of an emerging organizational paradigm that combines field insights with complexity theory and time-paced evolution to describe organizations in which change is frequent, rapid, and even endemic to the firm. This perspective contrasts with many paradigms in organizational and strategic thinking, such as transaction cost economics, agency theory, and organization ecology, in which organizations are assumed to be static or nearly so. These theories were developed in the 1970s when speed and flexibility were less relevant to organizational success than they are for contemporary firms. So while these theories accurately describe organizations in slow-moving or very powerful environments, they are not well suited to describing successful organizations in the highly competitive, high-velocity oligopolies in which many contemporary firms compete. In these environments, the ability to change continuously is a core capability of successful firms.

As is typical of inductive research, we begin by discussing theory-building through the multiple case method. We then describe the data and the insights drawn from them and conclude by tying these insights to the broader agenda of exploring continuously changing organizations, which seem to have three key properties: (1) ''semistructures'' that balance between order and disorder, (2) ''links in time'' that direct attention simultaneously to different time frames and the ties between them, and (3) ''sequenced steps,'' which are the recipe by which these organizations are created over time. Overall, this work extends complexity theory from mathematical simulations to real organizational practices and suggests insights into the nature of core capabilities, time-paced evolution, and punctuated equilibrium.

METHODS

Research Design

The research design is multiple-case, which permits a ''replication'' logic (Yin, 1984), in which the cases are treated as a series of independent experiments that confirm or disconfirm emerging conceptual insights. We gathered information on the perspectives of two and often three levels of the management hierarchy. We also incorporated into the analysis the impact of company- and industry-level forces. In addition, this study includes both real-time observations and retrospective data.

This research is part of a study of nine strategic business units (SBUs) across nine firms in the computer industry. The

dataset includes six U.S., two European, and one Asian site. All firms are publicly held, multibusiness computer firms. The SBUs studied are a mixture of four hardware and five software SBUs, all of which compete in markets that are extremely competitive and have high rates of technological change. Thus, this dataset is ideal for studying rapid, frequent change. The SBU was selected as the unit of analysis because of its centrality in the product innovation process. Typically, the management team of an SBU makes important strategic decisions and yet is also directly involved in daily management.

Table 1 describes the six cases used in this paper. We selected three SBUs that had successful multiple-product-development portfolios and three that did not. We defined successful portfolios as our informants did, in terms of positive project characteristics (e.g., on schedule) and negative ones (e.g., stop-gap, stuttering). For this paper, we eliminated the larger study's "middle" three cases so that we could more clearly distinguish the key processes and describe them in a limited space. Fortuitously, these six cases include three pairs of strategically similar firms in which one firm had a successful product portfolio and one did not. There is a pair of firms pursuing pioneering technical strategies, a pair of moderately innovative, component-integrator firms in extraordinarily competitive markets, and a pair of mature companies switching from mainframe to client/server technology.

Table 1

Description of Case Data

	Strategic profile	Total interviews	High-level interviews	Low-level interviews	Projects in SBU
Titan	Mainframe to client/server	12	4	8	10
Midas	Technology pioneer	7	3	4	5
Cruising	Component integrator	8	3	5	6
NewWave	Technology pioneer	7	5	3	6
Saturn	Mainframe to client/server	12	5	7	8
Wanderer	Component integrator	9	3	6	6

Data Collection

We collected data through interviews, questionnaires, observations, and secondary sources. The primary source was semistructured interviews with individual respondents. At each site we interviewed two types of respondents: those responsible in some capacity for a single project (low-level interview) and those responsible for multiple projects (high-level interview). High-level respondents were a mixture of general managers and vice presidents, with responsibility for the entire SBU, and those who reported directly to them, who were responsible for some portion of the SBU. At both the high and low levels, there was a mix of marketing and engineering informants.

We conducted interviews during several-day site visits to the SBU. The 81 interviews we conducted were taped and transcribed. Interviews typically lasted 90 minutes, although a few ran as long as three hours. During the site visit, we

kept a daily record of impressions and recorded informal observations we made as we participated in activities such as lunches, coffee breaks, and product demonstrations. In addition, whenever possible, one of us attended meetings as a passive note taker. These observations provided real-time data.

We used two interview guides to conduct the two levels of semistructured interviews. In both cases, we asked respondents open-ended questions that let them relate their stories of how particular product development projects had evolved. We asked probing questions to establish details (e.g., when a particular event occurred). The high-level interview guide had four sections. It began with the background of the respondent and the competitive sector. The second part of the interview focused on strategic issues, and the third part concentrated on structure, human resource management, and generally on the process of managing multiple projects. The final part of the interview was a structured questionnaire that asked respondents to give numerically scaled responses to identify characteristics (e.g., communication levels) of the current set of projects.

The low-level interview guide had three sections. It began with the personal background of the respondent and a detailed chronology of the particular project. In the second part of the interview, the questions focused on strategic issues for the project. The third part concentrated on group processes within the team and the team's relationship with other projects. In both the second and third sections of this interview, some questions asked respondents to give numerically scaled responses to characterize their projects.

In addition, a finance-staff member completed a financial questionnaire. We also gathered secondary data on-site and from the media about the SBU and its parent to build an understanding of the forces the industry and parent firm exerted on the SBU.

Data Analysis

As is typical in inductive research, we analyzed the data by first building individual case studies and then comparing across cases to construct a conceptual framework (Eisenhardt, 1989a). As a first step, we entered all transcribed responses into a database indexed by case, interview number, interview type, and question number. Next, we constructed a single version of both the high- and low-level interviews for each case by collecting all responses to the same question together as a single response.

Using these interviews and secondary sources, we wrote a case study for each site. This was an iterative process in which we revisited the data as important features of multiple-product innovation within each case emerged. Although we noted similarities and differences with other cases, we left further analysis until we had completed all case write-ups to maintain the independence of the replication logic. As a check on the emerging case stories, a second researcher read through the original interviews and formed an independent view of each case. We then used

this view to cross-check the emerging story. The case-writing process took about six months to complete.

Once the individual case studies were complete, we used a cross-case analysis, relying on methods suggested by Miles and Huberman (1984) and Eisenhardt (1989a), to develop the conceptual insights. We had no a priori hypotheses. Initially, we compared the cases to identify common dilemmas and refine the unique aspects of each particular case. We created tables and graphs to facilitate further comparisons and compared successive pairs of cases for similarities and differences to develop the emerging constructs and theoretical logic. With each iteration, we used new permutations of case pairs to refine the conceptual insights. We took several breaks during the analysis process to refresh our thinking. The rough outline of the insights in this paper emerged after about three months. We then worked in two more three-month blocks, separated by several week-long breaks, to refine the analysis. As the analysis evolved, we raised the level of abstraction. Each time that we completed a pass at building the insights, we then went back through the cases to confirm and adjust our ideas as needed. We also went back to the original interviews to ensure that our ideas continued to be consistent with the data. During the editorial process, the editor and anonymous reviewers pushed us further to develop our analysis of the less successful product portfolios. This lengthy, iterative process led to the insights that follow.

ORGANIZING MULTIPLE-PRODUCT INNOVATION

What emerged from our data were insights that linked successful product development portfolios with a set of organizational structures and processes that are related to continuous change. We defined successful product portfolios as our informants did, in terms of both the presence of positive portfolio characteristics (i.e., on schedule, on time to market, on target to market projects) and the absence of negative ones (e.g., make-work, competing, stop-gap, stripped, endless, stuttering projects).

We assessed the positive characteristics in several ways. First, we asked informants to determine whether each project in the present portfolio was currently on time to market and on schedule. We supplemented these data with a questionnaire in which informants were asked to rate the overall on-target-to-market and on-schedule performance of each project using a 10-point Likert scale. We then averaged these scores across projects. We also gathered qualitative assessments from the interviews. Table 2 shows this combination of qualitative and quantitative data, which creates a more robust assessment than either data type alone.

We assessed the negative characteristics using a two-step process. We began by developing a list of project characteristics that were identified by our informants as problems in their portfolios that would hamper product development efforts and/or the commercial success of products. These characteristics fell into categories that included stripped, competing, stuttering (stopping and starting), make-work,

and stop-gap projects. We then computed the percentage of projects with problems, problems per project, and firm rankings. As before, we complemented these data with qualitative assessments.

As indicated in Table 2, there were substantial differences in product portfolios across firms. Three firms (Cruising, Titan, Midas) had successful product portfolios. On average, over 90 percent of their projects were on time to market and on schedule, while less than 10 percent had problems. Their average on-target performance was rated 9 out of 10, and informants reported few problems. For example, Cruising had a virtually problem-free product portfolio.

In contrast, three other firms (NewWave, Wanderer, Saturn) had less successful portfolios. Their on-time-to-market, on-target, and on-schedule performances were, on average, much lower than those of the first three firms, and they reported numerous problems. For example, Wanderer had three of five projects that were behind schedule, none that were on time to market, and an average of 2.8 problems per project.

In attempting to understand these differences, we found that managers with successful product portfolios combined limited structure, in the form of clear responsibilities, priorities, and formal meetings, with extensive communication to manage current projects. Second, they looked to the future using a variety of low-cost probes. Finally, these managers linked present projects to future ones through rhythmic transitions from one project to the next. This framework is colorfully captured by an informant's analogy. Successful managers are like ''Tarzan,'' they swing on the current vine, look ahead for the next, and make the switch between the two. In the next sections, we elaborate on these insights and describe their grounding in the data.

Improvising in the Present

Why do some firms have successful product portfolios while others do not? Previous research (e.g., Burns and Stalker, 1961) suggests that organic structures may be the answer. Firms with fluid job descriptions, loose organization charts, high communication, and few rules may be conducive to innovation because they free developers from constraints, allowing them to change flexibly and create novel ideas (March, 1981; Peters, 1994). Typical of an organic structure is the organization referred to in one executive's comment (Burns and Stalker, 1961: 93), ''Of course, nobody knows his job here.''

The evidence from this study, summarized in Table 3, suggests an alternate view. While communication was associated with successful product portfolios, purely organic structures were not. In fact, neither organic nor mechanistic structure was the answer. Rather, the managers of these firms balanced between mechanistic and organic by combining clear responsibilities and priorities with extensive communication. One illustration is Cruising. Here, there were well-defined managerial responsibilities and clear project priorities. Marketing managers were explicitly responsible for product definition and the financial performance of projects,

Table 2

Summary of Data on Product Portfolio Performance

Case	On time to market	On target to market*	On schedule†	Problems	Rank‡	Examples
Titan	Yes 100% 10 of 10 on time. Anticipate markets and release many products ahead of competitors. "Our reaction time (for new products) is very short."	Yes Average = 9 Products meet needs of current customers "We work very closely together with customers, so we avoid having a product which is not accepted in the market."	Yes 100% 10 of 10 projects on schedule. Average = 8 "I think that this was one of the great things we have solved within the last 3 years—to be really better in not just planning the functionality (of projects), but in being on time."	No 0% with problems Problem-free portfolio of complementary products.	1	"This company is so successful because we deliver new functions rapidly."
Midas	Yes 100% 5 of 5 on time. By regularly releasing products, they have built a technology lead over competitors. Whenever they get a new product out, customers are waiting. "We serve our lunatic fringe customer base. They either want to do things faster than anyone can do them or they want to do things that no one else can do."	Yes Average = 8 Products meet most needs of customers. "We will have customers' engineers in before the product is released. We will do everything in our power to see that their applications run on day one."	Yes 80% 4 of 5 projects on schedule. Average = 9 New products released like clockwork every two years. Core products have not slipped schedule in 8 years. "I (GM) can definitely produce products on time. That's why they hired me."	No 20% with problems Almost problem free portfolio of core and experimental products—1 experimental product behind schedule.	2	"Once we set a date, we don't miss it."
Cruising	Yes 85% 5 of 6 on time. Focus is hitting market windows with latest technologies that consumers want. "We've got market windows and so we try to be very aggressive, but realistic about technologies."	Yes Average = 10 Products have the right set of tradeoffs. "Quite frankly, we've developed a good feel for this marketplace. We've got a lot of horse sense when it comes to what's needed and what isn't."	Yes 85% 5 of 6 projects on schedule. Average = 8 "We are able to take a group of folks and put a product together in a very short time frame."	No 15% with problems Almost problem free portfolio of low-end, high-end and experimental products: 1 behind schedule, 1 late to market.	3	"We've been told—we've had a lot of consultants in here in the last couple years—that we are the best implementors in the industry. We can take technologies and make the right set of tradeoffs.

Table 2 (*continued*)

Case	On time to market	On target to market*	On schedule†	Problems	Rank‡	Examples
New wave	No 0% 0 of 6 on time. Products already late for market windows. Rushing so will not miss windows altogether. "Now we're scrambling to catch up and to develop technology that we really needed a year for, but only have 6 months to do it."	Mixed Average = 8 Products are roughly on target, but there are problems with specific features. "The group is bright and creative but they don't understand how to create the specific products needed by this industry."	No 0% 0 of 6 projects on schedule. Average = 5 Schedules are not being met. "It is kind of random. I guess if I don't meet (schedule) milestones I might hear about it."	Yes 100% with problems. Problematic portfolio. An average of 2.3 problems per project: 6 behind schedule, 6 late to market, 2 stripped of resources.	4	"In some cases we are creating more (features) than we need." "We have brought headcount off (stripped) projects shipping in the second round to help this first round. It means things aren't going well."
Saturn	No 25% 2 of 8 on time. Many products released after market windows have closed. Even their most cutting edge product is late to market. "There are competitors in this area. I'd say they were earlier into the market."	No Average = 6 Most products developed with little understanding of how they fulfill market needs. "We just continued on with the development. I think we have only sold 2 or 3 copies and we were hoping to sell about 20."	Mixed 50% 4 of 8 projects on schedule. Average = 7.	Yes 100% with problems Problematic portfolio. An average of 2.5 problems/ project: 4 behind schedule, 6 late to market, 4 stop gap, 2 make work, 1 stuttering, 2 endless, 2 competing.	5	"What you tend to find is projects have a life of their own and when the project begins to wane it looks for other products to justify its existence." "We end up with competition between rival products within the company . . . it confuses the customer."
Wanderer	No 0% 0 of 5 on time, 1 too early to tell. Products often late, sometimes miss windows completely. "I had people investigating (Product X) for 9 months . . . it is very similar to the machine that a competitor just announced . . . and now we don't have one!"	No Average = 7 Products often miss market needs. "We miss a lot of opportunities in the market by not completely understanding the markets we are in. We misfire the gun a few times because we don't understand the markets."	No 40% 2 of 5 projects on schedule. Average = 5. Some projects on time, others slowed down because time is wasted negotiating about resources. "Dave (senior executive) thinks we are late on everything."	Yes 100% with problems Problematic portfolio. An average of 2.8 problems/ project: 3 behind schedule, 4 late to market, 1 stop gap, 1 stopped, 2 stuttering, 1 make work, 2 competing	6	"We would not be doing it (stop gap) if we could do (the late product) quicker." "They began it (stuttering) in December. Team members were dispersed when the project was stopped in late March. Later they tried to bring them back in mid-May when the project was restarted, but some had been assigned to other projects."

* The averages in this column are the average ratings by firm informants of how well current projects match market needs, on a 0–10 point scale.
† The averages in this column are the average ratings by firm informants of how well current projects perform in meeting schedules, on a 0–10 point scale.
‡ Average rank based on first 4 columns.

while engineering managers drove project schedules. Their job was to ensure that the actions related to these responsibilities happened. This was in stark contrast to earlier days at Cruising. As a marketing manager described, ''In past organizational structures, it was really pretty hard to hold anybody responsible . . . now this is more of a holistic (entire project) approach, more their own little businesses.''

Similarly, there were sharply defined project priorities. Cruising managers used their assessment of market potential to determine project priorities, with products having the largest potential markets gaining highest priority. The priority-setting process was wrenching. As a senior manager described, ''We go through a pretty excruciating process. We prioritize everything that we're doing. We draw a cut line and take a good hard look at it and take a big swallow. . . . If that one below the line is really a priority then you better be willing to kick something off the list. That's the gut check, it's tough.'' The result was crystal-clear priorities. As a marketing manager observed, ''We're well aware of where we sit in the priorities and we have a very specific priorities list. You know your number, you know where you sit on that list.'' Although Cruising managers claimed that ''we're always looking for a better way to set priorities,'' they also observed, that without priorities, ''you never get focused on the core business.'' These priorities were then tightly tied to resource allocations.

Cruising managers complemented these structures with extensive communication. As one manager explained, ''There's a tremendous grapevine inside this company and of course, we've got a great e-mail system.'' Some of the communication was internal to projects. As shown in Table 3, there was extensive within-project communication. One manager described it, ''Team members may go out to lunch or go into the lab to look at displays and others' things, think about tradeoffs, and do models, form focus groups together, a lot of close work.''

More striking, however, was the cross-project communication, because Cruising managers had transformed the firm from one in which there was little cross-project communication to one that emphasized the necessity for it. As one manager explained, ''It used to be that it was a badge of honor not to use anybody else's ideas or to improve upon them . . . now everybody's borrowing everybody's stuff, the cycle is just so short and the pressure is so intense.'' Another manager described, ''We encourage a lot of spreading the word back and forth across projects.'' A third summarized cross-project communication as ''dramatic, a tremendous amount.''

Much of this communication occurred in formal meetings. There was a weekly, cross-project engineering meeting and a Thursday product-planning meeting that was a cross-project review. These meetings provided opportunities to trade insights across projects. As one manager described, ''It's typical for someone to say 'oh you're doing that for this latest do da' or 'maybe I should do that same technology'. Even if it's not your own project everybody comes to the

meeting because they discover what other people are doing.''

Finally, equally important was what was *not* structured. While responsibilities, priorities, and some communication were, there was no evidence that the actual design process was tightly structured. In fact, Cruising had previously actually dismantled a very structured design approach. Developers were now free to create designs iteratively and flexibly. As one claimed, ''We fiddle right up until the very end.'' So, while limited structures such as priorities and some responsibilities were set, most of the design process was not.

At Titan, as at Cruising, there were well-defined responsibilities and clear project priorities, but other aspects of the design process were not well-specified. Managerial roles were defined such that ''ownership'' of project schedules, profitability, and product definitions were clearly defined. The project manager was responsible for the definition of the product and the schedule. The head of the department was responsible for product profitability. In addition, there were also clearly defined priorities, which although they were regularly reexamined, were fixed at any point in time.

Titan managers complemented these structures with extensive communication. As at Cruising, much of it was cross-project. They held frequent status meetings, including a monthly product meeting that all development managers attended. These meetings kept managers well informed about the status of each other's activities. In preparation for this meeting, all project managers prepared a written status report of their projects that provided ''a summary of all the products.'' These status reports were also circulated throughout the company to keep all developers well informed about projects across the SBU. In addition, approximately 30 percent of all projects were cross-department projects involving multiple development groups. These projects provided a vehicle for sharing information about the current status of development throughout the firm. More informally, there was extensive communication among Titan's product developers. Coffee bars were scattered throughout the development area explicitly to encourage informal connections and problem solving during breaks. One manager described the high communication at Titan: ''The normal way we work is to communicate across projects . . . most of the time the developers are talking with each other across different projects.''

In contrast, firms with less-successful portfolios (NewWave, Saturn, Wanderer) lacked well-defined responsibilities and priorities. Managers either did not have or did not agree on project priorities. Responsibilities for product profitability, definition, and schedules were often unclear. Although there was often communication within projects, communication across projects was particularly low. The way that these executives managed current products was in contrast to the limited structuring that the successful firms used.

The approach at Saturn and Wanderer was a very structured development process. Managers had created processes in which projects were planned out with work broken down

Table 3

Improvising in the Present

Case	Communication		
	Within-project*	Cross-project†	External‡
Titan	High Average = 8 Extensive communication among team members. "Communication is very good."	High Average = 8 Special cross-department teams exist for projects that cross boundaries. "The normal way we work is to communicate across projects. Most of the time we are talking with each other across different projects."	High Average = 8 Developers have frequent contact with customers, both off site and on customer service hot lines. "All the developers join customer groups. They have to."
Midas	High Average = 7 Collaboration between team members is frequent, open. "I would characterize it as friendly, open exchange."	Moderate Average = 6 Communication across projects is frequent and informal. "Informally, everyone has dinner together every night at the cafeteria, on the GM. A tremendous amount of engineering happens at dinner." "Everyone pretty much knows what the others are up to."	High Average = 8 Frequent visits to customers and vice versa. ". . . the way the GM runs the organization is that he wants the engineers to know the market, as opposed to relying on marketing to tell them what the market is."
Cruising	High Average = 7 Communication is now part of the culture. "We meet a lot. It's the way the company's built. You hammer it out."	High Average = 7 Cross-project communication is high and increasing. "Now everybody is borrowing everybody's stuff, the cycle is short, the pressure is so intense."	High Average = 7 Marketing does extensive user prototyping and works in pairs with engineering. "We do a lot of customer research, so we test a lot of concepts."
NewWave	High Average = 7 Open communication. "It's not cool to withhold information."	Low Average = 4 Cross project communication is not seen as critical. "We are very compartmentalized because we are all so focused on our own tasks."	Moderate Average = 6 The management team has modest exposure to customers. "We kind of forget our audience."
Saturn	High Average = 7 Fairly extensive communication. "It's quite high."	Low Average = 3 Very little communication across projects. "Communication is a funny thing. People complain when it's not there but it's very difficult to get them interested in it."	Low/Moderate Average = 5 Modest contact with customers. "I don't think we're well-informed by our customers."
Wanderer	Moderate Average = 6 Modest communication. "It (within team communication) could be better."	Low Average = 3 Very little communication across projects. "One of the issues when I (GM) first came here was the lack of vertical and horizontal communication. It still needs work."	Low/moderate Average = 5 Modest contact with customers. "We have tended to deal with customer feedback as more of an afterthought . . ."

Table 3 (*continued*)

Structure		
Responsibilities	**Priorities**	**Formal cross-project meetings**
Yes *Profitability:* Department head. *Product definition:* Project manager. *Schedule:* Project manager.	Yes *Clarity:* High. There is an explicit priority list. "There is a priority list which is part of internal development, that has to be referred to and discussed . . ." *Basis:* Market opportunities as decided by key managers.	Yes Monthly meetings. Written status reports are prepared for this meeting. "In the monthly meeting, we have a summary of all the products."
Yes *Profitability:* GM. *Product definition:* Director or project manager. *Schedule:* Director or project manager, depending on project scale.	Yes. *Clarity:* High. There is an explicit priority cycle. Core product is first, except during transitions. "You always want to make your highest priority project succeed." *Basis:* Products giving greatest revenue in shortest time. "Biggest bang for the buck . . . we do things that are fundamental first."	Yes Weekly meetings. "We have elbow to elbow discussions."
Yes *Profitability:* Marketing manager. *Product definition:* Marketing manager. *Schedule:* Engineering manager.	Yes *Clarity:* High. There is an explicit priority list. "We are all aware of where we sit in the priorities and we have a very specific priorities list." *Basis:* Market opportunities as assessed by key SBU executives. "We have a prioritization process based on market opportunity."	Yes Weekly meetings. "On Thursdays, a quick update on today's products. We have an intense tracking system."
No *Profitability:* Nobody. *Product definition:* Ambiguous. "To own a project (you) need to know everything that is going on. No such person exists in the structure right now." *Schedule:* Program managers, but lack authority. "We don't have a schedule and we don't know what we're doing."	Mixed *Clarity:* Low. Formal priorities differ from informal. "It's one of those breaking the rules things." *Basis:* Planned release date.	No Weekly meetings. These meetings are not very effective. "One of the first things I noticed when I came here was the lack of organization of meetings. Never any agenda, never know when the meeting is going to be."
No *Profitability:* Nobody. *Product definition:* Nobody. *Schedule:* Nobody.	No *Clarity:* No consensus. "The engineers don't know where their priorities should be." *Basis:* None. "It's ill-defined."	No "The degree to which things get reviewed at the group level is not a very detailed review of things."
No *Profitability:* Nobody. *Product definition:* Nobody. *Schedule:* Engineering manager.	No *Clarity:* No consensus. "The projects are being treated as though they all have equal priority." *Basis:* None.	No Weekly staff meetings are general in nature, not managers reviewing projects' status.

* The averages in this column are the average levels of communication within project teams, on a 0–10-point scale.
† The averages in this column are the average levels of communication between project teams, on a 0–10-point scale.
‡ The averages in this column are the average levels of project team communication with customers, on a 0–10-point scale.

into small tasks and then passed through a structured sequence of steps from concept specification to pre-prototype and so on. The objective was efficiency. One manager called it ''a process-bound environment.'' As each step was completed, the project passed to the next step. The whole process was governed by specifications, procedures, and checkpoints. Once started, a project proceeded through a sequence of lock-steps in which developers completed their own tasks and then passed the project to the next developers. Ironically, despite all this structure, no one was actually responsible for overall tasks such as product definition, schedule, or financial performance. As one manager described it, ''Most people only look at their part—they say I have this spec. If it fits the specs, meets the spec, then it's good.'' Another told us, ''The work of everyone else doesn't really affect my work.'' In contrast, at the more-successful firms, although shaped by priorities and responsibilities, the work itself was more ad hoc and iterative.

Some managers regarded these highly structured processes as effective. Several Wanderer managers called project management one of ''our competences.'' Another said, ''I think the distinctive thing about here is discipline and the extent to which we do this.'' While sometimes projects did finish quickly, it was difficult for managers at Saturn and Wanderer to adjust in mid-project to changing markets and technologies. For example, Saturn developed a product that sold only a tenth of what was expected. The product was originally well conceived but was never adjusted to changing market conditions during its development. One manager summarized: ''I think where we went wrong is we did not stop and check 'what is the business case for taking this through to development', and we just sort of continued on with the development and release process.'' Many of Saturn's other projects missed market windows. Similarly, managers at Wanderer had difficulty adjusting projects to changing conditions. Once started, the process took over. It was hard to backtrack or reshape product specifications as circumstances changed. As one manager lamented, ''By the time we figure out that there is a problem, it's already too late.'' Rather, Wanderer managers relied on extreme adjustments such as stopping projects.

At NewWave, the approach was different. Here there was a very unstructured process. Managers described their culture as ''rule breaking.'' It was acceptable and even encouraged to minimize structure and violate rules. One manager related, ''It's part of the culture not to write things down.'' Meetings existed, but they were free-form. As one project manager noted, ''One of the first things I noticed when I came here was the lack of organization of meetings as a form of communication. Never any agenda, never knowing when the meeting is going to be.'' Responsibilities were unclear. No one was accountable for the financial performance of specific products under development. Responsibility for product definition was ambiguous because two groups, graphics and software, considered themselves in charge. Program management, a third group, was responsible for schedules. Although these managers were sup-

posed to combine software and graphics schedules into a coherent master schedule, managers told us that they did not actually do this because of the mire between software and graphics. Also, these program managers were nontechnical people, overburdened with too many projects. As one manager described the situation: "Program managers have very little real authority. Mostly what they have been is facilitators." Structure was further obscured because senior executives often skipped over these managers to tell developers directly what to do. As one manager described, "The conceptualization of the products keeps changing. . . . What happens is the VP will walk down the hall and say, 'You should add this' to the developers."

Confusion reigned at NewWave. While some managers saw this as Silicon-Valley organic management and reveled in the excitement of panicked product development, others agreed that the "rule-breaking culture" and chaotic structures and processes were "a problem." They created "enormous time wasting." All NewWave products were behind schedule.

One reason why clear responsibilities and priorities coupled with extensive communication were associated with successful product portfolios is that they may be highly motivating. Extensive communication with colleagues and the external environment is likely to create feedback on performance, while clear responsibilities and priorities provide autonomy and accountability for significant aspects of the task. These, in turn, create intrinsically motivating jobs and, ultimately, high performance (Hackman and Oldham, 1975).

Another reason may be that these limited structures help people to make sense of a fast-changing environment. In such environments, it is easy to become confused, make mistakes, and fall behind. Previous research indicates that structure helps people to make sense of change. For example, Weick's (1993) discussion of smokejumpers in a firestorm indicates that loss of structure hampered sensemaking and was central to the tragedy. Similarly, Eisenhardt (1989b) found that fast decision makers used structures to create an understanding of their surroundings and build the confidence to act.

A third reason may be that the combination of clear responsibilities and priorities coupled with extensive communication lets developers improvise. Improvisation is an organizing strategy of "making it up as you go along" (Miner and Moorman, 1995: 1) or more formally "activities in which composition and execution of action approach convergence with each other in time" (Moorman and Miner, 1996: 2). In the context of jazz improvisation, this means creating music while adjusting to the changing musical interpretations of others. In the context of product innovation, it means creating a product while simultaneously adapting to changing markets and technologies. Although improvisation is popularly thought of as "winging it," true improvisation relies on two key properties that mirror our data. It involves (1) performers intensively communicating in real time with one another, yet (2) doing so within a structure of a few, very specific rules (e.g., order of soloing, valid chord sequences)

(Bastien and Hostager, 1988; Hatch, 1997). The limited structure provides the overarching framework without which there are too many degrees of freedom. The communication allows the players to coordinate and mutually adjust within that framework. Together, people can adaptively accomplish tasks even as the context is changing.

Finally, these ideas relate to product development research. As expected (e.g., Allen, 1977; Von Hippel, 1988; Ancona and Caldwell, 1990; Dougherty, 1992; Henderson, 1994), internal and external communication were related to successful products. What was unexpected was the importance of limited structure—e.g., clear priorities and responsibilities—to successful product portfolios. Managers of successful portfolios relied on structures that were neither too extensive (Wanderer, Saturn) nor chaotic (NewWave). Further, this suggests a metaphor shift from product development as "disciplined problem solving" (Clark and Fujimoto, 1991; Brown and Eisenhardt, 1995) to "improvisation" (Miner, Moorman, and Bassoff, 1996), in which projects are adapted to changing circumstances even as they are being developed. This latter metaphor better captures the flexibility and dynamism of rapid, continuous innovation that occurs in many high-velocity industries.

Probing into the Future

Building on the resource-based view of the firm, past research has emphasized leveraging firm competences to create successful products. The idea is to capitalize on what the firm does well. For example, Iansiti and Clark (1994) found that building on past knowledge for current projects was related to successful product generations in the mainframe computer and auto industries. So perhaps building on the past is key to successful multiple-product innovation.

Yet, while building on the past may be advisable, we found that looking to the future was critical. The managers with successful product portfolios (Cruising, Midas, Titan) seemed to have a good sense of the future and a vision for their organizations within that future. For example, at Cruising, we were frequently told about the vision of the firm as "*the* portable computing company of the '90s." At Midas, people shared a vision of themselves as the creators of the "fastest software on earth." At all three successful firms, managers claimed not only to react to the future but also sometimes to anticipate and even create it.

The managers at the other firms (NewWave, Wanderer, Saturn) were quite different. They had little sense of the future. As one said, "We don't know strategically what the hell we're doing." Another complained, "We miss a lot of opportunities." As they struggled to meet the future, their portfolios were plagued with problems. These firms were constantly playing catch-up.

How did the managers of the successful portfolios look to the future? The data revealed that these managers did not extensively plan or invest in any one version of the future. Yet they were not reactive either. Rather, they balanced between the rigidity of planning and the chaos of reacting by

frequently probing the future using a variety of low-cost lenses. Table 4 describes the four specific tactics that emerged from the data: experimental products, futurists, strategic partnerships, and frequent meetings.

Midas provides a good example of how managers probe the future. Midas managers routinely created experimental products to probe new markets. These product probes were typically product options that were potentially useful in new markets. If successful, these experiments were incorporated into future generations of the core product. As the engineering director described, "we are creating a more specialized system out of the more generalized system to meet the unique requirements of a variety of markets." These experimental projects were relatively low-cost investments involving between five and ten developers, compared with teams of 40 developers for core projects.

Strategic alliances were also used to probe the future. Managers at Midas allied with major, leading-edge customers—their "lunatic fringe"—and with potential customers to understand both future needs in existing markets and potential customers in new markets. As one developer described it: "The way Midas works is that we will go after a market area. We find out if there are people who want to use the product in that area. We justify how big that market is and see if we want to tailor our system."

Midas also had two futurists. One had a marketing orientation, while the other was a technology "guru." Both met frequently with the management team to create possible visions of the future. One manager summarized the multi-probe approach to the future: "We drive into what we think are our key markets trying to get feedback as quickly as we can. We try to align with partners in growth areas. At the same time, we look at technology and try to see where it will be in 2.5 years."

Titan managers, too, relied on quickly developed, experimental products. For example, they created a quick product probe to learn about low-end markets. Although the product was attractive to users, it was actually a "quick and dirty" design. After gaining a look at this new market, Titan managers then revamped the product. As one manager said, "It's a new market. . . . We can play this game (i.e., experimental product probes) very easily and at nearly no cost."

Titan managers also used alliances to anticipate the future. They described one with a leading accounting firm that helped Titan managers correctly predict European tax law changes. These laws substantially affected Titan's software, and their accurate prediction gave them an advantage over the competition. As a manager recounted, "The European taxes were changed at the beginning of last year and there was a different approach in all 16 European countries that we had to handle. So we asked our partner what the changes would mean, before the law had even passed. Our reaction time was very short."

Titan also had several senior executives with Ph.D.s who were charged with thinking about the future. They were both experts on specific technologies and well acquainted

Table 4

Probing the Future

Case	Experimental products	Strategic alliances	Futurists	Meetings
Titan	Yes. Explore new growth markets by stripping down existing products. "Within the next 7 or 8 months we will have a low end product. We will strip back (an existing product) and sell it in a PC shop. It is a new market. We can play this game very easily and at nearly no cost."	Yes. Partner complementary technologies and key customers. "We have established a partnership with (leading PC SW company). They help us in developing user interfaces."	Yes. Each development group is represented by a board member who is focused on the long term and is an expert on both the technology and the markets of that group.	Yes. Monthly strategy meetings. "The real strategic decisions within the company are not made by one person. They are made for development in these monthly meetings."
Midas	Yes. Explore new growth markets with options on existing products. "We deliver a (experimental) product and we drive it into what we think are our key markets. Then we try to get feedback as quickly as possible."	Yes. Partner current and potential customers in existing and new markets. "The way Midas works is that we will go after a market area and we find out if there are people (current and potential customers) who want to use the product in that area. We justify how big that market is and see if we want to tailor our system . . . in order to grab more of that market."	Yes. Senior technical and marketing gurus. "There is a lot of creativity in determining, given the hardware that we have, what new set of features can we do. Brian and George are the sort of people who make those kind of decisions."	Yes. Informal regular discussions between GM and VPs, and between GM and technical gurus.
Cruising	Yes. Explore new growth markets with new consumer products and with experimental options on current products. "For (these new products) we are not focusing on the corporate market. We are focusing on consumers (new market). Our approach to the technology is different. We are not just looking at traditional technology. We are looking at other types."	Yes. Partner key component vendors in new complementary technologies. "We were one of the earlier adopters of this technology which gives a very brilliant color . . . (a partner) said 'We've got this technology, why don't you guys find a product to take it into?' "	Yes. Long-range planner. "Our long-range planner said 'Gee, we are missing the whole low end of the marketplace' . . . We hadn't realized that before. We were sitting there running on 50/60% real profit margin, just fat, dumb, and happy, while our market share was going away."	Yes. Weekly strategy meetings, plus occasional brainstorming sessions. "We have Wednesday morning strategy meetings. Right now we are trying to look at 1997 and figure out where we are going to be then."
NewWave	No.	No.	No. Many knowledgeable people, but no one has the futurist role. "Forget the future and worry about it later."	No. "People are busy and the priority is on the projects. It's a luxury to think about the future."
Saturn	No.	No. Two backward-looking relationships to extend life of old products.	No. No one within the SBU focuses on the future. "We don't know strategically what the hell we're doing."	No. No discussion of strategy within SBU. The GM is involved in strategy discussions but doesn't communicate them down. "I wish (the GM) would give us more guidance and be more clear about what the company's direction is."

Table 4 (*continued*)

Case	Experimental products	Strategic alliances	Futurists	Meetings
Wanderer	No.	No.	No. No one within the SBU focuses on the future. "We are so focused on today's tactics that sometimes we can't see the forest for the trees. We are really thinking only one program ahead. We really need to be thinking multiple programs ahead."	No. No discussion of strategy within SBU. "Reactive" decision making from above. "How does (strategy) get decided other than Dave (boss) has a 'dream'! Dave looks at the product plan, decides he doesn't like it and comes up with a new plan."

with particular customer markets. Titan executives also met monthly explicitly to ponder the future.

In contrast, managers at the firms with less-successful product portfolios (NewWave, Wanderer, Saturn) did not use these or other tactics to probe the future. There were no organized meetings about the future and no experimental products. Although many people were knowledgeable at these firms, no one played the futurist role. Only Saturn had strategic alliances; ironically, these were backward-looking relationships to extend old products.

Rather than probing the future, managers at Saturn and NewWave planned the future. Managers at each firm described spending several months prior to this study building a comprehensive strategy and then creating a follow-on product development plan. In effect, they created a single view of the future and then bet their product development portfolio on that view, a tactic that was ineffective. For example, at Saturn, managers misjudged the timing of the future. As one manager related, "They thought everything was going to the new technology and they responded too soon really. There is a large customer base out there for the old technology . . . we got disconnected from our customers for a year in the process, which was silly." Saturn managers tried to recover by extending old products and creating new, stop-gap projects. But, as it turned out, they did not know much about the future that did arrive. As one manager claimed, "The company is drifting."

At NewWave, the strategy relied on a vision of the future that was never refreshed in light of changing competition. At the time of our study, the strategy appeared promising. But, as NewWave managers learned some months later, the strategy was outdated. As one told us, "Unfortunately the critical assumption about technology turned out to be different from what we expected it to be . . . a lot of these people's skills were wasted." Ironically, NewWave managers had become so caught up in managing current products that they never reassessed the future. One executive said, "People are busy and the priority is the projects. . . . It is a luxury to think about the future." NewWave managers ended

up stripping resources at the last minute from one set of projects to give to another to meet the future that did arrive.

At Wanderer, the approach was different. Here managers reacted to the future. In a process known cynically as ''Rick has a dream,'' a senior executive periodically imposed a fresh strategic vision on Wanderer. Rick's ''dreams'' were often not connected from one time to the next. Rather, they were simply the reactions of this busy executive to unanticipated industry events. As one manager put it: ''We're followers. I would like the industry to be following us.'' This practice was problematic in several ways. Because of the emphasis on reaction, products were typically late in getting launched and were behind the competition. In one case, Wanderer was so far behind competitors in a critical high-end product that managers rushed in a stop-gap product that extended old technology. But it was a poorly designed product that was embarrassingly described by its developers as a ''big head on a little body.'' Reaction also created several ''stuttering'' (i.e., start, stop, restart) projects. As one manager recalled, ''They began Project A in December. Team members were pulled in and then dispersed when the project was stopped in late March. Later, they tried to bring them back in mid-May when the project was picked up again, but some had been assigned to other projects. As a result, new people had to be brought on and there was a big learning curve.'' More insidiously, this practice sapped the interest of Wanderer's managers in developing their own future awareness. They were left to focus on the day-to-day management of projects. As one manager complained, ''We are so focused on today's tactics that sometimes we cannot see the forest for the trees. We're really thinking only one program ahead. We really need to be thinking multiple programs ahead. We're not doing a good job of that.''

One reason that probing the future is associated with successful product portfolios may be that probes give managers options for the future. In high-velocity industries, new futures arrive quickly, making it particularly challenging to predict which of the possible futures will arrive and when. Given this uncertainty, options give managers more possible responses. When the future does arrive, managers are more likely to have something readily available to do and can more quickly adjust. Further, since the probes that we observed are relatively low cost, managers can afford to create more of them, thereby increasing the probability that they will have viable options available.

A wide variety of probes (i.e., alliances, experimental products, futurists, meetings) is also effective because it lowers the probability of being surprised by an unanticipated future. Relying on one type of probe leaves a firm vulnerable to changes in other areas. For example, focusing on the future needs of existing customers can leave firms vulnerable to new entrants with emerging technologies (Christensen and Bower, 1994). Variety in who (e.g., customers, alliance partners, top management team) assesses the outcome of the probe is also valuable. Variety not only in number and types of variations but also in selection mechanisms (i.e., how the outcome of a probe is assessed)

creates particularly effective change (Adner and Levinthal, 1995).

A wide variety of low-cost probes also enhances learning about possible futures. Learning is critical because, while the future is uncertain, it is usually possible to learn something about it, making it easier for managers to anticipate and potentially even create the future. The probes that emerged from our data were effective learning devices for several reasons. Direct, hands-on experience through experimental products and strategic alliances creates ''learning by doing,'' which is a particularly good way to learn, especially compared with vicarious or second-hand learning (Brown, Collins, and Duguid, 1989). ''Small losses'' through experimental products that fail or futurists' predictions that do not come true are among the most powerful learning devices (Sitkin, 1992). Such losses are particularly effective because they capture attention but do not raise defense mechanisms that inhibit learning. A variety of probes creates a mix of direct, hands-on (experimental products and strategic alliances) and indirect (meetings and futurists) experiences. This mix enhances learning because of the interplay among reinforcing sources of knowledge (Lave and Wenger, 1991). Such a triangulation of learning media helps people to learn more effectively. Overall, these tactics combine to enhance learning about the future, allowing managers to be more proactive. In contrast, planning (NewWave, Saturn) is risky, because the future is so hard to predict, while reacting (Wanderer) forces managers constantly to play catch-up.

Evolving from Present to Future

The third and most surprising distinction among the cases is the link between current and future projects. The data revealed that the managers of successful product portfolios (Cruising, Midas, Titan) carefully managed the transition between the present and the future. Much like the pitstop in a car race or the baton pass in track, this transition appeared critical for successful product portfolios. In contrast, at the other firms (NewWave, Wanderer, Saturn), managing the link between past and future projects was usually an afterthought. This haphazard approach created problems such as delays and make-work projects as managers struggled to organize between projects.

How did successful managers move from one project to the next? Instead of leaving transitions to chance or rigidly avoiding transitioning at all, the data revealed that the managers of successful product portfolios created an almost seamless switch from one project to the next. Table 5 describes the two tactics for achieving this switch that emerged from the data: predictable time intervals between successive projects and choreographed transition procedures.

At Midas, a transition was made to a new generation of the core product every 24 months. As the engineering director noted, ''We know we are going to do a new project just about every two years.'' Transition procedures were well choreographed. Transitions were led by technical gurus, who were charged with developing the overall product concept. Their work began while the previous core product was being

Table 5

Evolving from Present to Future

Case	Predictable intervals	Transition procedure
Titan	Yes. 18 months. Regular 18-month synchronization points pace development. "Projects are synchronized through release dates. You have to be ready with the project on the release date."	Yes. Project coordinator leads project transitions. As a version of an existing product is finished, team members transition to working on new projects. New teams are always a mix of old and new team members. A kernel team starts cross-department projects and pulls others onto the team as needed.
Midas	Yes. 24 months. A core product is released every two years, like clockwork. "We know we are going to do a new project just about every 2 years."	Yes. Technical gurus lead transitions with concept development. During concept development for next core product, other developers focus on small, state-of-the-art projects. Once core product concept development is complete, they transition onto the core project, by technical speciality.
Cruising	Yes. 12 to 24 months. 4 and 8 quarter rules of thumb for product replacement. "I have a goal in mind of keeping a platform in the market for 8 quarters and any particular product is about 4 quarters. We're always upgrading about ½ way through the cycle. That's pretty much the same across lines."	Yes. Marketing managers lead transitions to new projects by beginning with product definitions, while engineers are still working on completing current products and shifting them to manufacturing. Just prior to launch, engineers/marketers work together informally and a small core team forms. Others transition onto the new project at "kick off' when the current product goes into volume production.
NewWave	No. Intervals vary.	None. No particular routine. A mad dash, so transitions are not organized. They occur as resources free up. "We threw all the projects up on the board and people kind of said 'I want this and I want that,' and I sat back and said 'OK I'll take what's left'." "We will move the mass of people as they free up and play catch-up on the next products."
Saturn	No. Intervals vary, some projects never transition.	None. There is no routine for transitions. "It's very unstructured, ill-defined. It's all a bit messy, a bit of a shambles." Some projects do not finish . . . two have been going on for 15 years. You have to have a reason for moving people (off a project)."
Wanderer	No. Intervals vary.	None. There is no routine for transitions. When new projects arise, often without warning, then managers negotiate with each other to try to figure out how to staff the project. There is a lull while resources are sorted out and then the project begins. "People are anxious to get started. Right now things are a little slow. We are waiting for people to get off other projects, we are having meetings. We know the end point, but people haven't been able to get going yet."

passed to manufacturing. During the six-month period while the gurus completed the concept development, the remaining engineers worked on small, state-of-the-art projects. At the end of six months, these engineers then transitioned back, according to technical speciality, onto the next generation of the core product.

At Cruising, a transition from one product to the next occurred, like clockwork, every 12 months within a product line. A major platform transition occurred every 24 months. As the VP of marketing explained, "I have a goal in mind of keeping a product in the market for 8 quarters. . . . That is pretty much the same across product lines." In addition to making timing predictable, a transition procedure made switching from one project to the next a familiar routine at Cruising. Marketing managers led the project transitions.

They began work on the definitions of the next products for each line while the engineers were still completing the current product and shifting it into manufacturing. Just prior to the launch of the current product, engineers began interacting informally with marketers at a concept level. As one marketing manager described, ''What we will do is grab an engineering manager who is really working on something else and we will say, 'Well what do you think about these kinds of ideas?' '' Simultaneously, a small core team was also formed that carried the project through product concept. These teams consisted of an engineering manager for the hardware design, a marketing manager, and a manufacturing manager. When the current product entered volume manufacturing, the new project was formally begun at the engineering ''kick off'' meeting. At this point, the rest of the team from the old project joined the new project.

At Titan, transitions were timed for every 18 months. While old projects were being wound down, project coordinators led the transitions to the new projects. The new teams always consisted of a combination of old and new team members. In this way, current employees who understood old versions of the product shared that knowledge with new team members. At the same time, new members linked existing project teams to fresh ideas.

Although there were transition routines in the three successful firms, the transitions were not completely rigid. Rather, managers frequently reassessed their transitions, fine-tuning their processes. Cruising managers were considering shortening their project intervals to nine months to pick up the pace against competitors. Titan managers had recently elaborated their transition procedures to match their increasingly broad product line.

Finally, what was particularly striking among these three firms was what happened in the few instances in which predictable time intervals and transition routines were not followed. Midas managers described how they had once interrupted their normal 24-month interval to release an extra product. The rationale was to insert an extra product to meet a competitive threat, but because this extra product tied up substantial resources, the critical core product was delayed. Moreover, developers and salespeople became confused about product distinctions. Ultimately, core product sales suffered. As one manager described it, ''In the development of the previous core product we did an interim product. In the end there was a lot of fragmentation of understanding on how that core product worked. It was difficult to sell.'' Managers vowed never again to disrupt regular product intervals.

In contrast, the less-successful product portfolios (New-Wave, Wanderer, Saturn) had neither predictable intervals nor choreographed transition procedures. Projects lasted for varying times and ended unexpectedly. The transition procedures were also not defined as they were at the firms with successful product portfolios. For the most part, the transitions at these firms were managed haphazardly. As old projects wound down, developers attempted to land new project assignments on their own. One manager described

this process as ''going out into the parking lot for three months to find a new job.'' When new projects arose, managers negotiated with each other to figure out how to staff the project. Whoever happened to be free when a project came up received an assignment. One engineer described such an assignment. He recalled, ''I was assigned to be working on another project, but it got canceled, so I was free. . . . Since I was available, the management position was offered to me.''

The data indicate that these haphazard transition procedures were problematic. The unexpected endings sometimes caught managers with too few people, which delayed projects. An engineering manager at Wanderer described such a project: ''I have absolutely no way to staff it, and I have to figure out how to staff it and it is about 10 people worth of work. It is my responsibility . . . to put together the whole project plan—the headcount, the dollars, and everything else.'' This project was eventually late.

At other times, too many staff members were available, and managers took on make-work projects. A manager described one of these projects: ''This project does not strategically fit. . . . I would rather put those resources on doing something for our business.'' Ironically, this manager eventually needed some of the people who were assigned to the make-work project for an important new one, but she had to wait until these people were free.

In contrast to these haphazard transitions, two Saturn projects never had transitions. Although there were occasional product releases, these projects were never reconsidered, restaffed, or reprioritized. Managers claimed that there was no formal way to stop them, and developers became rigidly locked into these seemingly endless projects. As one manager complained, ''Some projects do not finish . . . two have been going on for 15 years.''

One reason why the transition between present and future products relates to successful product portfolios is that it is easy for the present and the future to become decoupled. While some managers are busy focusing on developing current products and others are creating a sense of the future, the two time perspectives often drift apart. Transition procedures put the two together in an efficient way that coordinates a complex task involving many people and resources. Just as a routinized pitstop in car racing quickly brings competitors back to the race so, too, may a choreographed transition procedure get developers back to creating products quickly and maintaining their flow through time.

A second reason may be that, when specific behaviors are combined with predictable time intervals, a rhythm is created. Rhythm, which depends on a consistent ritual of uniformly recurring behaviors, enables people to pace their work, synchronize their energies with one another, and ultimately get into a ''flow.'' They become focused, efficient, and even confident about the task at hand. Like a tennis player in the rhythm of a match or a skier in the rhythm of a mogul field, transitions at predictable times are likely to create a focusing flow of attention that enhances performance. In addition, predictable transitions create a relentless

sense of urgency that keeps people driven to maintain the pace.

A third reason may be that the rhythm created by the transition processes may become entrained to the rhythm of the environment. Entrainment (Ancona and Chong, 1994), a biological concept, refers to the linking of the periodicity of two related rhythmic processes. That is, related rhythmic processes tend to synchronize with one another over time. For example, human body rhythms synchronize with night and day cycles. Similarly, rhythmic product innovation may become entrained with market cycles, allowing managers to get in step with the market, hit market windows on target again and again, and perhaps even create the competitive tempo for the rest of the industry.

Finally, our work on transitions relates to Gersick's compelling research (Gersick, 1988, 1989, 1994). Her focus is on single projects and the midpoint transition that occurs between launch and deadline. Our focus is on multiple-product innovation and the continuous change that it creates. The common theme is time-paced evolution, in which change is keyed to the passage of time, not the occurrence of particular events. Time-paced evolution is powerful in fast-changing settings because it creates a regular, explicit opportunity to reassess actions. This is vital in uncertain settings because it limits excessive commitment to obsolete courses of action (Gersick, 1994; Okhuysen and Eisenhardt, 1997). Further, the rhythmic transitions that we observed reveal how time-paced change may entrain organizations to their environment and, more strikingly, permit them proactively to set the tempo of their industries. In contrast, event-paced change, which is the dominant perspective in traditional thinking (Tyre et al., 1996), emphasizes reactive change in response to failure. Taken together, Gersick's work and our own offer a more proactive view of change than the event-paced one and suggest that time-paced transitions may be central to understanding how organizations continuously change.

DISCUSSION

This paper explores organizations that can continuously change. In particular, the focus is on multiple-product innovation as firms regularly shift in competitive, high-velocity settings. As noted at the outset, this kind of change is increasingly crucial for firms (see also Miller and Chen, 1994; D'Aveni, 1994; Galunic and Eisenhardt, 1996) but is rarely discussed in the literature.

There are three key findings. Managers with successful multiple-product innovation improvise current projects by combining clear responsibilities and priorities with extensive communication and freedom. They probe into the future with a variety of low-cost experiments. Finally, they link current products to future ones using predictable product intervals and choreographed transition procedures. Table 6 summarizes the supporting data.

We also measured the pre- and post-study performance of the firms. Although firm performance is affected by many factors and confidentiality agreements limit what we can

Table 6

Summary of Data Analysis

Case	Performance				Organization		
	Strategic profile	Product portfolio	SBU Study*	SBU Post-study†	Current	Future	Transition
Titan	Mainframe to client/server	High	*Rising Star* Moderately successful, regional firm. Ranking: 1 of 4 Rating: 8	*Market Leader* Worldwide market leader, successfully entering new markets. Revenue growth 50%, up from 30%. Profits rising faster than sales. "They're giving us hell." (*competitor*) "Titan is on top." (*major publication*)	Improvisational	Probing	Choreographed
Midas	Technology pioneer	High	*Market Leader* Perennial market leader. Ranking: 1 of 5 Rating: 8	*Market Leader* Perennial market leader. Revenue growth over 15%. Profitability steady, highest in the industry. "They set the standard." (*competitor*)	Improvisational	Probing	Choreographed
Cruising	Component integrator	High	*Turnaround* Also-ran firm in the midst of a turnaround. Ranking: 2 of 6 Rating: 8	*Market Leader* Market leader in high-competition segment. Revenue growth up 20%. Profitability steady despite price cutting in the segment. "Such a rapid and dramatic turnaround was not an easy task. Cruising has been the big winner. (*major publication*)	Improvisational	Probing	Choreographed
NewWave	Technology pioneer	Low	*Rising Star* High growth firm. Ranking: 2 of 6 Rating: 9	*Disappointment* Revenue growth well below expectations. Profitability down 50%, lost money. "They're behind their best dreams of how they would take off." (*analyst*)	Unstructured	Planned	Haphazard
Saturn	Mainframe to client/server	Low	*Mediocre* Mid-pack firm. Ranking: 3 of 5 Rating: 5.5	*Mediocre* Mid-pack firm, struggling to enter new markets. Revenue growth flat. Profitability flat. "We're an 8 or 9 in the old products, but much worse in the new." (*self*)	Structured	Planned	Haphazard

Table 6 (*continued*)

Case	Performance				Organization		
	Strategic Profile	Product Portfolio	SBU Study*	SBU Post-study†	Current	Future	Transition
Wanderer	Component integrator	Low	*Mediocre* Mid-pack firm. Rank: 3 of 5 Rating: 7	*Mediocre* Sacrificed profits for growth, but could not catch leaders. Revenue growth up 7%. Profits down 6%. "We have been reasonably successful. But then looking at (competitors) which are even more successful than we are . . . should that be the place where we put all our investments?" (*self*)	Structured	Reactive	Mostly haphazard, but several never transition

* Rankings in this column are the average rankings by firm informants of SBU performance in its segment; the ratings are the average ratings by firm informants of SBU performance on a 0–10-point scale.
† Post-study data from secondary and firm sources.

reveal, the data do indicate a positive link between successful product portfolios and post-study firm performance. For example, prior to our study, Midas dominated its market for a decade. Since our study, this firm has continued its domination and become a widely cited managerial exemplar. Titan was a long-established, regional firm that was taking off as our study began. Post-study, Titan has become the worldwide leader in its industry segment. Cruising was a flagging performer with falling market share and profits in the two years before our study. Post-study, Cruising rebounded to become the leader in a hotly contested industry segment. In contrast, Saturn and Wanderer were mediocre performers, while NewWave has not lived up to expectations. Overall, these results suggest that these multiple-product innovation practices form a core capability that is central to organizational success.[1]

Nature of Continuous Innovation and Change

Our work ties in closely to strategy and organization theory. In these domains, change is traditionally modeled as a punctuated equilibrium process in which long periods of incremental movement are interrupted by brief periods of cataclysmic adjustment (Miller and Friesen, 1984; Tushman and Romanelli, 1985). In innovation, this has meant that invention has often been categorized as radical or incremental (e.g., Tushman and Anderson, 1986; Tripsas, 1997). In organizational change more broadly, this has meant a focus on change as rare, disruptive, and often ill-advised reorientation (Hannan and Freeman, 1984; Romanelli and Tushman, 1994). Radical processes have been the focus of interest.

This research began as an exploration of the less-studied incremental processes. The setting was the 1993–1995 computer industry, in which there were numerous innovations surrounding the Pentium processor, multimedia,

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The three "middle" performing cases provide further empirical support. Current projects were organized using the same tactics as the most successful firms, the future was only weakly probed, and transitions were not choreographed at all.

Internet, and convergence with telephony and consumer electronics. The rate and scale of innovation within the industry and among our firms was such that the term ''incremental'' seemed, in retrospect, stretched. Yet it was not radical innovation such as DNA cloning, either. As one manager observed, ''I don't know if I'd call this innovation a breakthrough, but it's probably somewhere between that and next generation.'' Similarly, managers described ''constantly reinventing'' themselves. This too seemed more than incremental (i.e., unlike replacing a top manager here and there) but also not the massive, rare, and risky change of the organizational and strategy literatures. And so we realized that we were probably looking at a third kind of process that is neither incremental nor radical and that does not fit the punctuated equilibrium model and its critical ''deep structure'' assumption (Gersick, 1991).

Two fundamental organizational characteristics emerge from this research that appear to be particularly related to this continuous change. One is what we term ''semistructures.'' By semistructures we mean organizations in which some features are prescribed or determined (e.g., responsibilities, project priorities, time intervals between projects), but other aspects are not. Semistructures exhibit partial order, and they lie between the extremes of very rigid and highly chaotic organization.

For the organizations with successful product portfolios, we found that semistructures emerged in each time frame. For example, the effective management of current projects lay between very structured, mechanistic organization, in which bureaucratic procedures were tightly determined, and very unstructured, organic organization, in which there were few, if any, rules, responsibilities, or procedures. For the successful portfolios, some responsibilities, meetings, and priorities were set, but the actual design process was almost completely unfettered. For the future, the managers of these more successful portfolios probed using tactics such as futurists, experimental products, and strategic alliances. They neither rigidly planned nor chaotically reacted. And they executed choreographed transitions from current projects to future ones that were neither haphazard nor rigid connections between present and future. The managers with successful product portfolios thus balanced on the edge between the extreme structures used by managers with less-successful portfolios.

Several managers offered unsolicited descriptions of semistructures to us. They emphasized the challenge of staying poised on this edge between extreme structures. Managers at Midas described how they operated at the edge of too little structure. One related, ''We do things on the fly. . . . I've done some things at IBM and other companies where there is a very structured environment—these companies are failing and we are leading the way. I'm not comfortable with the lack of structure, but I hesitate to mess with what is working. . . . We've gotten away with it so far.'' At Cruising, managers related their tendency to slip into too much structure. One told us, ''It is real easy for the division to sort of just put its head down in blinders and just go run

forward and implement . . . we've got to force ourselves to step back."

Others have also begun to note this same semistructure phenomenon. Uzzi (1997) described how firms that are only partially embedded in alliance networks within the New York garment industry are more adaptive than firms that are either more or less embedded. Moorman and Miner (1996), in their theoretical work on improvisation, observed the relationship between semistructures and change in a wide variety of contexts, including the arts, the military, and manufacturing. At the industry level of analysis, Garud and Jain (1996) tied partial industry standards to high rates of innovation. Perhaps closest to our research is work on complexity theory (Gell-Mann, 1994; Kauffman, 1995). Like organizations, complex systems have large numbers of independent yet interacting actors. Rather than ever reaching a stable equilibrium, the most adaptive of these complex systems (e.g., intertidal zones) keep changing continuously by remaining at the poetically termed "edge of chaos" that exists between order and disorder. By staying in this intermediate zone, these systems never quite settle into a stable equilibrium but never quite fall apart. Rather, these systems, which stay constantly poised between order and disorder, exhibit the most prolific, complex, and continuous change (Waldrop, 1992; Kelly, 1994; Kauffman, 1995).

Although speculative, our underlying argument is that change readily occurs because semistructures are sufficiently rigid so that change can be organized to happen, but not so rigid that it cannot occur. Too little structure makes it difficult to coordinate change. Too much structure makes it hard to move. Finally, sustaining this semistructured state is challenging because it is a dissipative equilibrium and so requires constant managerial vigilance to avoid slipping into pure chaos or pure structure. If future research validates these observations, the existence of semistructures could be an essential insight into frequently changing organizations.

The second characteristic of organizations that can continuously change is what we term "links in time": the explicit organizational practices that address past, present, and future time horizons and the transitions between them. What we observed was that managers with successful portfolios created such links in time. They explicitly focused their attention on managing current projects. At the same time, they also developed a sense of where to go next through future probes. And they organized how to get from the present to the future through choreographed transitions. Related was their proactive view of change. They saw themselves as "aggressive," "opportunistic," and "striking first." Theirs was a time-paced, not an event-paced, approach to change.

In contrast, the managers of less-successful portfolios lacked links in time. Without an up-to-date view of the future, they could not effectively anticipate it. This left them behind the competition. Without stitching current projects to future ones, they fell further behind. Rather than creating links in time, these managers operated in the present, struggling to finish current projects with little sense of the future or how

to get there. Transitions were chaotic and the future was a surprise. Change became labored and reactive. Managers saw themselves as ''following,'' ''reacting,'' and ''drifting.''

A few others have also begun to identify time as essential to change processes. Eisenhardt (1989b) found that the CEOs making fast decisions retained a simultaneous awareness of the present and the future. Arie Lewin has observed that Toyota has innovated more continuously than other Japanese auto firms by simultaneously attending to the present and future.[2] Moorman and Miner (1996) noted the importance of the past for change in the form of declarative and procedural memories. Closely related, Gersick (1994) described how a new venture remained adaptive through time-paced change. The CEO created a longitudinal path of successive milestones spaced through time. As described earlier, these milestones served as triggers to check current progress, reassess the future, and readjust the path as needed. Weick (1995) sketched how songs create longitudinal threads that carry musical performance through time.

Our argument is that organizational change readily occurs because links in time create the direction, continuity, and tempo of change. Attention to the present and future gives direction to change. Without a grasp of the present, it is difficult to have a base from which to change. Without a sense of the future, change becomes inefficient, aimless, and even random (Holland, 1975). Transitions provide the continuity and tempo of change. Transitions keep organizations relentlessly and sometimes even rhythmically moving from the past to the present and forward into the future. If subsequent research supports these ideas, the existence of links in time may offer a second insight into how organizations continuously change.

Origins of Core Capabilities

Our work also ties closely to strategy research on core capabilities. Although our data and confidentiality agreements do not permit us to provide detailed histories of why some managers created continuous change while others did not, we can offer some insights. In particular, two firms fortuitously provide a window into how some managers are able to achieve this core capability, while others failed.

Prior to the study, both Cruising and Saturn had substantial problems with multiple-product innovation, which their managers were attempting to overcome. Cruising succeeded. Managers described to us, in some detail, how they altered their processes for developing products. They began by focusing on current projects and getting rid of their lock-step and bureaucratic process, increasing communication, and adding project-level responsibilities. With that accomplished, they concentrated on developing their sense of the future through tactics such as futurists and alliances with leading-edge technology providers. Lastly, they turned to the transition between current and future projects, ultimately settling on a 4/8 quarter rhythm and a marketing-led transition. Ultimately, Cruising became the market leader. In contrast, Saturn managers faced with the same problem began with the future. They described developing a future strategy and then attempting to execute it. But, as their

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Arie Lewin, personal communication, 1996.

managers told us, they kept getting bogged down with problems in their current projects and were ultimately unable to revisit or implement their vision of the future.

Although speculative, this comparison between Cruising and Saturn suggests three further insights about continuously changing organizations and the properties of core capabilities. One is that such organizations must be grown, not assembled at a single point in time. For example, Cruising managers did not instantly create their organization but, rather, "grew" it over a period of several years. They developed and stabilized some pieces of the process, and then moved on to the next. Second, Cruising managers relied on particular "sequenced steps" of implementation. That is, they started with the current time frame, then tackled the future, and finished with the linkages across time. In contrast, Saturn managers began with the future but were consistently waylaid by problems with developing current products and maintaining current revenues. They never really got to the future. To use a sports analogy, Cruising managers perfected their moves and then developed a game plan, while Saturn managers attempted a game plan before they had the moves.[3] Third, sequencing and growth contribute to the inimitability of this important capability (see also Peteraf, 1993). In particular, sequencing and growth help to explain why the managers with weak portfolios could not easily imitate the "best practices" of others. Imitating these practices requires not only knowing what the critical processes are (a difficult task from outside of the organization) but also the sequence in which they need to be adopted. So would-be imitators need both a "snapshot" of the organizational practices at a single point in time and the "recipe" of sequenced steps to build a continuously changing organization. This suggests that inimitability is determined not only by tacitness of the capability (Peteraf, 1993) but also by a complex, time-sequenced implementation process such as we have here.

"Bad Management" and Links to Contingency Thinking

Finally, were the poor product portfolios at Saturn, Wanderer, and NewWave simply the result of "bad management"? While we certainly observed a number of practices that many would call bad management, we think that this explanation is too simplistic. These managers were often engaging in managerial practices that would have been reasonable and possibly even effective in other settings. For example, at Wanderer, the lock-step procedures for managing current products have been described as exemplar by other authors and were quite successful in Wanderer's sister SBUs, where the marketplace evolves more incrementally. Unfortunately, they emerged as ill-suited to the fast-moving industry in which Wanderer competes. The strategic planning at Saturn was done well, but the contemporary computer industry is a poor setting for extensive planning. At NewWave, managers created a very unstructured organization that might have been successful for radical invention in settings without competitive pressure. Indeed, one NewWave manager poignantly told us, "the group is a giant petri dish that we have all been thrown into with an agenda to grow some stuff. . . . unfortunately we also have to produce

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The three "middle" performing cases provide further empirical support for sequenced steps as well (see footnote 1)

results." So, rather than attributing lack of success to bad management (although there probably was some), a more useful observation is that these managers were engaging in practices that fit closely with the punctuated equilibrium perspective, but did *not* mesh with the demands of their very competitive, high-velocity settings.

CONCLUSION

This paper explores continuously changing organizations in the context of multiple-product innovation. The rationale is that organization and strategy research have become locked into the punctuated equilibrium view that emphasizes radical change at the expense of understanding the kind of rapid, continuous change that is in the foreground of many managers' experience. Gersick (1994: 11) captured our spirit in suggesting that research should focus "on when and how organizations steer successfully through changing environments."

Successful multiple-product innovation involves improvisation of current projects through limited structures and real-time communication, experimentation into the future with a wide variety of low-cost probes, and rhythmically choreographed transitions from present to future. These practices form a core capability for creating frequent, relentless, and endemic change that is associated with the success of firms in high-velocity, competitive settings.

At a more fundamental level, the paper suggests a paradigm that combines field insights with complexity theory and time-paced evolution to describe organizations that are much more dynamic than they are assumed to be in traditional organization and strategy theories. Continuously changing organizations are likely to be complex adaptive systems with semistructures that poise the organization on the edge of order and chaos and links in time that force simultaneous attention and linkage among past, present, and future. These organizations seem to grow over time through a series of sequenced steps, and they are associated with success in highly competitive, high-velocity environments. If these inductive insights survive empirical test, then they will extend our theories beyond a static conception of organizations and the punctuated equilibrium view of change to a paradigm that emphasizes dynamic organizations and continuous change and that is a more realistic description of how many firms actually compete.

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