ORGANIZATION SCIENCE
Vol. 3, No. 2, May 1992
Printed in U.S.A.

INTERPRETIVE BARRIERS TO SUCCESSFUL PRODUCT INNOVATION IN LARGE FIRMS*

DEBORAH DOUGHERTY

Management Department, The Wharton School, University of Pennsylvania, 2000 Steinberg-Dietrich, Philadelphia, Pennsylvania 19104-6370

The development of commercially viable new products requires that technological and market possibilities are linked effectively in the product's design. Innovators in large firms have persistent problems with such linking, however. This research examines these problems by focusing on the shared interpretive schemes people use to make sense of product innovation. Two interpretive schemes are found to inhibit development of technology-market knowledge: departmental thought worlds and organizational product routines. The paper describes in some depth differences among the thought worlds which keep innovators from synthesizing their expertise. The paper also details how organizational routines exacerbate problems with learning, and how successful innovators overcome both interpretive barriers. The main implication of the study is that to improve innovation in large firms it is necessary to deal explicitly with the interpretive barriers described here. Suggestions for practice and research are offered.
(INNOVATION; NEW PRODUCTS; INTERDEPARTMENTAL COLLABORATION; INTERPRETATION)

Successful product innovation is vital to many firms. This paper builds on three findings in the literature to explore the product innovation process in large firms. The first finding is that the commercial success of a new product depends on how well the product's design meets customers' needs (Rothwell et al. 1974; Lilien and Yoon 1988). An effective design requires that technological possibilities for a product are linked with market possibilities, e.g., who are the users? what will they use the product for? The second finding is that collaboration among the technical, marketing, manufacturing, and sales departments contributes to a new product's success (Bonnet 1986; Dean and Susman 1989). The third finding is that product innovators often do not link technological and market issues, and often do not collaborate across departments (Cooper and Kleinschmidt 1986; Souder 1987).

This research seeks to explain why innovators fail to develop a comprehensive appreciation of their product in its market. Three implications are developed from the findings. First, collaboration is necessary to technology-market linking, which means that collaboration enhances the product's design along with improving the execution of the development process. Second, the styles in which people organize their thinking and action about innovation—their "interpretive schemes"—are major barriers to linking and collaboration. Like "culture," such schemes provide shared assumptions about reality, identify relevant issues, and help people make sense of those issues (Daft and Weick 1984; Bartunek 1984). In the case of product innovation, two interpretive schemes become interpretive barriers: (1) departments are like different "thought worlds," each focusing on different aspects of technology-market knowledge, and making different sense of the total; and (2) organizational routines separate rather than coordinate the thought worlds, further constraining joint learning. The third implication is that correcting the innovation problems caused by these interpretive barriers requires cultural solutions, not only structural ones.

*Accepted by Richard L. Daft; received August 1989. This paper has been with the author for two revisions.

1047-7039/92/0302/0179/$01.25

OPCO—An Example

Before defining terms and then explaining how these implications arise, excerpts from a case in the research are presented to illustrate thought worlds and routines, and to introduce the research. The data management division of OPCO, a communications company, decided to develop and sell a software accounting system that would process credit card transactions over their data network. They purchased a start-up firm with a system under development to enter the business quickly, and, after several months additional work at OPCO, the service was introduced to the market. The system did not operate properly, however, and was cancelled. As suggested by the quotes below, the innovation encountered many problems. The quotes also suggest that the participants interpret issues with unique departmental perspectives. The business manager sees no need to talk with customers since he considers the market opportunity to be obvious. He feels, however, that they failed to position the product properly against competitors:

> [Interviewer: Did you talk to customers?] No, because we knew that this was needed. We could see some competitors getting into the business. ... We could see that this was logical for us to do, so we decided to go. ... Had we done some market research and defined needs more carefully, and figured out the dozens of pieces we would need for a full system, we'd be positioned with a much better strategy.

The technical director sees no "market" problems at all with the effort. He describes design problems, however, that perhaps could have been resolved had a thorough analysis of users and how they operate been carried out:

> There were no market problems with this product. ... Our mistake was we didn't understand the application in total. ... We had a difficult time trying to figure out the relationships between us here at the operating level and the retail establishments, and the relationships between them and their banks and credit card clearing houses. ... There were a lot of players involved, which is different from (our regular product), where we interface with one customer at a time. It looks very nice theoretically, but the more relationships there are, the more complex the recovery.

The sales support person downplays general positioning and technological design to blame instead their failure to specify which users in the market could best use the product:

> I have never seen a definition for this service. There are no criteria on what makes a good or bad customer for this product. ... One person here had a pretty good understanding of what kind of customer would benefit from a system like this. More people here should have known. We needed a brain transplant.

The innovators also followed established routines at OPCO Data to develop and launch this new service. These routines included project teams and matrices, structures that are recommended for innovation (e.g., Tushman and Nadler 1986), but all participants note how they did not work. The routines did not synthesize components of the innovation itself nor relevant knowledge, and they squashed interaction:

> We were not successful in fully integrating the new business within the organization. A new product is unique—it has different distribution, different billing, a myriad of things have to work out well. It is difficult for a small organization [referring to the business unit] to handle all these issues, so things fall apart. We didn't see the pitfalls (business manager).
>
> At OPCO we tend to categorize people into roles, and give people only what they need to know. ... There are little shadings of meaning that get lost in the requirements statement from marketing (technical director).

> They [from the small company] were a very tight group, and they all talked to one another all the time. But when we brought them here they were dispersed into our matrix... (sales support).

In hindsight at least, these innovators knew that they should link technological and market issues, but they did not. This case along with 17 others is analyzed to explain why.

Conceptual Background

Components of Technology-Market Linking

To understand problems with technology-market linking, it is first necessary to understand what that linking comprises. Research suggests that technology-market linking has a process and a content component. On the process side, linking involves the construction of new knowledge about the product and the market. Henderson and Clark (1990) suggest that nonroutine innovations require new "architectures," in which innovators break out of existing procedures and know-how and reconfigure components of design and procedure into a new framework. Freeman (1982) describes product innovation as a "complex coupling" between market needs and technologies over time. Linking technological and market possibilities is challenging, because choices must be made among multiple design options, each with different outcomes. At the same time the market may be new so it is difficult to determine who the most likely customers are and what they actually need (Clark 1985). Developing innovative products is thus a process of double loop learning (Argyris and Schon 1978), in which new insights are incorporated and the premises themselves are reconsidered.

On the content side, linking means that a complex array of specific insights must be gathered and brought together. Dougherty (1990) finds that successful new product developers had more insight into users' applications, technological trends, distribution systems, and market segments. Urban and von Hippel (1988) suggest that developers determine key trends in both the technology and market areas, and then search for "lead users" who can identify viable design specifications. According to Bonnet (1986), integration of R & D and marketing facilitates both the assessment of commercial viability and the optimization of design characteristics. Requisite knowledge for new products is thus multi-faceted, multi-leveled, and detailed.

Organizational Barriers to Technology-Market Linking

To understand why people do not link technology and market issues effectively, it helps to understand what prevents them from frame-breaking learning, and from gathering and connecting diverse insights. Organization research contains numerous references to interpretive schemes at the department and organization levels which may intervene in these necessary innovation processes. Departments can develop different perspectives through which they might separate rather than combine information, including cognitive orientations such as goals, time frames, and formality (Lawrence and Lorsch 1967), languages (Tushman 1978), perceptions (Dearborn and Simon 1958), occupational cultures (Van Maanen and Barley 1984), or power (Riley 1983).

At the organizational level, firms create "programs" (March and Simon 1958) or "routines" (Nelson and Winter 1982) which can inhibit new product development. According to Nelson and Winter, routines are regular and predictable behavior patterns, which, first, comprise the organizational memory. When the firm is in a state of routine operation, each person knows his or her job, and there is no need to know others' jobs. Second, routines represent a truce for intra-organizational conflict,

which, as Perrow (1986) notes, binds the firm in a network of practices that are difficult to alter. Third, routines are standards which managers try to keep from changing.

Few organization studies have connected departmental differences and organizational routines directly to new product development and technology-market linking, however. Lawrence and Lorsch (1967)'s often cited insights concern ongoing businesses, not discrete new products. Several studies suggest that their cognitive differences do not differentiate departments for new product development (Harrison 1980; Gupta, Raj and Wilemon 1986). And, while organization theorists may refer to knowledge development (Galbraith 1982; Kanter 1983), most concentrate on structures and cultures for innovativeness in general, not for product innovation in particular.

Toward a More Complete Model

Fleck (1979) was the first to apply differences in interpretive schemes to innovation (or at least to scientific discovery—Douglas 1987). His views suggest how to integrate the insights outlined above into a more complete understanding of the organizational and interpretive processes underlying product innovation and technology-market linking. Fleck emphasizes the social basis of cognition, and adds that innovations often are epistemologically unsolvable by any one person. They require insights from a variety of specialties, called "thought collectives" or "thought worlds" as Douglas (1987) proposes to retranslate the term. A thought world is a community of persons engaged in a certain domain of activity who have a shared understanding about that activity. Microbiologists, plumbers, opera buffs, and organizational departments all can be viewed as thought worlds.

Departmental Thought Worlds. Two aspects of thought worlds are relevant to product innovation: their "fund of knowledge"—what they know, and their "systems of meaning"—or how they know. According to Fleck what is already known influences the method and content of cognition. Thought worlds with different funds of knowledge cannot easily share ideas, and may view one another's central issues as esoteric, if not meaningless. A thought world also evolves an internally shared system of meaning which provides a "readiness for directed perception" based on common procedures, judgements, and methods. These systems of meaning produce an "intrinsic harmony" for the thought world, so ideas that do not fit may be reconfigured or rejected outright.

For new product development, one could infer that departmental thought worlds would selectively filter information and insights. Because of specialization, a certain thought world is likely to best understand certain issues, but also to ignore information that may be equally essential to the total task. Their intrinsic harmony would also reduce the possibility for creative joint learning, since members of a department may think that they already know everything.

Organizational Routines. Fleck does not deal with organizations per se, but argues that the collective action necessary to innovation is motivated by pressure from the social context. "Collective work proper" (1979, p. 99) is different from additive work, as when people come together to lift a large rock. Rather, it refers to "the coming into existence of a special form, like a soccer match, conversation, or orchestra." This new social form alters the thought worlds' existing readiness for directed perception to allow new possibilities for discovery and new facts. Fleck studied the development of the Wassermann test for syphilis, and argues that the disease was undefined for 400 years in part because there were no means for collective action. Different groups such as astrologers, priests, pharmacists, and physicians operated with their own

theories. If it were not for the "insistent clamor of public opinion for a blood test" (1979, p. 77), Wassermann would never have gathered the collective experience necessary to develop a test. Wassermann began with the incorrect immunology perspective that syphilis is caused by a virus. But because of external pressure, his persistence coupled with developments from chemistry, medicine, and laboratory thought worlds to uncover the actual cause of the disease (a spirochete). A new social form among these diverse groups emerged, and they *collectively* produced a test for the disease.

Fleck's dynamics can be combined with Nelson and Winter's (1982) routines to suggest that the organizational context affects the thought world's capacity to collaborate, inhibits the development of new knowledge, and keeps innovators from creating a new social form.

Research Questions. This study will explore these dynamics by addressing the following questions: (1) What are the different funds of knowledge and systems of meaning for new products in the departmental thought worlds, and how do they affect product innovation? (2) What are the routines that inhibit product innovation, and how do they affect collective action among the thought worlds?

Methods

Data regarding 18 new product efforts in five firms were collected by interviewing 80 people from different departments who worked on these products. Schall's (1983) multi-method analysis suggests that such interviews are a valid means to assess departmental interpretive differences. An embedded, multiple case design was used (Yin 1989) in order to consider the effects of organization and product success and failure on the findings (Bailyn 1977).

Organizations and Products

Two of the firms are in the computer/communications industries (OPCO and SALECO) and three are in the chemical materials industries (TECHCO, COMPCO, and PRODCO). All generate over $1 billion annually, employ over 20,000 people, and are over 35 years old. The criteria used to select products for the study are: (1) they incorporated new or unfamiliar technology for the firm and/or were marketed to new or unfamiliar users; (2) the products were almost or already introduced to the market, to eliminate variance due to development stage; and (3) some products were commercially successful, and some were failures. "Success" was defined as generating at least as much profit as planned and "failure" as cancellation after introduction.

Data were collected in two stages. First, eleven cases were studied at TECHCO and OPCO. At TECHCO, a manager in each of the six product groups in its industrial division was asked to suggest a product from his group that met the criteria. One said he was too busy, so five products were selected. At OPCO, managers directed me to their voice venture (one product), and their data division, where five more cases were studied. Only one of these eleven cases was successful as defined above, however, and even though six were in the market their profitability was still uncertain. A second stage of data collection was undertaken to add more successful cases. SALECO, COMPCO, and PRODCO were asked to identify one success already introduced, and one failure that had been introduced but cancelled. At COMPCO, people also described an uncertain product, and this was included.

Seventeen products were in the market, so all but one were in the post-introductory stage when people were interviewed. The products are described in Appendix A. In addition to success and failure, a new category labeled "uncertain" was made for

TABLE 1
Comparing Product Innovation Cases by Success Status

	Successful (4 cases)	Uncertain (7 cases)	Failed** (6 cases)
Comparisons			
Average Time in Development Before Introduction in Months (1)	31	26	23
Average Time After Introduction in Months	42	19	18
Unfamiliarity to Firm (% of cases): (2)			
% new technology	50%	63%	50%
% new manufacture	75	88	83
% new market segments	50	75	50
% new applications	100	88	67
% new distribution	100	100	67

**Successful = already introduced and meeting/exceeding expectations;
Uncertain = not meeting expectations but not cancelled (7 cases already introduced, 1 still in development);
Failed = already introduced and subsequently cancelled.
(1) The starting time is when the particular product began to be developed, not when underlying technologies were invented.
(2) If 2 of the participants said that the product was unfamiliar to the firm in this area, it was coded as unfamiliar.

the seven cases that were in the market but not generating profits as expected. Table 1 compares the successful, uncertain, and failed cases. The successful cases were in development longer on the average, but this difference is because of one case which took over five years. The uncertain cases, however, have been out on the market for less time than the successes. Post-introductory time may enhance success, since some of the uncertain cases will eventually become successful, while some will be cancelled. The success or failure might depend on the case's unfamiliarity to the firm. To compare cases on unfamiliarity, if two people said that the product was unfamiliar in any of the five areas noted, it was coded as such. As can be seen in Table 1, there is no difference in unfamiliarity by success status.

The People and the Interviews

At least two people who worked on each product were interviewed, and most were still working on the product. All were operational and middle level managers, and only six had less than four years experience with the firm. All interviews followed the same protocol: describe the product; outline your role; tell the story of the product; and describe customers, technology, and working relationships with others. The interviews were structured around these general questions, but unstructured regarding what the person chose to emphasize. The interviews lasted from about one hour to over two hours. Notes were taken and filled in as soon as possible afterwards. Table 2 summarizes the people interviewed by product, department, and firm.

Retrospective interviews have two important sources of potential distortion: memory failure and attribution bias. To guard against memory failure, people were asked regularly for dates and names to keep them grounded in particulars, and one person was reinterviewed briefly to clarify any conflicts in reported events. In addition, archival data were reviewed for three of the products, and no conflicts with people's stories were found. To check for attribution bias, the uncertain cases were compared

TABLE 2
Number of People Interviewed by Department, Company, and Product Case

Company and Case:	Technical	Field	Manufacturing	Planners	Total
TECHCO (chemicals)					
*F Battery	1			1	2
U CRT Device	3	1	1		5
U Video Device	2	1			3
U Medical System	2	1		1	4
S Film Cover		1	2		3
Others		1		2	3
OPCO (communications)					
F Accounting System	2	1		1	4
F Document System	2			2	4
U Software System	1			2	3
U Text System	4	1	1	2	8
U Voice System	1	5	1	1	8
U Transmit System	1			2	3
Others				3	3
SALECO (computers)					
F System II	2		3	2	7
S System I	1	1		2	4
Others				2	2
COMPCO (chemicals)					
F Hardpoly	2	2		1	5
U Stretchpoly	1			1	2
S Hotpoly	1	1		2	4
Others		2		1	3
PRODCO (chemicals)					
F Pit Liner	1			1	2
S Roof Liner	1	1			2
Others				1	1
TOTAL	28	19	8	30	85**

*F = failure, U = Uncertain, S = Successful.
**Several people were interviewed twice, so figures add to more than 80.

to the successes and failures. Many of these people presented their product as a success, yet the measures of their knowledge matched the failed people's more closely, suggesting that attribution bias does not seriously affect the measures (see Dougherty 1987, 1990, for details). Failed developers may have underreported the knowledge they had due to attribution bias. I conclude that memory failure and attribution bias do not dominate the data, but they may distort the findings somewhat.

Since labels vary by firm, people were categorized into departments (used in the same sense as "function") based on their responsibilities when they worked on the product. Four labels are used: (1) technical: those who worked in research or engineering; (2) field: those who worked in sales or customer relations; (3) manufacturing: plant and purchasing people, or manufacturing engineers and (4) planners: those who handled market research or business analyses but were not in regular contact with customers.

Data Analysis and Findings

The findings and methods of analysis are interdependent, and are described together for each issue being studied.

TABLE 3
Technology-Market Content Analysis of Interviews and Cognitive Orientations by Department

Issues and Orientations	Technology	Field	Manufacturing	Planners	Statistic
% of Interview:					
Business Issues	23%	24	17	42	$F = 16.1$ p = 0.000
Customer Issues	17	28	10	18	$F = 12.9$ $p = 0.000$
Selling Issues	4	22	3	10	**Chi 2: $p = 0.000$
Technical Issues	49	21	27	23	$F = 27$ $p = 0.000$
Manufacturing Issues	8	6	39	6	$F = 71$ $p = 0.000$
Orientations mean ranks:**					
Long-Short time	34	33	25	44	**Chi 2: $p = 0.11$
Task-People	39	20	43	42	**Chi 2: $p = 0.006$

**The four departments do not have homogeneous variances on these measures, per a Bartlett test. The original measures were ranked by case from 1 to 71 (71 of the original 85 interviews are used in this analysis because "others" and people who did not work on the product prior to its launch were deleted). A Kruskall-Wallis test that compares mean ranks was run. The mean percentage is reported for the Selling Issues to be consistent with the other content measures, but the statistic is a Chi Square used for the K-W test on the ranked scores. Two orientation measures are the mean ranks, with the higher rank reflecting more long-term or task orientation.

Thought Worlds

Technology-Market Funds of Knowledge. The first research question asks what are the different funds of knowledge about technology-market issues in the different departmental thought worlds? It is assumed that the content of the thought worlds would be evident in the emphases in people's stories. To assess these emphases, a coding scheme to measure "technology" and "market" was developed with five categories: (1) product technology and design issues, (2) manufacturing (plant, suppliers, materials), (3) business issues including segments, competition, and size forecasts, (4) customer issues such as needs and problems, and (5) distribution or selling issues. The author coded each statement of each interview into one of these five areas. A research assistant coded a subset of interviews, and we had 80% agreement. Issues we disagreed over were redefined and all interviews were recoded by the author.

Measures were also developed for two of Lawrence and Lorsch's (1967) "cognitive orientations." Time orientation was measured by counting the number of statements that referred to events more than one year prior to the start of the product, or one year into the future beyond the date of the interview (divided by the number of pages to control for interview length). This assumes that people with a longer time orientation would discuss more long-term events. A task versus people orientation was measured by a ratio of statements that referred to working with people versus those that referred to a task in the development.

To make comparisons as similar as possible, only those people who worked directly on the product *prior* to introduction were included in the analysis. Table 3 summarizes the technology-market contents and cognitive orientations of each thought world

using this subset of 71 interviews. One-way analyses of variance suggest differences on six measures, with long-short term orientation statistically significant at only $p = 0.11$. Planners dwell on business analyses in their stories and are the most long term, while technical people emphasize design issues. The field people discuss customer and distribution issues more often, and are the most people oriented.

If the departments are like thought worlds, however, one would also expect to see these differences regardless of company and success versus failure. Two-way analyses of variance between the thought world fund of knowledge measures and orientations were run by department and by company and success status to check on this expectation. See Appendix B for the results. The department has a main effect in five of the seven comparisons. There are also a few differences by company and success status, as discussed in the Appendix. Since the department main effect is found across the firms and success outcomes, however, these findings lend support to the idea that departmental thought worlds differ systematically on technology-market issues regardless of the firm or product status.

Systems of Meaning. The Fleck model suggests that departments not only know different things, but also know things differently. That is, each would have a different system of meaning through which its members interpret technology-market issues. To understand these systems of meaning, dimensions to describe them were developed following Strauss's (1987) methods for qualitative analysis. First, people's descriptions of other departments and frustrations with them, how they thought about customers, and what they considered important to product development were written onto separate coding sheets. These were then compared across department, case, and firm to search for underlying patterns or themes which summarized the essence of the departmental differences. Preliminary themes were discussed with colleagues and with several of the people interviewed.

Three final themes seem to most distinguish how the four thought worlds interpret technology-market linking and new products: (1) what people see when they look into the future, including issues that are most uncertain; (2) what people consider to be the critical aspects of the product development process; and (3) how people understand the development task itself. By looking at technology-market issues through the unique combination of these themes, people in each thought world understood the product in qualitatively different ways. Each thought world had an "intrinsically harmonious" perspective on the product which did not overlap extensively with perspectives held by other departments. Table 4 summarizes the unique understandings about product innovation which arise from these different systems of meaning.

These themes are first outlined, and then the different views they engender are illustrated with case material. The first theme captures the future orientation inherent in new product development. It also highlights the fact that people understand the future by in effect sighting along different emerging trends—technological change versus customer shifts versus market evolution (see Table 4). They make different sense of the nebulous future by looking at disparate aspects of it. What they see seems uncertain, while what they do not see does not seem particularly uncertain or even noteworthy. These contrasts can be seen in the OPCO excerpts. The business planner worried about positioning against competition while the field person worried about identifying the right potential customers. They partitioned the product into separate sources of uncertainty, which may have kept them from developing a more comprehensive understanding of the market.

The second theme comprises people's understanding of the development process itself. Each department concentrates on different subsets of the overall process. People do not ignore the activities they do not deal with directly, and do not merely

TABLE 4

Differences in the Thought World Systems of Meaning about Product Innovation

THEMES THAT DIFFERENTIATE THOUGHT WORLDS	THE TECHNICAL PEOPLE	THE FIELD PEOPLE	THE MANUFACTURING PEOPLE	THE PLANNING PEOPLE
What is seen when looking into future/uncertainties	Future comprises emergence of the technologies underlying the new product: design problems and their solution, new technical possibilities to include, new trends which might change development. Uncertainties comprise finding out what the design parameters are.	Future comprises shifts or trends in the users' uses of and need for this and related products. Uncertainties comprise how to get to buyers, discern if they like product, and how to adjust product for user.	Future limited to capabilities in plant, need careful shifts in operations. Uncertainties concern if manufacture is possible, what are the volumes.	Future comprises emerging business opportunities, competitive changes, new niches. Uncertainties concern developing market forecasts and income projections.
Aspects of development considered most critical	Focus on devising the product, specifying what it should do. Want to know what users want in product specifications. Market is seen as what the product does, and as such is rather obvious.	Focus on matching products to users, adjusting the product quickly to meet their shifting needs, creating the sale. Want to know who makes buying decision, what problems customers want to solve. Market is seen as what the buyer wants, and as such is difficult to develop.	Focus on the product's durability, quality, how many types of product. Want to know how good is good enough in product quality. The market is seen in abstract terms as product's performance.	Focus on developing the business case and general marketing plans. Want to know the best segment to be in, how to position the product in this segment. Market is seen as a general business opportunity.
How development task is understood	Task is to build the product—a hands-on, tactile activity. Product is real, has a physical presence, and is "neat."	Task is to develop relationships with buyers, which occurs when products change to meet their needs. Sense of task is one of urgency. Also hands-on but product is not real—it is a possibility.	Task is to build the capacity to build the product. Also hands-on, tactile, product is well built.	Task is to analyze alternate possibilities, determine income potential—a conceptual, abstract activity. Product is a business.

argue over relative priorities. Rather, they gloss over the concerns of others, and tend not to appreciate their complexities (Van Maanen 1979). Recall that OPCO's technical person saw no "market" problems for the product effort described. Had they identified a set of retailers who needed the service but who had simple transaction needs, however, perhaps they could have designed a workable system. As Table 4 suggests, each department seeks inputs from the others that differ from the others' primary focus. Technical people, for example, concentrate on solving design problems, and expect field people to tell them exactly what customers want in the design. Field people, however, cannot identify these "specs" because in their view users are uncertain. Rather, field people consider that product innovation is to meet *shifts* in customer needs, and expect technical people to produce alternate designs quickly.

The third category concerns how people understand the task itself. As Table 4 shows, all but the planners understand product development in concrete, hands-on terms, so all these departments have difficulty making sense of planners' reports. There are also significant differences within these three hands-on groups, however. The technical people think that the product has a specific reality, while field people think it is a possibility. These contrasting perspectives can seriously impede a dialogue over what the product is and how it should be developed. Excerpts from the interviews illustrate these thought worlds for product development.

The Technical People. The product's design dominates the technical people's understanding of product development. When they look into the future, they see ever emerging design possibilities and numerous technological trade-offs. For example, an engineer with SALECO's System II discussed the decision over the disk drive at some length:

> The diskette started as a single side, but we had technical problems with that. ... Also when we started there was no question that we'd do half size. That was a new technology so it had to be single sided. But a guy in the group said in a few months we could fix the problems, so let's take a risk and forget single sided and do double sided. That helped push the technology... (SALECO)

Consistent with this view of the future, technical people emphasize establishing the product's performance specifications rather than what the customer does with the product. This is a complex and often frustrating process, as this engineer's comments about a communication system illustrate:

> There were a lot of specs, but these were only detailed conceptually. They wanted "something like this." What ended up as a result is that the specs get interpreted more widely. You end up delivering something they didn't ask for. ... I was working with one or two people (at the customer organization). Then they show it to fourteen others who say: "Oh My God!! We didn't want that!!" (OPCO)

Technical people define the market in terms of what the product does, and may overlook business aspects such as how many people will pay how much for the product. For example, the market for the battery was defined as "battery users," not particular sets of industrial customers who might need a more permanent energy source. Most technical people view the development task as a tactile activity that results in something objectively real. By concentrating on technological possibilities, however, they may assume the market is obvious and that customer needs are straightforward.

The Field People. As field people look into the future, they see constantly emerging customer applications rather than changing technological possibilities. Such changes are more immediate, often shifting with the user's model changes or competitor's

product or price changes, giving them a short-term, action orientation. Field people also seem to take a customer-by-customer view of the market. Consider:

> You need to listen to what the customers want; what is he ready to buy? what is he looking for?... You have to be specific, applications oriented. I want the least amount possible in the shortest time, but [engineering] may take three years. ... The more (engineering and operations) are buffered from customers, the more they tend not to understand the urgency. (OPCO)

Field people emphasize creating or crafting the sale, not the product, and describe this activity as vividly as the engineers discuss disc drives or communication networks. Explains a voice service field person:

> It's a blast to let it go. I never go on a one on one meeting. I always try to have a minimum of three people (from the prospective customer's organization) and I throw out functions until I find a use. ... It's the most amazing thing in the world. Usually there's at least one guy who's determined not to like the product. He sits pulled away from you like he won't let you penetrate his shield. But then after ten minutes he pops up in his chair and starts coming up with ideas... (OPCO)

To field people, the task is real but not tactile. Developing a new product means establishing new relationships and buying-selling arrangements. The relational nature of their work is evident in this quote:

> We know what they need. The market is obvious. But the selling process is complex. Who are they and what do they want is clear. But there are six or eight decision makers. No one says yes but anyone can say no. ... The production guy wants to know if his yield will be better... The quality control guy says 'will I have to change my tests?' The sales manager says 'will my customers like the finished product as well?' The purchasing guy says 'what will you do for me?'... You need to work with all these guys and their bosses. (COMPCO)

Note also that the speaker downplays the complexities of doing a market analysis by focusing on his own tasks. Field people concentrate on what the user wants to do with the product, but also assume that customer needs are unique or constantly changing.

The Manufacturing People. Manufacturing people worry about the plant or operations, and are concerned that the others do not appreciate their special inflexibilities. A person at COMPCO explained that manufacturing is very concerned that marketing will take orders for products they cannot produce. "... I don't like (them) taking risks (they) don't know (they) are taking." It seemed that these inflexibilities push manufacturing people to live in the ever present now. The director of operations for the voice service explained his problems with the others as follows:

> Sales and marketing live in the future and my needs are today. They are forever saying "why don't we do this?," or "isn't that easy to do?" But based on limited capacity now I can't do that. It's the same with networking. Sales and engineering wanted to bring up all the nodes at once! We said no, let's test it and do it one at a time... They know, they hear, but they aren't involved (as closely). And they don't get the 5,000 calls from customers (when the system fails)... There needs to be more interface between those who design the future and those who live in the real world. (OPCO)

Note that, like the others quoted above, the person is aware of the others' concerns and issues, but emphasizes his problems over theirs.

Manufacturing people concentrate on reliability and quality, evaluating and defining the product in these terms. For example, a manufacturing engineer picked up a keyboard for the failed System II and threw it into a corner of the room to show how well built it was. "Look at that!" he said. "That's a damn fine keyboard!" (SALECO). It turns out that the system was a commercial failure (in part) because the keyboard was difficult to use. How often it could be thrown around was not a factor.

The Planning People. The future that planners see consists of emerging business possibilities such as the size of the market and total revenue potential. For planners, both the technological trends and specific customer applications pale into abstraction. As a planner at TECHCO put it: "We locate markets and make recommendations if it's worthwhile to enter them. And that depends on the margins, or the amount of money you will make." Analyzing "the business" also can be very frustrating and uncertain, as one explained:

> The environmental scan is the most difficult part. There isn't enough information available. We looked at traditional sources (of information) including market research firms. But the problem is they are guessing too, they develop scenarios. An awful lot of projecting from just a few numbers goes on in this business. (OPCO)

The information the planners need for their reports is difficult to gather, so they resort to modeling. For example, several people at OPCO spent three months developing a model to predict the size of an electronic data transfer market, and then they developed their business proposal around the estimate. To do such extensive analyses with such ambiguous data, planners cannot treat design and applications as constantly emerging. Instead they abstract these issues into more general scenarios. The nature of the planners' work is conceptual, not concrete, which means that their concrete-thinking colleagues will have trouble with their plans. For example, a technical person said: "It's hard to know what to do with reports we get from marketing." A field person said: "I'll take luck to market research any day."

Thought Worlds and Product Innovation. Interpretive differences between departmental thought worlds play a strong role in problems with collaboration over technology-market linking. From the outside looking in, one can see the conventional stereotypes for each department in the sketches above: technical people never settle on a design, field people are short term, manufacturing people always say no, and planning people are conceptual. But from the inside looking out, each thought world is truly concerned with the successful development of the product. And as can be seen, each has an important insight into the product or market that is essential to a new product's development. Each emphasizes different aspects of development, however, and conceives of the whole in a different way.

When seen from the perspective of thought worlds, the collaboration problem runs deeper than conflicts over personality types or goals. Indeed, to attempt to resolve the problem through negotiation over goals may only begin to touch on the divergent understandings which lay at the heart of the problem. Nor is the problem like the proverbial set of blind men touching a different part of an elephant. It is more like the tales of eye witnesses at an accident, or of individuals in a troubled relationship—each tells a "complete" story, but tells a different one. Despite their potential benefits, departmental thought worlds separate the market-technology issues, limiting the possibility of a comprehensive understanding. The thought worlds also focus inward, reducing the possibility of learning. These data suggest that, to overcome the thought worlds' "inherent tenacity" (Fleck 1979) to focus on their own perspectives, managers may need to proactively foster collective action.

Organizational Routines

It became clear from the research that the thought worlds did not operate independently from the organizational context, however. Next, the analysis seeks to identify the organizational routines that affect product innovation, and how they affect collective action among the thought worlds. Most people described how products are usually developed in their firm, so the data provide some insight into

routines. Descriptions of usual practice for product development (including evaluating the product, making decisions, and determining market needs) were transcribed onto coding sheets. The same kinds of practices used for the new product were also extracted, and compared with the usual practices by success status.

The analysis suggested three important patterns. First, three routines encourage thought world separation and inhibit learning. These routines were systematically violated in the successful cases, followed in the failed cases, and followed partly in uncertain cases. Second, the successful innovators did create a new social order for innovation. Third, the routines in these firms were very strong. Breaking out of them to establish an innovative social order seemed to be an unusual and often temporary event.

Organizational Routines, New Products, and Thought Worlds. The three routines found to affect product innovation concerned interdepartmental relations, market definition, and product standards. The first routine governed thought world relations by prescribing narrow roles and limited relationships. People would routinely do their own work and expect the same of others. Even when interactive structures such as task forces were used routinely, relationships were constrained, so the possibility of creating a new collective order which produced cross-fertilization and mutual learning was limited. The second routine imposed a predetermined definition of technology-market issues on product efforts. This reduced people's search for new information as well as the likelihood of frame-breaking learning. The third routine imposed standards which did not fit these new products. The standards varied by firm, and included set pay-back periods, profit margins, quality, and use of inhouse facilities. Following them forced developers to redefine the new product as an established business, further reducing new learning.

Successful developers violated all three routines, and created a new social order for their collaborative efforts. They developed mutually adaptive interactions in which knowledge of the work was developed as the work unfolded, as Mintzberg (1979) describes. They also created an alternate definition of the product in its market that was grounded in actual use, and developed appropriate standards to evaluate their efforts. The outcome was collective action as Fleck (1979) describes it: each thought world rechanneled its readiness for directed perception from an inward to an outward focus so that their knowledge could join to produce new insights and new facts.

An Example of Routines at SALECO: System I vs. System II. To illustrate the routines and how successful developers stepped out of them to create a new social order, SALECO's successful System I is contrasted with its failed System II. Both products used similar technology and some of the same people, and the failure followed the success, so the comparison holds constant some of the effects of individuals, technology, and experience. Appendix A summarizes how the other cases related to their organization's routines.

SALECO is a computer and communications manufacturer which has dominated several niches in these markets. The director of market research explained that, until five or ten years previously, SALECO's products were self-contained "turnkey" operations. SALECO maintained close relations with their dependent, installed base of business users through an extensive sales force. These customers' changing needs were easily monitored with in-depth customer profiles; product development became a sequential and highly organized process which abstracted customers' needs into financial indicators. A planner explained that they would look at a price-performance curve, and come up with a new product that sits further down the curve. "We would know what the market requirement is, and would invent nuances on the technology to

do it." Predetermined goals and specifications were used to coordinate complex interdepartmental relationships, managed in a matrix structure. "The market" was given, so little energy would routinely go into feretting out user needs. And, befitting a company with market dominance, product norms included high profit margins, high quality production, and complete control of the product by handling all aspects inhouse.

The successful System I violated these carefully orchestrated, big business-oriented, financials-focused product routines, while the failed System II followed them. One person explained the overall routine violation as follows:

> The unique thing was they cut off (the System I group) from the culture. Basically a few top executives decided to play Daddy Warbucks. They disconnected (the team leader) from the normal process of building business cases.

The System I team's interdepartmental relationships encouraged ideas to be heard and built on and enhanced appreciation of one another's contributions. They interacted extensively, and, according to a field person, all participated in all the aspects of the product. Thus, rather than separating various concerns into pre-established role behavior, all problems and ambiguities were addressed from all angles, producing a more comprehensive design. Rather than coordinate by the usual formal but abstract plans, one member said "...we had no formal business plan, but everybody knew what it was." They did not create a single group mind, however. One explained that each department considered itself to be the one most important to the project, but that the leader fostered a sense of appreciation:

> ...(the team leader) always listened to everyone when it came to making a decision, so even if his decision differed from your recommendation, you knew your information was as important as the others'.

Along with redefining relationships, they redefined the task, and perhaps stepped out of the usual political truce that Nelson and Winter (1982) describe. The group created a vivid view of the product in its market which was more simple yet more realistic than SALECO's usual abstractions of price-performance ratios, market penetration estimates, and volume projections. The team used these general data, but combined them with first-order, direct experience with customers. An engineer describes their technology-market linking in what is almost a field person's perspective, as follows:

> The first thing was to define what the product was, who would buy it, and what they would use it for... You have to get into the hearts and minds of users... If you can't explain the product in 30 seconds, you're dead.

People's descriptions of their development process were full of instances in which they broke out of usual perspectives. For example, they broke out of SALECO's notion of customers as business people, and came to appreciate the new users for themselves. According to a planner:

> I remember our first focus group. It was a riot. There was this guy out there in a green T-shirt, long side burns and a flat top, jeans, a belt with a big silver buckle, and cowboy boots. He happened to be the president of the local micro-computer club. It's frightening when you realize that on the other side of the oneway mirror there was a room full of men in [conservative business attire]. We had to understand that that guy was our new customer. It took a leap of faith.

Third, they broke most of SALECO's product norms and created new standards appropriate to the System I market. Instead of the usual inhouse manufacture which "made equipment you can drop off ten story buildings," according to one, the machine was assembled from off-the-shelf parts purchased externally. This more effectively met the needs of low price in a market where "industrial strength" durability was not critical. Instead of total control by SALECO, they designed an open architecture to allow others to write software for sale. The group even published a book explaining how outsiders could build on the machine with their own products. Instead of careful quality control, some of the external software had bugs in it—the number of applications was more important to this market than perfect operation.

Less than a year later, this business unit began work on a follow-on product aimed at both professionals and home use. A number of new people were involved, but so were many of the System I group, including the leader and the senior people who played "Daddy Warbucks." More like SALECO's usual product development, however, the plan was simply to continue the momentum begun by System I. Interdepartmental relationships seemed to have also reverted to routine, and the inwardness of thought worlds dominated the people's work. When asked to describe the System II organization, an engineer went to his board and drew a circle to show the System I team. Then he drew an arrow over to a matrix to represent the System II organization, with columns for departments, and rows for various products under development—SALECO's routine matrix form. A planner explained that some people from the first effort were not fully focused on this product, that several key people left, and that the group had lost what he called its "group think."

For the technology-market definition, System II developers relied on assumed applications and users, as usual. A market had been "analyzed" with the routine calculus of price-performance trade-offs and buyer potential, and not questioned again. The design had unique features but these were not tested with users. As it turns out, few users liked the product. An engineer explained:

> We didn't get the system into real scenarios to test out our premises. We were overconfident... We all thought we were very smart... We made a lot of decisions daily to change the product based on what we thought we understood about the market place.

A market researcher noted that perhaps some focus groups would have picked up the problem they found after introduction with certain features. But he said that the design and manufacturing process had generated such a momentum, that:

> We would have been disappointed with the negative feedback, but we would have gone on with (the design) anyway.

Third, the System II team followed some of SALECO's usual product standards that were appropriate to its large systems, but not, perhaps, for System II. In-house manufacturing rather than assembly was used, and reliability and durability were emphasized. According to a manufacturing person:

> The product was fantastic. But it was high priced. You can't cut price or quality. There is no way SALECO would sell a lower quality product. But then people would say why should I pay so much for this computer, instead of paying attention to all the enhancements we put on it... It has half-size disk drives... Our fundamental error was in the design of [a certain part]. It didn't have user flexibility. That got us a lot of negative press. But the function was great. It should have sold like hotcakes.

By following the usual product development routines, the System II team produced a high quality, rather expensive but durable machine—just what SALECO's routines are designed to produce. Unfortunately the team did not begin with an established market, which the routines also presume, so the system did not fit any real needs. Sales were not high enough to cover the manufacturing costs, so the company shut down the plant, laid off the factory workers, and cancelled the product.

Discussion

An extensive literature tells managers how they ought to develop new products, and how they ought to design their organizations for innovation. This study has examined product innovation in practice in order to understand why these prescriptions are not often achieved. The research is limited by its exploratory nature, and the fact that commitment, leadership, politics, and other possible factors have not been included. However, it describes how two interpretive schemes can become barriers to effective technology-market linking. Departmental thought worlds partition the information and insights. Each also has a distinct system of meaning which colors its interpretation of the same information, selectively filters technology-market issues, and produces a qualitatively different understanding of product innovation. Organizational product routines reinforce thought world separation by providing for only limited interaction, and further inhibit the kind of collective action that is necessary to innovation.

Implications for Theory and Practice

This research suggests two important implications for the study and practice of innovation. The first is that theorists and practitioners need to pay attention to the effects of thought worlds and organizational routines. Innovation is an interpretive process, so the management of innovation must involve the management of the interpretive schemes that shape and frame how people make sense of their work. Innovation requires *collective action*, or efforts to create shared understandings from disparate perspectives. The advocation of rational tools and processes, the infusion of market research information, and the redesign of structures, while important, are not enough.

The second implication is that the potential barriers these interpretive schemes may become need to be dealt with specifically and in depth. This study suggests three intermediary processes which together can help overcome the barriers. Innovators must: (1) use and build on the unique insights of each thought world, (2) develop collaborative mechanisms that deal directly with the interpretive as well as structural barriers to collective action, and (3) develop an organizational context for collective action that enables both. The work suggests that, unless all three processes occur together, the thought world boundaries and routines may dominate. If so, pitfalls will be overlooked, meanings lost, and communication curtailed, as was the experience of OPCO's accounting system developers.

Building on the Thought Worlds. Each thought world knows about aspects of technology-market knowledge that others may gloss over. All must actively contribute to the product design, and actively challenge each other, or the final design will be awry. This means that reservations or skunkworks comprised solely of R&D people, as some theorists suggest (e.g., Galbraith 1982), would not be effective. The management of innovation is not merely the management of the R&D group or the coordination of activities, it comprises the *collective* creation of the product in its market.

This analysis has gone beyond the general differences in orientations usually cited to identify specific interpretive differences that must be confronted and overcome for new products. As argued here, innovators from different departments may *not* conflict over general goals or even over such intermediate goals as being "market oriented." They do, however, have unique interpretations of these goals, along the themes described in Table 4. Technical and field people focus on customers and have a concrete view of development. This means that reports from the conceptual market researchers may not make any sense to them, and may be ignored. Field people's close view of customers could contribute important insights to design, but it may also keep them from summarizing specifications that technical people need. Technical people's search for a general design makes them seem unresponsive to field people's requests for specific changes. Manufacturing people worry that others do not understand the limits of the plant, and so may dig in their heels unless their concerns are handled openly. These differences can preclude the development of an optimal design by producing severe frustrations and perhaps withdrawals into separate thought worlds. They must be deliberately and directly addressed as they come up.

Developing Collaboration Mechanisms. Collaboration mechanisms need to take into account the interpretive dynamics that separate the thought worlds. Their "intrinsic harmony" prompts people to focus inward on their own tasks, and to fill in unknowns from their thought world. Thought worlds most likely always exist where tasks are specialized, so efforts to surmount them always have to be made. Participants on interdisciplinary teams may feel "drawn inward" into their thought world over time, especially if they have other assignments, as is often the case. The analysis suggests one important way to overcome the inward dynamic. As in the SALECO System I case, thought worlds can come to a similar understanding of the product in the user's hands, and innovators can perhaps build a comprehensive appreciation from this common view. Interdisciplinary responsibility for focus groups, market research plans, technology audits, and visits with users should enhance collaboration. Structures alone such as liaison and boundary spanner roles or project groups do not assure that these dynamics of separation will be overcome. A realistic customer focus may.

Developing the Context for Collective Action. This research also suggests that thought world barriers cannot be overcome unless aspects of the organizational context which foster separation are also overcome. The capacity for collective action depends in part on organization level interpretive dynamics. It is inferred that an innovative social order must be designed specifically for new products so that: (1) interactions between thought worlds are based on appreciation and joint development, (2) product definitions are based on collective, first-order customer knowledge, and (3) product norms are based on the specific market. It is inferred further that general organizational attributes such as a risk-taking climate, visionary leadership, and/or an integrative culture may not address these day-to-day practices, although perhaps they increase innovative activity. Moreover, routines, like thought worlds, are probably inertial, and thus always have to be overcome. No matter what the general organizational design, managers must foster ongoing processes of knowledge development, joint learning, and customer interactions.

Future Research

Research is necessary to clarify and test all these implications. This study has not considered the structural aspects of thought worlds that might affect their collective action. Fleck (1979), for example, theorizes that stability of membership, the strength of the established beliefs, the clarity of boundaries, and power relationships within the thought world can all have an effect. For departments, one could speculate that

people's training, experience, and professionalization would affect thought world separation or integration. Studies might explore whether and how job rotation, team experience, and bringing the tacit thought world differences to conscious awareness improve the propensity for collective action. Research on the R&D-manufacturing relationship is perhaps the most advanced (Adler 1990, Dean and Susman 1989), and these insights can be elaborated to include all four departments. Other approaches for mapping frames of reference (Dunn and Ginsberg 1986) should expand our understanding of departmental differences.

The implications for organizational routines are the most potentially confounded by attribution bias and the limited number and types of firms in the study. Additional research is essential to define the routines that inhibit innovation and articulate more clearly how they work. Research should also identify the routines, if any, which can foster innovation. The literature contains numerous discussions of *general* organizational attributes and phenomena that presumably engender innovation (e.g., Kanter 1983; Galbraith 1982). An important next step is to understand the relationships between such general contexts and the specific tasks of innovation, including technology-market knowledge development and thought world collective action. Focused research which examines these dynamics directly, and longitudinal research which sorts out the causal relationships between interpretive barriers and other factors are necessary.

In conclusion, this work indicates that improvements in the new product success rate are possible if innovators combine the prescriptive models with attention to these interpretive barriers, and the *ongoing processes* necessary to overcome them. Rather than test theory, this study has applied theory to the problem of new product development. The insights are more practical than theoretical, but the findings support the growing literature that understanding the interpretive dynamics of innovation and change is crucial (Bartunek 1984; Schein 1985; Barley 1986). The results show that such dynamics apply to product innovation, and can be studied systematically. Continued research into these interpretive dynamics, along with continued efforts to join organization theory with insights from marketing and technology, should advance our understanding of the complex problem of product innovation in large firms.

Acknowledgements

The data on which this paper are based come from a study sponsored by the Marketing Science Institute and a pre-doctoral fellowship from the American Association of University Women. A grant from the Reginald Jones Center and a Doris and Michael Goldberg Fellowship from the Snider Center for Entrepreneurial Studies, both of the Wharton School, supported this analysis. I would like to thank Ed Schein, John Van Maanen, David Thomas, Larry Hirschhorn, Stew Friedman, and Marsha Wilkof for insightful critiques. This paper has also benefitted significantly from critiques by editor Richard Daft and three anonymous reviewers for *Organization Science*.

Appendix A. Summary of Cases and Their Relationships with Routines

This appendix provides a thumbnail sketch of products in this study. See Dougherty (1987) for a complete description of each case, and Dougherty (1990) for an analysis of development processes. Since the relationships with organizational routines are important, so the cases are reported by company rather than success status. All firms and products are disguised.

TECHCO: Producer of chemical based products. Routines for product development stress technological innovativeness, and market analyses routinely not done. High quality was also a standard. Product development usually begins in R&D; procedure was to include others in sequence as the product was ready for a business analysis and marketing plan. People interviewed in Fall 1985.

1. *Failed Battery.* A technologically unique no-leak battery; originally invented for a product line, but because of excess production capacity, TECHCO decided to sell battery to others. Toy manufacturers were

selected as market since toys were a big user of batteries; no analyses of needs, problems, etc. Introduced in late 1981. Product required redesign of toys, and was not widely available so toy companies were not interested. Cancelled after 3 years. *Routines*. A technology dominant task force used for development, sponsored by senior VP; market definition based on what the battery could do, not what users needed; standards of uniqueness and high quality met.

2. *Uncertain CRT Device.* Electronically transfers computer images to produce a hardcopy. Began in R&D. Introduced in Fall 1983. Sales very slow; an interdisciplinary team was set up after introduction, and they were redesigning the product and changing the distribution system. *Routines*. Technology driven, limited interdepartmental interaction; marketing research advised against the product but were ignored. Market defined as white collar office workers; development delayed until quality standards could be met.

3. *Uncertain Video Device.* Similar to CRT device, but captures television signals. Also began in R&D, developed for home use. Commercial division took it, so product redesigned for commercial use. Were design, manufacturing, and quality problems. Concerns over quality and technical design persist. *Routines*. Partially broke routines by doing a market test jointly with R&D and marketing people; interaction seemed good; hung up on established product standards based on chemicals (this was electronic).

4. *Uncertain Medical Hardcopy System.* A chemical and mechanical technology that produces hardcopy from medical diagnostics machines. Requires redesign by diagnostics manufacturers. Delayed for over a year because of manufacturing problems; in the interim a competitor came out with similar product at much less cost. Now looking for alternate markets and uses. *Routines*. Set up an interdisciplinary task force; good interaction except with manufacturing; market plans good but limited to existing markets, contrary to original plan. Hung up on usual markets and standards.

5. *Successful Film Cover.* Adapts a light-proof paper wrap TECHCO makes for other products to contain professional grade photography film purchased from others. Very "low-tech" but intended for new markets and applications. Test market sales exceeded projections, so introduction advanced by 6 months. *Routines*. Began in business unit; product champion incorporated manufacturing and purchasing people on informal or "bootleg" team; all visited users together; considerable market data gathered; design adjusted to meet particular problems. Violated product approval and quality procedures.

OPCO: An operating phone company whose routines stressed low risk ventures, short-term planning, and quarterly operations reviews of all businesses and senior managers. Corporate requires extensive analyses of all new business plans. OPCO's Data Division evolved a "fast-out" product routine to avoid the "corporate gauntlet." They sneaked their first product, the Text System, into the market. Interviews from February to April 1986.

1. *Uncertain Voice System.* (Not associated with OPCO Data) Electronically transfers voice to digitalized packets transmitted over network. One of the first uses of this technology, introduced in 1983; still losing money. *Routines*. Began by a planner; general plans with no applications analyses (files reviewed by author). No interdisciplinary work. During test market product redesigned for discovered market of interoffice uses; multiple market definitions still operate. A venture group formed 2 years after test market.

2. *Uncertain Text System.* Similar technology to voice but transfers text. Introduced in the early 1980's; sales growth high but competition is strong and earnings uncertain. *Routines*. Developed by a technical skunkworks, and introduced as a technology. Market plan based on the number of salespeople, not users or needs. Violated OPCO corporate's analysis, but followed technology driven, fast out routines in division. No interdisciplinary group or comprehensive market definition; these now being developed.

3. *Failed Document System.* Allows text system users to produce a hardcopy delivered overnight to people not on the network. System failed since some mail took 2 weeks; removed from the market. *Routines*. Business planning and technical development done separately. Technical and operational plan poor but chosen because it could be done by the end of the quarter. Original market defined in vague terms.

4. *Failed Accounting System.* Transacts credit card purchases for retailers over a network. System double-debited and double-credited, and then crashed. Removed from market. *Routines*. Followed usual planning process with little connection between technology and marketing; business plan was complete, but particular applications not examined for design. Followed fast-out standard.

5. *Uncertain Transmit System.* Product still in development. It will transmit data between manufacturers and suppliers. Plan created by an interdisciplinary team. The plan violates OPCO's standard for a 2-year payback, so developers were unsure if it would be approved.

6. *Uncertain Software System.* Product transfers software over the network, from terminal to terminal or downloading from a central file. Just introduced, and is being given 90 days to "make" it. Market very uncertain. *Routines*. Developed by a planner, with some interaction from technical people. Targeted market has changed because software firms initially agreed to cooperate but then refused. Market definition very general—now the "Fortune 1000." Followed standards of general business analyses.

SALECO: see text. Interviews Summer 1986.

COMPCO: Chemical materials producer. Has a dominant market position with a certain grade of plastic. Product development usually begins with requests from customers processed through field, and

these requests are responded to quickly. Market need is always known, so little analysis is routinely done. COMPCO has 102 variations of basic plastic. Interviews Fall 1986.

1. *Failed Hardpoly.* Combines a harder polymer with its basic one, giving the plastic more strength yet a lower cost than the stronger polymer alone. Previous efforts to combine these polymers could not overcome certain problems. The material was introduced into an application but failed the heat test and was withdrawn. *Routines.* The material began in technical, not field, but was then treated as a typical user request. An interdisciplinary task force was appointed, as is the routine, but there was little interaction between departments, and field assumed that it would perform as they expected.

2. *Uncertain Stretchpoly.* Combines a flexible polymer with COMPCO's basic material, for added flexibility and water resistance. The material was introduced 2 years ago into automotive, but does not meet those needs, and new niches are being explored. *Routines.* Like hardpoly, the material began in research, contrary to routines, so it had no clear market demand. Some market research was not used, and they assumed it would fit into their major market, the automotive business. An interdisciplinary project team has since been set up, and they are actively monitoring the product.

3. *Successful Hotpoly.* This is a new kind of polymer for COMPCO, with much greater heat resistance, and it opens up new market areas for the firm. The material was introduced in later 1982; only 1 other firm made it. Initial sales slow; field was not selling the product, and they overestimated users' willingness to

TABLE B-1
Thought World Measures by Company

Thought World Measures	Weighted Mean Score					ANOVA results Dept effect Company effect Interaction effect (prodco, manuf not included)
% of Interview:	SALECO	OPCO	COMPCO	TECHCO		
Business Issues	32	27	29	33		D F = 12.7* C 0.9 I 1.96**
Customer Issues	16	23	23	19		D F = 6.6* C 2.5** I 1.2
Selling Issues	12	12	17	9		D F = 12.5* C 1.6 I 1.6
Technical Issues	32	32	25	29		D F = 31.3* C 1.5 I 0.4
Manufacturing	7	5	6	8		D F = 0.5 C 1.8 I 0.3
Orientations mean ranks:						
Long-Short time	37	32	37	38		D F = 0.3 C 0.7 I 1.8
Task-People	38	29	32	38	33	D F = 2.6** C 1.0 I 1.4

*$p < 0.05$.

**$p < 0.1$; Department df = 2, 48; Company df = 3, 48: interaction df = 6, 48.

adopt a new product. With changes in sales-rewards and market analyses hotpoly has become successful, and COMPCO is building a multi-million dollar plant. *Routines.* A new task force was set up from the beginning with everyone but field involved; senior management gave strong support; new business and market plans were made.

PRODCO: A chemical materials producer. The five interviews were not adequate to develop a general appreciation of PRODCO routines. Interviews Fall 1986.

1. *Failed Pit Liner.* The product is a membrane-like material that lines industrial waste pits, creating large containment areas. Previous materials had to be buried a foot underground to avoid exposure to the sun. A supplier created a new material that resisted the sun, or so they thought. PRODCO entered the pit business with the new material in the early 1970's. After 3 years, material decayed. All pits had to be replaced. It seems that usual routines were followed, but in this case failure was an "act of God."

2. *Successful Roof Liner.* The product is a membrane-like material (but does not decay in the sun) used for industrial roofs. It was introduced in 1981 and has become a multi-million dollar business. *Routines.* A separate business unit was created with people from all departments in it. They worked together extensively, and the product was designed based on first-order data from users. They violated PRODCO's usual distribution process, planning process, and reporting structure. The team continues to run the business.

Appendix B. Thought Worlds Controlling for Company and Success or Failure of Product

The market-technology knowledge and cognitive orientations were analyzed with a two-way ANOVA by department and company to see if the thought world differences held across company. Manufacturing people and the 4 PRODCO people were deleted from the analysis since there are so few of them, so the

TABLE B-2
Thought World Measures by Success Status

Thought World Measures	Weighted Mean Score			ANOVA results: Dept effect Success effect Interaction effect
	Successful	Uncertain	Failed	
% of Interview:				
Business Issues	32	25	24	D F = 13.2* S 2.0 I 1.38
Customer Issues	20	21	15	D F = 4.12* S 8.1* I 0.99
Selling Issues	13	10	8	D F = 9.7* S 1.3 I 1.3
Technical Issues	23	29	30	D F = 20.7* S 4.8* I 1.3
Manufacturing	14	14	17	D F = 71.3* S 2.5** I 2.3
Orientations mean ranks:				
Long-Short time	46	32	30	D F = 3.08* S 2.5** I 0.72
Task-People	25	40	44	D F = 3.6* S 3.4* I 0.60

*$p < 0.05$.
**$p < 0.1$; Department df = 3, 59; Success df = 2, 59; Interaction df = 6, 59.

results are for 4 firms and 3 departments. The figures in Table B-1 are the means by company, weighted by thought world—the mean for planners, technical and field was added and divided by 3 to adjust for the different proportions of thought worlds in each firm. There is one interaction effect, and subsequent analysis shows that OPCO's field people are below average on business issues. There is also one company effect; analysis indicates that SALECO is below average on customer issues. The results, overall, however, suggest that the differences by department reported in Table 3 hold regardless of company. These analyses are exploratory only since there are problems with the variances.

Table B-2 summarizes the means by success status (again, weighted so each thought world has an equal effect) on the 7 thought world measures. Analyses were also run without the manufacturing people to check for problems with the small cell sizes, and the results are similar. The department effect is found for all 7 measures. Successful developers also emphasize customer issues more and technology and manufacturing issues less. In addition, the successful developers are long term and people oriented, consistent with the qualitative result that they have a more comprehensive technology-market knowledge and more collaborative relationships. Since the successful cases have been out longer, the results may be biased by time. To check for this, uncertain and failed cases which have been out for less than 2 years were deleted and the analysis rerun. The results were similar, which suggests no time bias.

References

Adler, P. (1990), "Shared Learning," *Management Science*, 36, 938–957.

Argyris, C. and D. Schon (1978), *Organizational Learning*: *A Theory of Action Approach*, Reading, MA: Addison Wesley.

Bailyn, L. (1977), "Research as a Cognitive Process: Implications for Data Analysis," *Quality and Quantity*, 11, 97–117.

Barley, S. R. (1986), "Technology as an Occasion for Structuring: Evidence from Observations of CT Scanners and the Social Order of Radiology Departments," *Administrative Science Quarterly*, 31, 78–108.

Bartunek, J. M. (1984), "Changing Interpretive Schemes and Organizational Restructuring: The Example of a Religious Order," *Administrative Science Quarterly*, 29, 355–372.

Bonnet, D. (1986), "Nature of the R&D/Marketing Co-operation in the Design of Technologically Advanced New Industrial Products," *R&D Management*, 16, 117–126.

Clark, K. (1985), "The Interaction of Design Hierarchies and Market Concepts in Technological Evolution," *Research Policy*, 14, 235–251.

Cooper, R. (1983), "A Process Model for Industrial New Product Development," *IEEE Transactions on Engineering Management*, 30, 2–11.

_____ and E. Kleinschmidt (1986), "An Investigation into the New Product Process: Steps, Deficiencies, and Impact," *Journal of Product Innovation Management*, 3, 71–85.

Daft, R. and K. Weick (1984), "Toward a Model of Organizations as Interpretive Systems," *Academy of Management Review*, 9, 43–66.

Dean, J. and G. Susman (1989), "Organizing for Manufacturable Design," *Harvard Business Review*, (January–February), 28–37.

Dearborn, D. and H. Simon (1958), "Selective Perception: A Note on the Departmental Identification of Executives," *Sociometry*, 140–144.

Dougherty, D. (1987), "New Products in Old Organizations: The Myth of the Better Mousetrap in Search of the Beaten Path," unpublished Doctoral Dissertation, MIT, Sloan School of Management.

_____ (1990), "Understanding New Markets for New Products," *Strategic Management Journal*, 11, 59–78.

Douglas, M. (1987), *How Institutions Think*, London: Routledge and Kegan Paul.

Dunn, W. and A. Ginsberg (1986), "A Sociocognitive Network Approach to Organization Analysis," *Human Relations*, 40, 955–976.

Fleck, L. (1979), *Genesis and Development of a Scientific Fact*, T. Trenn and R. K. Merton (Eds.), translated by F. Bradley and T. Trenn; originally published 1935; Chicago: University of Chicago Press.

Freeman, C. (1982), *The Economics of Industrial Innovation*, Cambridge, MA: MIT Press.

Galbraith, J. (1982), "Designing the Innovative Organization," *Organization Dynamics*, (Winter), 5–25.

Glaser, B. and A. Strauss (1967), *The Discovery of Grounded Theory*, Chicago: Aldine.

Gupta, A., S. Raj and D. Wilemon (1986), "R&D and Marketing Managers in High-Tech Companies: Are They Different?", *IEEE Transactions on Engineering Management*, 33, 25–32.

Harrison, F. (1980), "Goal Orientations of Managers and Scientists: An Illusory Dichotomy," *IEEE Transactions on Engineering Management*, 27, 74–78.

Henderson, R. and K. Clark, (1990), "Architectures for Innovation: The Reconfiguration of Existing Product Technology and the Failure of Existing Firms," *Administrative Science Quarterly*, (March), (forthcoming).

Kanter, R. M. (1983), *The Change Masters*, New York: Simon and Schuster, Inc.
Lawrence, P. and J. Lorsch (1967), *Organization and Environment*, Boston: Harvard School of Business Administration Press.
Lilien, G. and E. Yoon (1988), "Determinants of New Industrial Product Performance: A Strategic Re-examination of Empirical Literature," *IEEE Transactions on Engineering Management*, 36, 3–10.
March, J. and H. Simon (1958), *Organizations*, New York: Wiley and Sons.
Mintzberg, H. (1979), *The Structuring of Organizations*, Englewood Cliffs, NJ: Prentice Hall.
Nelson, R. R. and S. G. Winter (1982), *An Evolutionary Theory of Economic Change*, Boston: Belknap Press.
Perrow, C. (1986), *Complex Organizations: A Critical Essay*, (3rd ed.), New York: Random House.
Quinn, J. B. (1985), "Managing Innovation: Controlled Chaos," *Harvard Business Review*, (May-June), 73–84.
Riley, P. (1983), "A Structurationist Account of Political Culture," *Administrative Science Quarterly*, 28, 414–437.
Rothwell, R., C. Freeman, A. Horsley, V. Jervis, A. Robertson and J. Crawford (1974), "SAPPHO Updated. Project SAPPHO Phase II," *Research Policy*, 32, 58–291.
Schall, M. (1983), "A Communication Rules Approach to Organizational Culture," *Administrative Science Quarterly*, 28, 557–581.
Schein, E. (1985), *Organizational Culture and Leadership*, San Francisco: Jossey-Bass.
Souder, W. (1987), *Managing New Product Innovations*, Lexington, MA: Lexington Books.
Strauss, A. (1987), *Qualitative Analysis For Social Scientists*, Cambridge: Cambridge University Press.
Tushman, M. (1978), "Technical Communication in R&D Laboratories: The Impact of Project Work Characteristics," *Academy of Management Journal*, 21, 624–645.
_____ and D. Nadler (1986), "Organizing for Innovation," *California Management Review*, 28, 74–92.
Urban, G. and E. von Hippel (1988), "Lead User Analyses for the Development of New Industrial Products," *Management Science*, 34, 569–582.
Van Maanen, J. (1979), "On the Understanding of Interpersonal Relations," In W. Bennis, J. Van Maanen, E. Schein, and F. I. Steele (Eds.), *Essays in Interpersonal Communication*, Homewood, IL: Dorsey Press, 13–42.
_____ and S. R. Barley (1984), "Occupational Communities: Culture and Control in Organizations," *Research in Organizational Behavior*, 6, Greenwich, CT: JAI Press, 287–365.
Yin, R. (1989), *Case Study Research: Design and Methods*, Newbury Park, CA: Sage.