When Do Organizational Routines Work Well?

A New Approach to Knowledge Management

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March 8, 2002

Under review, *Organization Science*

The author wishes to thank Fariborz Damanpour, Deborah Dougherty, Paul Hirsch, Tom Kappel, Martin Kenney, Anne Miner, Michael Radnor, Al Rubenstein, Nareatha Studdard, and Stephen Shortell for advice and assistance.

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Abstract

The organizational routine—defined here as a coordinated, repetitive set of organizational activities—is an important element of organizational learning and knowledge management. Some scholars even consider routines to be the only source of sustainable strategic advantage for firms. Yet we know little about the actual operation of routines, particularly what makes them work well. This study helps fill this gap in the literature by examining two knowledge-intensive routines—one involving explicit knowledge; the other, tacit knowledge—in four large companies. Three main findings emerge from comparative case analyses both within and across these firms. First, in contrast to much of the knowledge and learning literature, which has tended to focus on capabilities, I find that capability alone is not enough to ensure even short- or medium-term success. Rather, I find that participants must have the desire, the capability, and the power to implement the routine. Second, I find that, while strong personal relationships help the functioning of a routine, it is not relationships per se, but interpersonal trust (with or without a prior relationship) that appears to be the underlying mechanism leading to better outcomes. Third, I find that certain capabilities (e.g., having sufficient technical competence) are critical for routines involving tacit knowledge but not necessarily for routines involving a lot of explicit knowledge, where other capabilities (e.g., finding intelligent ways to reduce complexity) are more important. Implications for theory and practice are discussed.

When Do Organizational Routines Work Well?

We still know little about how, in practice, routines actually work and, more importantly, what makes them work well (Grant 1996). Yet specialized knowledge and routines may actually be one of the few, if only, sources of sustainable strategic advantage, according to the resource-based and knowledge-based view of the firm (Collis 1994; Grant 1996; Levitt & March 1988). Focusing on the operation of routines, though, could provide us with a new and valuable approach for understanding knowledge management. For if, as Levitt and March (1988) and Miner (1990) suggest, routines are the building blocks of organizational learning and knowledge management, then it is important to begin understanding more about what leads to better or worse outcomes for a routine. To help fill this gap in the literature, I identify the main factors that, across a variety of companies, lead routines to be more successful—at least, as observed, in the short- and medium-term—in a knowledge-intensive domain (technology management).

I define an organizational routine "as a coordinated, repetitive set of organizational activities" (Miner 1991: 773). This focus on repeated activities is echoed in much of the literature on organizational routines (Cohen et al. 1996; Cyert & March 1963; Feldman 2000; Levitt & March 1988; Miner 1990; Nelson & Winter 1982; Pentland & Rueter 1994; Rura-Polley & Miner forthcoming). I do not further restrict this definition by requiring that the routine must be done without too much conscious thinking (i.e., "routinized"), as some have argued (e.g., Cohen 1991; Cohen & Bacdayan 1994; Nelson & Winter 1982; Stinchcombe 1990), although this surely occurs under a variety of circumstances. Routines are conceptually distinct from scripts, which are "outlines of recurrent patterns of interaction" (Barley 1986: 83)—e.g., (1) boss asks employee a question, (2) employee provides an answer, and (3) boss confirms the answer as appropriate—since scripts are at a level of analysis one step below (i.e., more detailed than) that

of a routine. Miner (1990; 1991) studied individual jobs as examples of routines, although my focus here is on "organizational routines [that] encompass many people's activities" (Miner 1991: 774). Along these lines, Feldman (2000) studied the multi-actor routines in a university's student housing organization for move-in, damage assessment, and hiring and training. The current study takes a similar approach, but focuses on multi-actor routines in the technology management domain of large corporations. Note that corporate practitioners often refer to routines such as corporate strategy making as a *process*. The focus here, however, is not on developing a step-by-step reengineering "process map" of how each routine does or should take place, but rather on the underlying themes that lead to successful outcomes for different types of knowledge in a variety of settings.

Organizational knowledge is often divided into two types: *explicit* knowledge—i.e., knowledge that is more easily codified—and *tacit* knowledge—know-how that is difficult to codify or explain (Hansen 1999; Nonaka 1994; Polanyi 1966). I therefore focus on two routines that practitioners across multiple firms in the technology management domain identified as critical: a routine involving mainly *explicit* knowledge and another routine involving mainly *tacit* knowledge. The first routine, technology roadmapping, produces an explicit "roadmap" documenting the technological intentions of an organization and communicating them to interested and affected parties (Willyard & McClees 1987); the main goal is to help overcome the age-old problem in organizations of "not [being able to] link technological and market issues" (Dougherty 1992). In practice, technology roadmapping participants typically meet, as part of a cross-functional effort, over a period of weeks or months to develop a plan for what technologies will be needed for a given product line in the next few years; this effort involves a combination of forecasting and planning (Kappel 2001). Participants often perceive this routine's

output—a technology roadmap—as strategically critical and worry a lot about it falling into the hands of competitors. The second routine, technology transfer, is defined here as the transfer of a technical artifact within the R&D domain (e.g., from central R&D to a business unit) and the accompanying flow of tacit knowledge among those involved; the focus here is primarily on intracompany transfer (Leonard-Barton & Sinha 1993). The technology transfer routine usually leads to, and is in support of, routines for product development and commercialization.

To uncover what makes a routine successful or unsuccessful, this study examines these two routines—technology roadmapping and technology transfer—in four firms in different industries (14 case studies in all). Successful cases of a routine were defined as ones where, on balance, the outputs from the routine were useful and worthwhile for the organization as a whole, including for any other related routines. I assess success using a subjective measure based on data collected from multiple sources. Only cases for which multiple sources of information were available have been included in this analysis (see sections below on validity concerns and on cross-case comparisons). I do not measure—indeed, I assume, for the purposes of this paper—the existence and persistence of these two routines. Rather, my focus is on how useful and worthwhile for the organization each instance (or, case) of a routine is and why.

As described in more detail below, what emerges from this analysis are three broad themes. For a routine to be successful:

- Participants must have the *desire* to do the routine;
- They must have the *capability*[1] to do the routine; and

[1] I use the term *capability* (or, ability) to describe the range of potential behaviors (e.g., for acquiring and processing knowledge) needed for a given routine. Although some authors use this term in a macro sense (e.g., building quality cars), where it is the result of many routines, I use it here in a more micro sense (e.g., having a shared language among car designers and assemblers) in support of a particular routine.

- They must have the *power* to make the routine happen.

In contrast to these findings, most research on knowledge management and organizational learning has focused only on the second issue of capabilities. I argue that, although this simplifying assumption has led to a certain amount of theoretical parsimony, taking a more fine-grained and careful look allows one to discover interesting, and arguably more realistic, interpretations of organizational learning. "From a conceptual perspective, then, organizational learning theory might benefit from incorporating the insights of "desire-and-ability" models of organizational change" (Levin 2000: 645). Moreover, as Miner (1991: 772) has noted, a "substantial body of research in other traditions implies that the study of routines will be sterile unless it addresses the impact of social and personalistic processes."

This paper thus makes three contributions to the empirical literature on organizational routines and knowledge management. *First,* this study identifies, in multiple firms and industries, the main themes and sub-themes affecting outcomes for knowledge-intensive routines. Given the importance of routines to organizational learning and knowledge management (Grant 1996; Levitt & March 1988; Miner 1990), the resulting comprehensive framework presented here provides an overall picture of this under-researched but important area. While many of these themes and sub-themes are familiar concepts in our field, the added contribution here is that we can now see how they operate, and *that* they operate, within the fresh context of the organizational routine. Thus, this study points out that capabilities, such as core competencies (Prahalad & Hamel 1990) and absorptive capacity (Cohen & Levinthal 1990), are likely not enough to ensure positive outcomes for knowledge-intensive routines; the themes of desire and power are important, too, and cannot always be taken for granted, as many scholars have implicitly done. *Second,* this study points out that, while strong personal relationships are a key

element for the functioning of a routine, it is not relationships per se, but interpersonal trust (with or without a prior relationship) that appears to be the underlying mechanism leading to better outcomes. *Third,* this study finds differences in the effects of explicit versus tacit knowledge. For routines involving a lot of explicit knowledge, it is more important for participants to find intelligent ways to reduce complexity; in contrast, for routines involving tacit knowledge, it is more important for participants to have sufficient technical competence.

I now turn to the methods used to gather the evidence for these conclusions, followed by the findings, and a discussion of the implications for theory and practice.

Methods

Study Setting

One area of organization science that can particularly benefit from a focus on routines is the management of technology and innovation, in part because this domain is one of the most knowledge-intensive environments in the modern corporation. R&D, after all, is in the business of absorbing, creating, adapting, and transferring new ideas, knowledge, and technology to the rest of the company (Cohen & Levinthal 1990). So if we care about how firms manage knowledge, here is surely a good place to look. For "R&D produces one product only—knowledge" (Roussel, Saad, & Erickson 1991: 67).

This study's findings are based primarily on in-depth fieldwork in the technology management domain at four multi-billion dollar companies, identified here by pseudonyms. A partnership of academic scholars and practitioners, under the auspices of the National Center for Manufacturing Sciences (NCMS), directed the study. The companies are in different industries but all have a connection to technology and manufacturing. Note that the sample of firms is not random because the research goal was not to draw statistical inferences but rather to generate

grounded theory (Eisenhardt 1989; Glaser & Strauss 1967). Although most studies of organizational routines have examined only a single organization, the focus here on multiple firms is an important advance in the external validity of research on routines.

Data Collection

The research team chose routines for in-depth examination from among the 27 generic routines in the technology management domain identified by an earlier study (National Center for Manufacturing Sciences 1996). Since some organizational routines are more important than others (Rura-Polley & Miner forthcoming), the research team held qualitative discussions with practitioners to see what areas or routines they saw as most critical in the technology management domain. These discussions took place during telephone conversations and in-person meetings over a five-month period among the half-dozen or so practitioners from the five core companies participating at that time. The routines identified were of great interest and importance to the practitioners yet did not always function well. More importantly, from a theoretical standpoint, these routines stood out as particularly knowledge intensive and critical to the overall flow of knowledge in what is already a knowledge-intensive domain. That is, these routines require the transfer of knowledge across functional boundaries and are firmly connected, as both inputs and outputs, to other routines in the technology management domain. For example, technology roadmapping is connected to routines for determining strategy, for managing the overall R&D portfolio, for selecting individual R&D projects, for assessing customers' technology needs, for planning product changes, and for monitoring the external environment. The two routines studied here also involved divergent types of organizational knowledge: technology roadmapping, which focuses on creating and transferring explicit knowledge, and technology transfer, which focuses on creating and transferring tacit knowledge.

Since our focus here is on knowledge management, we gain a more complete view by examining both of these two different types of routines.

For each routine, the research team developed a detailed 5-7-page position paper and interview guide. This document, which included a description of the routine and a list of open-ended questions (e.g., what are the goals for this routine? how are you involved? what happened during implementation?), was derived from the earlier research study of technology management routines in general. During the 12-month period of fieldwork for the current study, two researchers jointly interviewed 79 people (split 60/40% between R&D and business units) during visits to company sites in California, Florida, Pennsylvania, Illinois, Ohio, Michigan, New Jersey, New York, and Wisconsin (and a small number of international phone interviews). About half of the interviewees were managers. The average interview lasted 75 minutes. Technology roadmapping was discussed in 74% of all interviews and technology transfer in 69%. All interview notes were typed separately by each interviewer and then merged into a single document, for a total of 206 single-spaced typed pages. To supplement the formal visits, we also used nontraditional approaches such as roundtable discussions among academics and practitioners from core and outside companies, as well as informal academic/practitioner data analysis discussion meetings (see Table 1). In all, nearly 100 informants participated in the study.

[Insert Table 1 about here]

Data Analysis

To interpret the interview data, the two interviewers held intensive "data analysis meetings" over a four-month period, first for technology transfer and then, separately, for technology roadmapping. In these meetings, the two researchers sat in a room with a computer

and went through printed interview notes line by line, using them as a jumping off point for generating new theoretical insights about technology transfer or roadmapping. In addition, these analysis meetings included reactions to the relevant literature, as they related to the interviews and emerging insights. This process initially generated about 33 new single-spaced pages of analysis: 78 separate paragraphs ("insights") for technology transfer, and 135 for technology roadmapping. Eventually, this effort involved categorizing insights (e.g., on one occasion, putting dozens of scraps of paper into piles), combining insights, and eliminating some until a parsimonious but accurate representation of the overall data emerged for each routine. Then, the researchers wrote up detailed case studies, a process which helped clarify, integrate, and refine the categories that emerged from the data analysis. Finally, each case's themes and outcomes were scored (see below for cross-case comparisons). An overview of the cases and findings are presented in Tables 2 and 3. (For those interested in more detail, a 15-page appendix with quotes and evidence for each theme and sub-theme across all 14 cases is available from the author.) Because all four firms were large corporations, there was little or no variation in organizational structure (e.g., all had a corporate office, individual business units, a central R&D unit), and so this study focuses on concepts and themes other than organizational structure.

Quite a number of such concepts and themes, however, were ultimately rejected for explicit inclusion in this paper's framework as a result of the analysis process described above. For example, the need to avoid risk was a dominant theme in several case studies; however, all of this evidence came from one company (or possibly two) of the four studied. Since we wanted to avoid reporting findings idiosyncratic to just one firm or industry, and since this potential theme was somewhat contradicted at the other companies, we ultimately dropped it from the emerging framework. A second example of an early, but subsequently rejected, theme was the

importance of transferring expertise. Upon further scrutiny, however, we identified several cases in multiple companies where expertise transfer was not needed; in these cases, participants found other ways to achieve positive outcomes, such as prior expertise by knowledge receivers or expanded responsibilities by expert knowledge senders. As a result, we subsumed the concept of expertise transfer under the more widely applicable sub-theme of technical competence. A third example of a rejected theme was the need for good prior relationships. At first, comments like, "The transfer only happens if the relationships are good," led us to conclude that good, prior, personal relationships—what organizational sociologists have called strong ties (Granovetter 1973)—are critical to routines. After all, such ties are said to facilitate the transfer of complex knowledge (Ghoshal, Korine, & Szulanski 1994; Hansen 1999; Szulanski 1996; Uzzi 1997). Yet conflicting data from the roadmapping routine raised doubts about the importance of relationships *per se*. This lack of agreement suggested that something more fundamental than close ties is at work. Upon further analysis, it emerged that that fundamental element is interpersonal trust among participants, even if they do not have a relationship or history together.

So, in sum, this study's findings were selected because these were the most prominent themes and patterns in the data for these two routines across all of the firms and cases.

Validity Concerns

A major concern in qualitative research is ensuring that one's findings are reliable and real. To address this concern, the literature suggests several techniques to make inductive, grounded theory building more rigorous—without losing the special, unique benefits of going into the field to develop new theories and insights (Eisenhardt 1989; Glaser & Strauss 1967). The overarching theme behind these techniques is the notion of "triangulation" in data gathering and analysis; i.e., we gain confidence in the validity of the findings if we hear them from multiple

sources and in multiple ways. This study uses seven types of triangulation:

- Multiple routines: one involving mainly explicit knowledge (technology roadmapping); the other, mainly tacit knowledge (technology transfer)
- Multiple companies: 14 case studies from four firms in different industries: six cases for technology roadmapping; eight for technology transfer
- Multiple cases within each company: paired-case comparisons allow us to hold organizational and environmental factors relatively constant
- Multiple outcomes: cases include both successful *and* struggling (or failed) efforts
- Multiple participants interviewed per case (i.e., both knowledge senders and receivers)
- Multiple researchers from different disciplines—organization management and industrial engineering—jointly gathered and analyzed all the data
- Multiple "reality checks" with practitioners: group discussions of preliminary findings with practitioners at multi-firm meetings to revise the emerging insights

We did not use interview coding, which requires that interview questions be identical from a study's start to finish, because we felt that, given the high degree of sophistication of the interviewees, it was important to be able to ask later interviewees to reflect on and revise some of the insights generated by earlier interviewees.

Findings

Using evidence from the 14 cases and four companies studied, I now describe the various findings, which are organized around three overarching themes of desire, capability, and power. I then discuss, based on the cross-case comparisons, the impact of these themes on outcomes.

Theme 1: Desire to Implement the Routine

To be successful, an organizational routine's participants needed to have a desire to do the routine. This theme may be familiar to students of organizational change (e.g., Zajac & Kraatz 1993), but it is an area usually overlooked by knowledge management and organizational

learning researchers (Levin 2000). The theme of desire incorporates three sub-themes that came up in this study's interviews as consistently important. These sub-themes address the desire by participants to work with the relevant people, knowledge, and tasks, respectively. I.e., in routines with favorable outcomes, participants *trusted* one another; had a *craving for the knowledge* in question, which usually meant the relevant technologies; and had a lot of *task motivation* in following through on required day-to-day tasks.

Trust. An R&D manager at E-Corp stated that interpersonal trust is not just helpful, but necessary, for technology transfer to work at all. Similarly, a corporate R&D scientist at E-Corp recalled a successful technology transfer where he felt, early on, that he did not know or trust the competence of the business unit people well enough:

> I have to have a sense that they [technology receivers] know what they're doing. [So I told my counterpart's boss] "Lock us all in a room for a week and slide pizza and beer under the door."
>
> —Corporate R&D Scientist, E-Corp

A manager at Big Products reached a similar conclusion about the technology roadmapping routine: "You try to get people together who can work together." On the Flip Chip roadmapping team, which created one of the most thorough roadmaps observed at E-Corp, people trusted one another a lot:

> It's more like a family-like communication…. Your weakness is not a threat to you if I know about it. There isn't a fear that if you're telling the truth, something will happen to you.
>
> —R&D Manager, Flip Chip, E-Corp

So not only is it important to trust that other participants know what they are doing (competence-based trust), but also that they will not take excessive advantage (benevolence-based trust). Interestingly, these two types of trust correspond to two prominent dimensions of trustworthiness in the trust literature (e.g., Mayer, Davis, & Schoorman 1995).

As mentioned earlier, lacking a prior relationship did not doom a routine if trust could be established in other ways. For example, in the successful Compass case, R&D lab scientists from Budapest went to the U.S. at the start of the project for a few months to work jointly with the technology receivers.

> This [early visit] builds a personal relationship. The guys go for a beer in the evening…. They know each other well…. This initial stay in the U.S. helps a lot.
>
> —Divisional R&D Manager, E-Corp

Trust in these scientists was also generated initially by Gábor, the director of the Budapest R&D lab, who had a close relationship with the relevant business unit manager. Even though this manager had never met Gábor's people, he was willing to trust them: "If Gábor says someone is really good, they're really good." In addition to the use of third-party recommendations, another successful example of building trust without a prior relationship was Venture's counterpart pairing program. This "buddy system" paired up Venture engineers in the business unit with a counterpart in corporate R&D. "They tend to help each other," one manager noted.

In contrast to the above findings, trust was *not* generated, interviewees reported, by such mechanisms as the quarterly reports published by divisional R&D at E-Corp. As one engineer noted: I am "too busy" and do not pay that much attention to them. Similarly, one might predict that the recently popularized electronic "knowledge bases" will also fail to generate much trust; i.e., they will become merely a computerized version of R&D's little-read newsletters.

Craving for the Knowledge. Participants in a successful routine strongly desired, even actively sought out, the knowledge or technology in question; i.e., they had a "knowledge craving." In less successful cases, though, receivers ignored or resisted what they saw as "castor oil" knowledge or technologies—supposedly good for you, at least in someone's eyes, but unpleasant to "swallow."

The failed Memory project typified a "castor oil" case of a routine: the attempted transfer of a technology that no one in a business unit had asked for or wanted. In contrast, researchers on the more successful Junction project created a business-unit craving for their technology:

> They were pretty comfortable with it [in the business unit. After we showed how easy Junction made things for customers and that competitors were planning to use it, their reaction was,] "Holy s——, we better get on this!"
>
> —Divisional R&D Researcher, Controllers Division, E-Corp

The Junction team learned how key it is to get *other* people to care by focusing on *their* interests.

> If you just tell them about new technologies, then they ignore you. If you tell them how discontinuities affect their products, then you get their attention.
>
> —Corporate R&D Manager, E-Corp

Successful cases had or developed this "buy-in" (Burgelman 1983) for the knowledge involved.

Task Motivation. Beyond trusting one another and having a knowledge craving, participants in successful routines were also motivated to follow through on all the little day-to-day tasks required. In less successful cases, though, key people were simply not interested in participating in the routine. If the company mandated participation, as some firms did with roadmapping, then this lack of desire surfaced as a "decoupling" between stated goals and actual behaviors (Levin 2001; Meyer & Rowan 1977); i.e., people just went through the motions. Although Nelson and Winter (1982: 108) do raise this issue of "motivational considerations," they argue that results should still be consistent from one case of a given routine to the next. The current study's findings, however, do not support this contention.

In the successful Junction case, R&D researchers kept on top of the business unit:

> I will give them [in R&D] credit. They called me last week to push me on how we can productize this thing.
>
> —Senior Engineering Manager, Controllers Division, E-Corp

This follow-up is precisely what did *not* happen on the failed Memory project. Instead, the lead

R&D engineer was shy ("I'm not a big conversationalist.") and reluctant to engage the community of potential users ("I go to people who first contact me."), and the routine in this case suffered. Similarly, in the less-successful case of Big Products:

> The people doing roadmapping see it as a chore…. With business unit people, even if you hold their hands and walk them through it, they still have problems with technology plans.
>
> —Technical Managers, Big Products, Environmental Systems

At Printing Systems, too, where roadmapping outcomes were especially poor, business units sometimes claimed to be roadmapping but only went through the motions: "It's not connected to their capital plans. It's not connected to their budget plan," one senior R&D manager lamented. In sum, managerial dedication to a routine, to putting forth a strong effort and doing the tasks required (Porter & Lawler 1968), was important in making the routine successful. Feldman (2000), in her study of a student housing organization, assumed that participants had a desire to do the routines studied (which they may have had); however, the current study of large technology-oriented firms suggests that this motivation is not always in place, with important consequences for the organization.

Theme 2: Capability to Implement the Routine

Organizational capabilities emerged as another important theme across the four firms and 14 cases. In contrast to the earlier definition of routines "as a coordinated, repetitive set of organizational activities" (Miner 1991: 773), I define capabilities in this context as the range of potential behaviors (e.g., for acquiring and processing knowledge) needed for a given routine. This definition is analogous to what Nelson and Winter (1982) call a *skill* and is similar to what Huber (1991) calls *learning,* although I prefer to define learning instead as something that, unlike capabilities, *does* by definition result in observable changes in behavior. So while an organization with a particular capability—as defined here, with its emphasis on what is

possible—*could* operate a routine skillfully and with good results, it may or may not actually do so in practice, as we have already seen with the earlier discussion of the desire to implement a routine. For this study's routines, the most critical capabilities all center around what Cohen and Levinthal (1990) have called "absorptive capacity"—i.e., the organization's ability to take in and make use of new knowledge. This theme includes three sub-themes underlying a routine's success: namely, outcomes appeared to improve when participants developed a *shared language* across different groups; found intelligent ways to *reduce complexity* when confronted with a lot of explicit knowledge (for roadmapping); and had sufficient *technical competence* when dealing with tacit knowledge (technology transfer).

Shared Language. With cross-functional routines like the two studied here, successful cases were those where one or both sub-units understood the other's perspective, needs, and jargon. In the words of an R&D Manager at Machine Tools, "You gotta talk their language." Indeed, one E-Corp R&D scientist revealed that his most successful technology transfer in 15 years occurred when the senders and receivers had complementary abilities, but enough overlap to be able to speak a shared language. That is, "each must have a sufficient knowledge and understanding of the others' problems to be able to communicate effectively about them." (Simon 1991: 131). This notion is related to the cognitive dimension of social capital: "resources providing shared representations, interpretations and systems of meaning among parties" (Nahapiet & Ghoshal 1998: 246)." Argyres (1999: 162), who identified a similar finding, calls this shared language, "a 'technical grammar' for communication." Yet bridging a language gap is not a trivial matter, since different functions such as marketing and engineering inhabit very different "thought worlds" (Dougherty 1992).

The key to translating between the language of technology and the language of business

was to do so at a detailed enough level to be useful. In the successful Midrange case, the R&D lab chief showed the two interviewers his department's roadmap and said:

> If we would quit at THIS and above [pointing to a broad, high-level technology objective at the top of the roadmap], then we wouldn't have anything. All this [technology planning] stuff in the past was done at the top level and put on a shelf somewhere. You have to make it alive!
>
> —R&D Lab Chief, Midrange

Broad objectives needed to be *translated* into detailed technical issues, this lab chief further explained, but they could nonetheless still be traced back to market drivers. In short, as one R&D manager put it, good roadmaps help transfer to the scientists the idea of "customer driven" and what it means *operationally*. When participants lacked this capability to translate deep knowledge between thought worlds (Dougherty 1992), then the routine would suffer, as people, even when they ventured outside their functional "silos," would end up talking past one another.

Complexity Reduction. Participants in a successful routine also were able to simplify, in an intelligent way, the daunting task of dealing with a large amount of data. This ability was particularly important for the roadmapping routine, which involves creating an explicit, written roadmap. Knowledge management theorists (e.g., Nonaka 1994) sometimes seem to imply that knowledge that is codified is easy to absorb, but the evidence here suggests otherwise. The problem for knowledge-intensive routines like technology roadmapping is that there may be an overwhelming amount of explicit knowledge, making it hard for people to absorb it all in a meaningful way. In these cases there is a greater importance for the capability to reduce complexity. From a theoretical perspective, complexity reduction is also related to the idea of sense making (Weick 1993), where boundedly rational actors are forced to make sense of and manage the complexity of their environment.

People in less successful cases were unable to convert information into useful,

meaningful knowledge. For example, the sheer volume and complexity of roadmaps at low-performing Printing Systems made it hard for executives to absorb the content of roadmaps.

> It's a dog and pony show [when we review a few *dozen* roadmaps in a single meeting]. And we're the donkeys. People are glazed over. There is no content.
>
> — R&D Executive, Printing Systems

As a result, decision makers at Printing Systems were quickly overwhelmed and could not easily interpret or absorb the complexities of the roadmapping routine. In contrast, at Machine Tools, roadmappers successfully used a familiar picture—a cartoon-like schematic of a "machine tool"—to make a complicated technological landscape more comprehensible and meaningful. When the new information was connected to people's existing mental models—i.e., when it had a "slot" to go into—then it could be more easily absorbed and acted upon (Barsalou 1992).

Technical Competence. If complexity reduction is primarily important for routines focused on explicit knowledge (e.g., technology roadmapping), then the issue of technical competence was mainly cited by interviewees as important for routines focused on tacit knowledge (e.g., technology transfer). Technical competence, a type of capability, is defined here as the firm's ability to understand enough of how a technology works so it can incorporate it into new products. This concept is related to notions of core competence (Prahalad & Hamel 1990) and core capabilities (Stalk, Evans, & Shulman 1992) and often involves tacit knowledge. Roadmapping participants could get by with just knowing *about* the relevant technologies; but, for technology transfer, someone—either the receiver, sender, or both—had to know all of the nitty-gritty details of how the technology worked for the routine to be successful. This point is easy to say in theory but quite difficult to implement, due to the "stickiness" of (i.e., difficulty in transferring) tacit knowledge within a firm (Szulanski 1996). The firms in this study used a variety of techniques to overcome the problem of getting technical competence to where it was

needed, with mixed results. For example, according to one interviewee, "This is the most important thing in technology transfer: personnel transfer." On the other hand, a corporate R&D scientist at E-Corp quit because he was bored doing commercialization work. Scientists helping with commercialization at Venture did not quit, but they bungled the documentation:

> When we started wiring up the equipment, we'd find terminals that didn't go anywhere! So we'd have to ask, "What did you intend to do with this?" [Since then,] we are [now] doing the drawings for prototype assembly.
>
> —Engineering Manager, Venture project, Machine Tools

In sum, when a routine involves a great deal of tacit knowledge, it is important to have sufficient technical competence *in the right place* in the organization. When a routine involves a great deal of explicit knowledge, though, the issue is not so much this cognitive-based knowledge "stickiness" (Szulanski 1996), but rather the need to reduce intelligently the cognitive complexity of the large amounts of explicit knowledge. Moreover, in both routines—whether focused on explicit or tacit knowledge—it is important to have (or develop) a shared language.

Theme 3: Power to Implement the Routine

In addition to desire and capability, a third theme was that routines were more successful when supported by powerful and influential actors in the organization. Power is an issue that has rarely, if ever, been integrated into theories of organizational learning, knowledge, or routines. Nelson and Winter (1982: 110), however, in their discussion of routines, do at least raise the issue of power and conflict: "manifest conflict follows largely predictable paths and stays within predictable bounds that are consistent with the ongoing routine. In short, routine operation involves a comprehensive truce in intraorganizational conflict." In this view, power and conflicting interests exercise little direct influence over the operation of a routine. Yet I find that power moves are an important factor in the success of a case of a routine. Interestingly, whereas Cohen et al. (1996) note that routines can affect the distribution of power, I focus in this paper on

the reverse: that powerful actors can make or break the success of a case involving a particular routine. In particular, the two sources of power that most affected outcomes for this study's routines were *senior management support* and *expert support*.

Senior Management Support. Routines experienced many more problems when senior managers did not support a technology transfer or roadmap. While this point seems obvious in retrospect—and is practically a truism in the literature on organizational change (e.g., Kanter 1983) and product champions (Burgelman 1983; Day 1994; Dougherty & Hardy 1996)—many practitioners did not consciously address or manage this issue, instead hoping that technical rigor alone would overcome any problems. Even more striking is that *scholars* of organizational learning, knowledge management, and routines have often overlooked non-capability factors (Levin 2000) such as power. Yet this study consistently found that senior managers can galvanize resources for a routine, and they can confer legitimacy upon it.

> Roadmaps need a champion or they don't get done.
>
> —Divisional R&D Manager, Machine Tools

> If senior managers talk about or acknowledge a roadmap, it causes people to take notice.
>
> —Technology Manager, E-Corp

> We are an impatient company, [but Vice President Roger is] keeping the sharks away [so the start-up Venture project can grow].
>
> —Product Engineering Manager, Machine Tools

This study's cases were probably a conservative examination of senior management support, since a lack of such support probably killed many transfers and roadmaps before they got too far.

Expert Support. Besides having senior management support, successful routines also tended to enjoy the support of those with structural power (Pfeffer 1992), such as technical experts in a strategically important domain. For the highly successful Compass case, the

technical guru associated with the product group receiving the Compass technology was in fact the one who initiated the Compass project; thus, he felt a special sense of ownership towards it and his commitment to the project never waned. In contrast, opposition by such experts, when it occurred, typically took the form of neutral and polite indifference. In other words, expert support and opposition were *not* the simple reverse of each other. For example, in the Memory case, no one especially powerful backed, let alone championed, the technology transfer, but there were also no signs of open opposition or hostility either. Rather, Memory technology was simply rejected silently by potential receivers:

> They didn't tell us they were doing it [as they chose an alternate technology].
>
> —R&D Engineer, Memory Project, E-Corp

Why waste political capital, opponents seem to conclude, if no one powerful is a supporter anyway? Naïve participants who mistook an expert's silent opposition as quiet consent did so at their own peril.

In sum, routines were rarely fully implemented unless they were supported politically by key stakeholders, such as top managers and those with structural power, such as technical gurus.

Cross-Case Comparisons

To help illustrate the above findings, we now turn to examine how the three broad themes of desire, capability, and power affected the outcomes in the 14 cases studied. Although this sample is too small for formal theory testing, the case comparisons are nevertheless strongly suggestive and are thus presented here to help clarify some of the themes and theoretical issues that emerge from the data. To make these comparisons, both interviewers read through the five-to-six-page case studies and independently rated each theme on a four-point scale, where 1 = poor, 2 = fair, 3 = good, and 4 = excellent. A doctoral student blind to the research also read the full case studies (minus any information on outcomes) and rated them along each theme. The

average initial inter-rater correlation was .72 (after discussion, .75, ranging from .71 to .79).

Overall, I define a successful instance of a routine as one where, on balance, the outputs from the routine are useful and worthwhile for the organization as a whole. Because a good technology transfer outcome is not quite the same as a good technology roadmapping outcome, though, I used parallel but distinct metrics for each. For technology transfer—to allow for apples-to-apples comparisons, since some technologies are inherently more useful than others—the two researchers independently scaled the outcome measure to indicate the extent to which each transfer's goals were achieved without major problems (inter-rater correlation of 1.00). For the technology roadmapping routine, one of the researchers estimated the extent to which a given roadmap influenced cross-functional decision making. That is, did the organization actually *use* the knowledge embedded in the roadmap? Note that the focus here is thus on changes in actions (i.e., from the routine), not just in understanding (which alone could only affect the capabilities for a routine). One limitation of this study's approach is that it does not include a long-term (i.e., beyond two years) or objective measure of impact on the organization, although it is based on multiple interviews per case. Future studies, however, might look at success over several years as well. The outcomes scale for the 14 cases here are on a five-point scale; however, to avoid confusion with the scale for themes, the outcome values range from zero to one (see Table 2).

[Insert Table 2 about here]

Based on several paired-case comparisons, it appears that the capability theme alone does not explain the outcomes for these cases very well:

- Two technology transfers at E-Corp's Controllers Division (case #7 vs. #14)
- Two technology transfers at Machine Tools (case #10 vs. #13)
- Two technology roadmaps at Environmental Systems (case #2 vs. #5)

These paired comparisons allow us to hold constant much of the organizational and environmental context to help us determine when the two routines appeared to work well.

Perhaps the most dramatic of these contrasts is between Compass (case #7) and Memory (case #14). These two cases appear quite similar on the surface: they both took place in the same division of the same company, were of similar strategic importance, were both technologies designed to improve product development, and both appeared to possess a strong capability (Compass=4, Memory=3). Yet, for outcomes, Compass scored a .95 and Memory, only .05. This dramatic difference seems to lie in their very different scores for desire and power: whereas Compass received a 3.7 (excellent) for desire and 3.3 (good) for power, Memory scored a 1.3 (poor) in both areas. That is, even though Memory participants had the *capability* to transfer the technology in this case, they lacked much desire: many of them had little trust in the other participants; had no knowledge craving for the technology in question, seeing it as a "castor oil" technology; and had no task motivation to follow up on all the little chores required. Moreover, no one powerful, either senior managers or technical experts, much supported the Memory technology. The result was that this project was widely seen as a failure. In contrast, Compass participants did have a high level of desire and political support, and so Compass thrived.

Another paired comparison, between Venture (case #10) and Turnkey (case #13), also suggests that capability alone may not be enough to predict the outcomes of a knowledge-intensive routine. Here, both cases had a fair-to-good capability (Venture=2.7, Turnkey=2.3), both cases had good support from powerful players (Venture=3.3, Turnkey=3), both cases had at least moderate strategic importance, and both cases took place at Machine Tools. Yet Venture's outcomes were rated as .75, while Turnkey scored only a .25. Why the discrepancy? The answer appears to be that, at Venture, participants eventually developed a desire to work with the people,

knowledge, and tasks involved. Early on, according to one manager, "we underestimated the soft issues." Yet through various techniques such as counterpart pairings, Venture participants developed trust, knowledge craving, and task motivation. At Turnkey, though, this high level of desire never materialized. Ultimately, the Turnkey project was put on hold. As a senior manager stated, "Today we are in a monitoring mode, not a selling mode."

Devices (case #2) and Big Products (case #5)—two roadmapping groups at Environmental Systems—both scored a 2.3 (fair/good) on capability, but Devices had an outcomes score of .75, while Big Products roadmappers struggled to get the organization to use their roadmap in decision making (outcomes=.25). Why? For Big Products, task motivation was a big problem, as was the lack of both senior management and expert support, all of which effectively dried up any knowledge flow.

In sum, what the evidence here suggests is that, contrary to the tenor of much of the knowledge management and organizational learning literature, a superb organizational capability is no guarantee of full success—it appears to depend, too, on the themes of desire and power. Several alternative explanations—such as the possibility that limited internal resources or changes in the external environment might have favored the success of one case at the expense of another in the sample—did not apply and thus could not explain these results.

Discussion and Conclusion

> Technology roadmapping and transferring a technology is a sociological issue. They are not really technical issues.
>
> —R&D Manager, Controllers Division, E-Corp

This study's empirically grounded insights have painted a picture of organizational routines as something much different than a straightforward—even sterile—process of knowledge exchange that persists apart from individuals (Feldman 2000; Miner 1991). Rather,

the technology transfer and roadmapping routines are affected profoundly by the feelings participants have in wanting to work with one another, with the knowledge, and with the tasks involved, as well as the political power of supporters vis-à-vis other important stakeholders in the firm (Pfeffer 1992). Skills and competencies are surely important to the functioning of knowledge-intensive routines like technology transfer or roadmapping, but capability alone does not appear to be enough. Yet, with few exceptions, the issue of motivation is under-appreciated in the organizational learning literature (Levin 2000); and, with even fewer exceptions (e.g., Cohen et al. 1996; Rura-Polley & Miner forthcoming), the issue of power is nearly absent altogether. The framework proposed here is an attempt to incorporate these themes into a more complete model, to refine our understanding of when organizational routines work well.

Interestingly, the themes of desire, capability, and power bear some resemblance to psychological models of motivation and ability (e.g., Porter & Lawler 1968). More generally, many of the sub-themes highlighted here—such as task motivation; trust; senior management support; expert support—link up nicely with concepts familiar to students of organizational behavior. The added contribution here is that these concepts are shown in action in the context of knowledge-intensive organizational routines. Moreover, these concepts are systematically linked to short- and medium-term outcomes for routines, which prior research has suggested are critical for a firm to achieve a sustainable strategic advantage (Grant 1996; Levitt & March 1988).

For managers, the themes and sub-themes identified here could serve as leading indicators of success for a routine like technology transfer or roadmapping. This feature is an important practical contribution, since one of the most intractable problems in the innovation and knowledge management arenas is the question of how to measure results. Many managers simply focus on salient, global outcome measures, notwithstanding the woeful inadequacies of such

metrics; e.g., most R&D metrics have too long a time lag (e.g., commercialization occurs three years later) or too diffuse an impact (e.g., was the product successful because of the technology, the roadmap, or the myriad other factors?). What managers need is a set of metrics that can act as *leading* indicators, so they can take appropriate action today. This theory-building research study, by striving to develop a good theoretical understanding of routines, allows us to identify beforehand what are the areas that can ultimately lead to a better-performing routine. It is these areas that knowledge- or technology-oriented managers should consider measuring. Moreover, Table 3 illustrates some practical implications from this study in the form of a list of "do's and don'ts" for organizational routines. This list parallels the themes and sub-themes in the paper.

[Insert Table 3 about here]

From a theoretical perspective, this research study adds to our growing understanding of *how* organizations learn. Given that routines form the basis for organizational learning (Levitt & March 1988; Miner 1990), this multi-firm study has taken two critical routines—technology roadmapping and technology transfer—in a critical, knowledge-intensive arena (Roussel et al. 1991) and specified what makes them succeed. Because this study is theory building (Glaser & Strauss 1967), and relies on only 14 cases at four firms, further investigation is needed to clarify and formally test the findings. Already, though, recent work confirms the finding here that interpersonal trust (with or without a prior relationship) is the mechanism underlying the knowledge benefits of strong working relationships (details available from the author). In addition, future research could see if this paper's findings, based on large, technology-oriented companies, also apply to other contexts, such as professional service firms or high-tech start-ups.

This research study thus contributes to the literature on organizational learning and knowledge management in three ways. *First,* this study, along with others (Feldman 2000;

Pentland 1995; Pentland & Rueter 1994; Rura-Polley & Miner forthcoming), begins the process of tackling the challenge put forth by Grant (1996: 384) for more "detailed study of the operation of organizational routines." The current study actually goes a step further by not only studying the operation of routines, and doing so in more than just one organization, but also by specifying the main themes and sub-themes that appear to lead to better outcomes for organizational routines. This contribution—i.e., knowing what makes routines work well, at least in the short- and medium-term—is an important one, because routines form the basis for organizational learning (Levitt & March 1988; Miner 1990). Ultimately, improved understanding of routines helps us pinpoint more precisely how firms use their knowledge and resources to achieve strategic dominance in the marketplace. Contrary to the assumption of much of the knowledge management literature to date, an organization's capability does not appear to be enough to ensure full success for a routine; rather, this study's cases suggest that one must also take into account the themes of desire and power. This addition to our understanding of how firms manage knowledge—i.e., that desire, capability, and power are all apparently important if routines are to function well—seems sensible, but it has rarely, if ever, been explicitly or empirically demonstrated in the context of routines or knowledge management. *Second,* and more specifically, this study suggests that interpersonal trust appears to be the mechanism that explains why strong personal relationships are a key element for the functioning of a routine; i.e., strong, trusting ties usually helped improve outcomes, but trust alone was often just as good a substitute when only weak ties existed. *Third,* this study finds that, for routines involving tacit knowledge, participants must have sufficient in-depth technical competence; but, for routines involving a lot of explicit knowledge, this capability is less important: rather, it is more important for participants to find intelligent ways to reduce the complexity of too much explicit knowledge.

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Table 1
Fieldwork Statistics

Company / Event	Time (hours)	People	Notes (pages)
Environmental Systems	23	21	51
Printing Systems	14	10	28
Machine Tools	21	13	50
E-Corp	32	35	77
INTERVIEW TOTALS	90	79	206
Roundtable discussions	3	15 (9 new)	4
Analysis discussion meetings	12	22 [a] (3 new)	25
TOTAL	105	91	235

[a] Number of *unique* participants involved in four meetings.

Table 2
Summary of 14 Cases

Case	Company	Desire [a]	Capability [a]	Power [a]	Outcomes [b]
Technology Roadmapping cases:					
1. Spectrum	Environmental Systems	4	3	4	.95
2. Devices	Environmental Systems	3	2.3	3.3	.75
3. Midrange	Machine Tools	3.3	3.7	1.3	.75
4. Flip Chip	Controllers Div., E-Corp	2.3	2.7	2	.50
5. Big Products	Environmental Systems	2	2.3	1	.25
6. Office Products	Printing Systems	1	1.3	2	.05
Technology Transfer cases:					
7. Compass	Controllers Div., E-Corp	3.7	4	3.3	.95
8. Tester	Controllers Div., E-Corp	4	4	2.7	.95
9. Junction	Controllers Div., E-Corp	4	3.3	2	.75
10. Venture	Machine Tools	3.3	2.7	3.3	.75
11. Sensor	Controllers Div., E-Corp	1.3	1.7	2.3	.50
12. Neutralizer	Detectors Div., E-Corp	1.7	2.3	2.3	.50
13. Turnkey	Machine Tools	1.7	2.3	3	.25
14. Memory	Controllers Div., E-Corp	1.3	3	1.3	.05

[a] Average of three raters, where 1=poor, 2=fair, 3=good, and 4=excellent.

[b] Coded on a 0 to 1 scale. For technology roadmapping, .95 indicates that more than one functional group made three or more decisions based on a common roadmap; .75, two such decisions were made; .50, one significant decision, .25, no evidence; .05, multiple contrary decisions. For technology transfer, .95 indicates that all goals were achieved with no major problems (e.g., big delays or technical glitches); .75, most goals were achieved (so far) with no major problems; .50, most goals achieved but some major problems; .25, did not achieve main goals but not seen, on balance, as a failure; .05, did not achieve main goals and seen mainly as a failure.

Table 3
Practices that Helped or Hurt the Organizational Routines Studied

Theme	Sub-theme	Do	Don't
Do participants <u>want</u> to do the routine?	*People*	Build on or create trust between the people involved *—e.g., Flip Chip, Compass, Venture*	Assume that publishing a newsletter or "knowledge base" will get people to work together *—e.g., E-Corp*
	Knowledge	Get people to crave the knowledge in question by focusing on *their* interests *—e.g., Junction, Venture*	Hope that "buy-in" will eventually increase on its own *—e.g., Memory*
	Tasks	Be willing to follow through on all the little day-to-day tasks required *—e.g., Compass, Junction*	Look the other way when people just go through the motions *—e.g., Big Products, Printing Systems*
Are participants <u>capable</u> of doing the routine?	*Shared language*	Translate knowledge between domains at a detailed, operational level *—e.g., Midrange, E-Corp*	Focus on excellence only within each domain (e.g., marketing, R&D, strategy) *—e.g., Office Products*
	Complexity reduction	Link new knowledge to existing and meaningful mental models *—e.g., Spectrum, Midrange*	Overwhelm decision makers with large and complex amounts of data *—e.g., Printing Systems*
	Technical competence	Involve at least some people who understand the "nitty-gritty" details *—e.g., Tester, Compass, Neutralizer*	Overlook the ancillary skills required (e.g., documentation) *—e.g., Venture*
Do participants have the <u>power</u> to make the routine happen?	*Senior mgmt. support*	Use senior management support to get resources and legitimacy *—e.g., Spectrum, Turnkey, Neutralizer*	Hope that technical rigor alone will overcome any internal political problems *—e.g., Memory, Big Products*
	Expert support	Get active support from respected experts *—e.g., Compass, Venture, Turnkey*	Misinterpret silence by experts (a typical form of opposition) as tepid support *—e.g., Office Products, Memory*