

Thinning Knowledge:

An Interpretive Field Study of Knowledge-Sharing Practices of Firms in Three Multinational Contexts

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Abstract:

Knowledge is often tacit and “sticky,” i.e. highly context-specific and therefore costly to transfer to a different setting. This paper examines the methods used by firms to facilitate cross-site knowledge sharing by “thinning” knowledge, that is, by stripping knowledge of its contextual richness. An interview-based study of cross-site knowledge sharing in three industries (consulting, industrial materials, and high-tech products) indicated that highly developed knowledge-sharing systems do not necessarily involve extensive codification and recombination of personalized knowledge. Many multinational firms evidently conceive their knowledge-sharing systems with more modest objectives in mind than any large-scale “learning spirals” featuring iterative conversion of personalized knowledge into codified knowledge and vice-versa. A typology of knowledge-thinning systems was derived by interpreting the field study results from the perspective of knowledge-thinning methods used in earlier eras of history. The typology encompasses topographical, statistical and diagrammatic knowledge-thinning systems.

Keywords: Knowledge Thinning, Cross-Site Knowledge Sharing, Knowledge Management, Multinational Corporations, Personalized and Codified Knowledge

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Introduction

The ability of the firm to share internally generated knowledge is widely considered to be a cornerstone of the multinational firm's competitive advantage (Kogut & Zander, 1993). Just as endogenous growth theory in economics postulates the aggregate stock of knowledge to be the critical vector of economic development, it is tempting to view the firm's ability to generate knowledge as its core resource (Nonaka & Takeuchi, 1995; Kang & Snell, 2009). In a large complex firm, however, no single person or group has access to more than a small body of the firm's knowledge at any given time. This makes knowledge sharing among individuals and groups a necessity. Yet the process of knowledge sharing can be costly, and despite heavy investment in knowledge management systems by firms, payoffs are often illusive (Cabrera & Cabrera, 2002; Newell, Bresnen, Edelman, Scarbrough & Swan, 2006). This is due to the inherent properties of knowledge, i.e. the fact that the firm's knowledge is often largely tacit in nature (Polanyi, 1966), "sticky" (von Hippel, 1994), and highly specific to the context in which it is embedded (Foss & Pedersen, 2002). It is also due to limitations in the time and mental capacity that organizational members have to process new information and knowledge (March & Simon, 1958). Technological change has arguably exacerbated the problem. As new IT systems increase the volume of knowledge available to firm members, they engender bottlenecks of information overload and deepen attention deficits (Simon, 1997; Hansen & Haas, 2001).

In taking stock of the costs and obstacles standing in the way of intra-firm knowledge sharing, this research categorizes some of the means by which firms endeavor to economize and cope with barriers to knowledge sharing across firm units. A comparative field study of cross-site knowledge-sharing practices of six multinational companies (54 interviews at 18 total sites in three different industries) revealed a consistent pattern in which firms evidently felt compelled to advocate cross-site

knowledge sharing in conformity with contemporary management norms. Yet in reality these firms implemented knowledge-sharing practices aiming at a surprisingly modest level of cross-site knowledge transfer. Indeed, these practices appeared designed to facilitate knowledge sharing across geographically dispersed sites by “thinning” knowledge, that is, by stripping knowledge of its contextual richness. At the same time, the particular embodiment of these practices varied systematically across the three industry settings surveyed (consultancies, industrial materials, high-tech products).

Discussion proceeds as follows. The next section provides theoretical background on the “thinning” of knowledge. Since contextual richness, stickiness and tacitness raise the cost of sharing knowledge across organizational units, firms have an inherent incentive to focus on sharing knowledge that is contextually less rich, less sticky, and less tacit in nature. The process of “thinning” knowledge is a means of accomplishing this. However, only empirical investigation can identify the specific kinds of knowledge-thinning practices that firms actually elect to use. The Methodology and Results sections report on a field study undertaken to investigate the varying nature of knowledge-sharing practices in a sample of multinational firms.

The Analysis section extends the scope of these findings by presenting a typology of knowledge-sharing systems involving the “thinning” of knowledge. Following the lead of Mokyr (2002) and other technology historians (Ferguson, 1992; Alder, 1998), this section reinterprets the field-study findings by considering knowledge-thinning systems that were used in earlier historical eras. The recourse to economic history has both an analytical and demonstrative rationale. Analytically, a historical perspective is useful for deriving a conceptual vocabulary that distills the core processes of the knowledge-sharing practices observed in the field study (Thatchenkery, 2007). Demonstratively, the recourse to economic history helps make a case for the generalizability and robustness of our findings and interpretation (Kieser, 1994). The Discussion section works out further practical and theoretical ramifications of this research.

The proposed typology of knowledge-sharing practices involving the thinning of knowledge encompasses *topographical*, *statistical*, and *diagrammatic* systems. Given the absence of a clear terminological paradigm of knowledge management (Spender,

2005) and given also the conceptual confusion surrounding terms like “tacit” knowledge (Tsoukas, 2003; Håkanson, 2007), historical experience provides a basis for identifying underlying constants in the way individuals and organizations economize on the costs of knowledge sharing.

Theoretical Background: The Sharing of “Thinned” Knowledge

The advent of powerful communication and information technology (ICT) facilitates the electronic storage and dissemination of knowledge that can be rendered into a codified form. This fact has prompted interest in the process of knowledge codification (Cowan, David & Foray, 2000; Håkanson, 2007). Although such a process is frequently expressed as the “conversion” of “tacit” knowledge into “explicit” knowledge (Nonaka & Takeuchi, 1995), in the following discussion we adopt the historically demonstrated, and hence empirically vouchsafed terms of “personalized” and “codified” knowledge. One reason why the printing press was such a watershed in Western history was that it dramatically altered the comparative costs of personalized and codified knowledge sharing. Prior to Gutenberg transfer of knowledge by means other than personal interaction was in most cases prohibitively expensive due to the high cost of duplicating written materials. By greatly reducing the cost of knowledge dissemination and access, the printing press provided individuals and organizations with the option of whether to share knowledge via personalized or via codified means or some combination thereof (Mokyr, 2002). This has led to a proliferation of alternative knowledge-sharing “systems” in Western history (Thatchenkery, 2007).

Some knowledge-sharing systems feature a densely structured underlying “architecture” of participating actors (Grabher, 2004; Kang & Snell, 2009). Such an “architecture” generally involves not only mere transmission of knowledge from one party to another, but also an effort to aggregate existing dispersed knowledge in ways that result in learning, innovation, or competitive advantage (Kogut & Zander, 1993; Nonaka & Takeuchi, 1995). For modern IT tools to be involved in the process, firms are required to invest in a high level of knowledge codification (Steinmueller, 2000; Prencipe & Tell, 2001). The commonly given rationale for codifying knowledge is that,

beyond an initial investment of rendering knowledge into a commonly shared code, the cost of subsequently diffusing and accessing such knowledge is very low (Arrow, 1974). In addition, the codification process does not merely reproduce personalized knowledge in any static way, but rather induces firm members to raise the level of their cognitive understanding in the act of articulating knowledge (Prencipe & Tell, 2001; Zollo & Winter, 2002). Some scholars see firms as nurturing a large-scale “learning spiral,” a virtuous circle in which firms are incessantly involved in the transformation of personalized into codified knowledge and vice-versa (Nonaka & Takeuchi, 1995; Boisot, 1998).

Nonetheless, the costs of maintaining knowledge management systems are now widely acknowledged to be substantial. Knowledge and information are often sticky (von Hippel, 1994), that is to say, highly context-specific (Foss & Pedersen, 2002) and therefore difficult to transfer to a different setting (Szulanski, 1996). As Boisot (1998) points out with his distinction between codified and abstract knowledge, even after codification there remains the challenge of generalizing knowledge so that it becomes applicable to a wide range of situations. On top of the cognitive challenge of sharing knowledge, individuals and groups within organizations often lack the proper incentives to share knowledge (Davenport & Prusak, 1998). Within companies, knowledge sharing involves the risk of making contributors redundant to the company (Kalling & Styhre, 2003).

Thin Knowledge. In contrast to large-scale knowledge management systems and learning spirals, there exists a multidisciplinary body of scholarship on what one could term “thin” knowledge. The concept of “thin” knowledge is usually associated with Geertz (1973) who used the concept in a rather negative way, contrasting the “thick” description of ethnography with the “thin” categorizations of scientifically minded anthropologists. Yet the history of scientific and economic development demonstrates precisely the vital importance of “thin” knowledge and the conversion of contextually rich (“thick”) knowledge into thinner and hence more easily transmittable bits of knowledge, a process that can be called the “thinning” of knowledge. For example, Alder (1998, p. 504) explains in his study of the French 18th-century breakthrough in mechanical drawing:

The thickness of both artifacts and their representations can be contrasted with *the ‘thinning’ process by which scientific objects are often made amenable to analysis*. Here Gaston Bachelard provides a valuable hint. He notes that the synthesizing power of explanation in the physical sciences depends on a vast array of precision scientific instruments which investigators wield to create objects that are mathematically tractable, and can therefore constitute legitimate objects of inquiry. In the extreme case of 20th-century physics, these objects ... become more than similar; they become ontologically identical; and this in some sense accounts for the fact that their properties can be described with unsurpassed precision and economy. (Our italics)

The cited need for “precision and economy” illustrates that parsimony in knowledge diffusion is quite an old imperative and not just a symptom of the Internet age. The perspectival and projective drawing systems developed by French engineers, for example, became an effective tool for diffusing technical knowledge because of their capacity to reduce (“to thin”) the physical properties of machines to a two-dimension visual representation.

This perspective on the “thinning” of knowledge highlights an important research question that emerged in the course of field research: What different kinds of “knowledge-thinning” systems can and are used by firms to facilitate the transfer of knowledge across geographically dispersed sites? As reported below, the field study revealed a variety of methods used by firms to facilitate cross-site knowledge sharing by “thinning” knowledge, that is, by stripping knowledge of its contextual richness.

Sample and Research Method

We conducted an exploratory field study to examine the process of knowledge sharing across sites (headquarters, subsidiaries) within multinational corporations. The objective was to identify and categorize different ways by which firms managed the potentially high cost of sharing knowledge across units.

The research approach consisted of multiple case studies. A case-based approach is useful for developing new analytical categories (Eisenhardt, 1989). Case-based research is also applicable when, as here, the boundaries between the phenomenon under study (e.g. knowledge sharing) and its broader contexts (e.g.

organizational context, industry context, etc.) are somewhat unknown and in need of explorative clarification (Yin, 1993). The analytic goal is then to relate a narrow range of phenomena to a broader context covered by a more macro level of theory. Such theorizing can be denoted as “analytical generation” (Yin, 1993, p. 37) or theory refinement (Weick, 1995; Snow, 2004).

Sample Selection. Since knowledge-sharing patterns vary by industry context (Grabher, 2004), the interviews covered three different industry settings (consultancies, industrial materials, high-tech products). Following the logic of theoretical sampling (Strauss & Corbin, 1990; Flick, 2007), the selected industries spanned a wide contextual range from settings where personalized interaction and knowledge would be most important (e.g. consultancies) to those where codified knowledge could be expected to play a more important role (e.g. high-tech products). The effort to ensure variety along this dimension was motivated by prior studies indicating substantial cross-firm variation in the mix of personalized and codified knowledge (Hansen, Nohria & Tierney, 1999; Maier, 2004). In the three represented sectors we interviewed two different firms to build in a certain replication logic (Yin, 1993).

Initial contacts indicated that all selected firms considered cross-site knowledge sharing to be an important process and a source of potential or actual competitive advantage. Interviews were conducted at three different country sites of each firm in order to assess knowledge-sharing practices from multiple perspectives within the organization. The field study thus took place at 18 sites of the six companies, in 10 different countries and on three continents. At each site 2-4 (usually three) interviews were conducted with experienced managers, yielding a total of 54 interviews. All six firms were headquartered in Western countries, either in Europe or North America. Restricting the sample in this way helped control for possible confounding effects from macrosocial variables; for instance, Inkpen and Dinur (1998) and Zhao and Luo (2005) note that Western and Japanese firms tend to exchange qualitatively distinct types of knowledge. Table 1 provides an overview of the firms interviewed.

INSERT TABLE 1 ABOUT HERE

The choice of interview sites and interviewees had to satisfy multiple criteria. One interview site for each company was always the headquarters, whose managers were asked to recommend two foreign subsidiaries of strategic importance for further interviews. At each firm, one subsidiary in relative proximity to the headquarters and one subsidiary at a greater geographical distance were requested. This was done in order to build center-periphery variation into the sample, again adhering to the logic of theoretical sampling (Strauss & Corbin, 1990; Yin, 1993). The selected interviewees were recommended by our firm contacts as especially qualified to comment on the firm's use of knowledge as a strategically important resource and to answer questions about strategic and organizational issues within the firm. In sum, the subsidiaries and managers were selected with the aim of collecting a diverse range of perspectives on the phenomenon under investigation (Tyler & Gnyawali, 2009).

Survey Instrument. Semi-standardized interviews with firm managers lasted approximately two hours, with two members of the research team present at each. Interviews were taped, subsequently transcribed for analysis, and finally codified according to a categorical framework described below.

The semi-structured interviews were organized around several sets of questions, each devoted to a specific issue area (Fontana & Frey, 2000). Overall these questions aimed to ascertain the function, specific practices and relative intensity of cross-site knowledge sharing in the interviewed firms. Since knowledge-sharing systems consist of both personalized and codified components (Hansen et al., 1999; Maier, 2004), the interview protocol included questions about both the technical infrastructure for knowledge sharing and more personalized knowledge-sharing practices. With regard to the latter, the nature of internal firm "networking" and "communities of practice" were of particular interest. Concerning both personalized and codified knowledge flows questions were asked about the frequency and intensity of knowledge exchange and about the degree of its strategic importance, that is, whether the exchanged knowledge involved bilateral discussion of topics relevant to strategic decision-making or instead merely operational data. Table 2 provides an overview of the interview protocol.

INSERT TABLE 2 ABOUT HERE

Other questions asked pertained to the structure, strategy, and industry context of the organization, including questions about the global product strategy of the firm, such as the degree of local tailoring of products (Bartlett & Ghoshal, 1989; Lehrer & Behnam, 2009). Related inquiries about the industry context centered on the extent to which the firm's markets were local, global, or some combination of the two.

Content Analysis. Content analysis was conducted as “an approach of empirical, methodological, controlled analysis of texts within their context of communication, following content analytical rules and step by step models, without rush quantification” (Mayring, 2000). The transcribed interview statements were coded and grouped according to ten basic categories, namely the ten “variables of interest” listed in the interview protocol (Table 2). The categories were derived from previously published frameworks using systems theory (Kasper, 1990), social psychology (Weick, 1979), and other theories mentioned in the literature review above.

To promote inter-coder reliability the material was encoded only by trained researchers. Each interview was encoded by two different members of the research team in order to prevent important aspects from being overlooked. Consistent with the recommendations of Eisenhardt (1989), the research team of five members spent considerable time as a group sharing impressions and data in order to achieve a consensual view of the knowledge-sharing similarities and differences among the six interviewed firms.

The applied iterative method of data analysis was as follows. We integrated the results of the three interviews per site to obtain an overall assessment on each firm unit (headquarters or foreign subsidiary). Thereafter we combined the assessment of the three units per company and performed an analysis at the company level. Thus, assessments of knowledge-sharing patterns at each firm were triangulated by synthesizing the varying perspectives of different interviewees at multiple company sites.

This exercise was performed for each of the ten topic categories listed in Table 2. These ten categories concerned the (1) *means of access*, (2) *perceived value*, (3) *patterns of use*, and (4) *mechanisms for retention* of knowledge generally within the company; the firm's (5) *cross-site knowledge-sharing patterns* (involving both personalized and codified knowledge), as well as the presence or absence of (6) *formal/informal networks and "communities of practice"*; and finally, the (7) *strategy*, (8) *structure*, (9) *industry context* and (10) *organizational culture* of the firm. Findings were compiled into a 60-cell matrix consisting of 6 columns (one column per company) and 10 rows (one row for each of the 10 categories listed above). This matrix was posted and reworked in a cycle of iterations until an overall consensus could be reached. This was important not only for triangulating findings within each company, but also for making comparisons between the companies. In particular, the assessment of knowledge-sharing intensity in these firms was made in relative rather than absolute terms. Only after the entries in the 60-cell matrix stabilized was the next stage of analysis conducted.

Interpretation of Results and Typology Construction. The final two stages of analysis, the interpretation of results and construction of a more generalizable typology, are reported in the following two sections respectively. In a sense, both stages involve categorization of a certain kind. The first stage, the presentation of results, essentially uses categories to summarize the basic findings without claim to wider validity beyond the sample. The categories are empirically descriptive. Here the goal is to identify categories minimizing differences within groups of firms while rendering differences between groups of firms as significant as possible (Kluge, 2000).

In contrast, the second stage of categorization aims at constructing a typology with wider applicability (external validity) while possibly sacrificing descriptive relevance (internal validity) to the research sample. The goal is to construct "empirically grounded types" that synthesize theoretical considerations with empirical findings: "Empirical investigations always need theoretical knowledge, because investigations cannot be carried out purely inductively. (...) On the other hand, qualitative social research must also be based on empirical investigations, if meaningful statements about social reality are to be made and not empirically remote constructs. It is only when empirical

analyses are combined with theoretical knowledge that ‘*empirically grounded types*’ can be constructed” (Kluge, 2000). In our case, the empirically grounded types relate to different basic methods for “thinning knowledge,” focusing on a narrowed range of phenomena from the field study and amplifying one of the most salient findings.

Results

The scope of cross-site knowledge sharing was consistently more modest than initial contacts had led the research team to expect. More specifically, only a modest volume of knowledge was shared across sites. However, the factors responsible for this varied by firm and industry sector. Analysis of the results involved three basic steps: 1) identifying the primary cross-site knowledge-sharing practices used by the firms; 2) understanding the function as well as the immediate reasons for the use and non-use of such practices; 3) putting the knowledge-sharing practices of the surveyed firms into the context of their respective business environments.

Table 3 summarizes the results of the content analysis. In general, knowledge-sharing patterns clustered by industry group. Both consultancies exhibited similar distinctive patterns, as did both high-tech firms. In contrast, the industrial materials firms differed from each other in the level of development of their cross-site knowledge-sharing practices, with Industrial Materials 2 reporting much more developed practices than Industrial Materials 1. Nonetheless, these firms remain lumped together in the tables because of other characteristics that were common to both.

INSERT TABLE 3 ABOUT HERE

Table 3 also summarizes the reasons for the modest level of shared knowledge in terms of the apparent obstacles and disincentives to more intensive knowledge sharing. These obstacles varied systematically by industry setting and emanated from the nature of the firms’ respective business.

Table 4 expands on the basic findings with regard to industry and organizational factors. For instance, the standardized nature of products sold by high-tech firms favored centralized organization and evidently reduced the need for cross-site knowledge sharing. In contrast, the localized nature of consulting favors decentralized operations connected by informal networks of knowledge sharing. This table also indicates the research team's overall assessment of the relative intensity of knowledge sharing among the firms. This assessment was derived from two basic dimensions: (a) the frequency of knowledge exchange, that is, whether it was continuous (daily/weekly), regular but less frequent (e.g. monthly), or intermittent (as per variable #5 in the interview protocol, Table 2); and (b) the strategic relevance of such knowledge (Hong & Nguyen, 2009, p. 348; Kasper, Lehrer, Mühlbacher & Müller, 2009), that is, whether interviewees indicated that the knowledge exchanged involved topics relevant to strategic decision-making or whether it was merely operational information used in routine processes (as per variables #2, #3 and #5 in the interview protocol, Table 2).

INSERT TABLE 4 ABOUT HERE

The following paragraphs review the findings on an industry-by-industry basis, fleshing out the factors behind the “thinness” of knowledge exchanged across geographically dispersed sites within the interviewed firms.

Management Consulting. While both management consultancies considered cross-site knowledge-sharing systems a must for reutilizing knowledge gained from prior projects, such systems were described as “pointers to knowledge” rather than as repositories of knowledge. Interviewees described the knowledge-sharing system as a kind of news and matchmaking platform, enabling individuals to broadcast their skills and experience while providing project leaders with a means to survey the experience profiles of individuals who could be selected to participate in future projects. The consultancies' knowledge-sharing systems consisted more of a summary about which individuals possessed what kinds of knowledge based on past experience rather than a real compendium of such knowledge itself.

A couple of factors constrained the use of the existing knowledge-sharing systems. First and foremost, interviewees indicated a clear reluctance of consultants to provide too much information that would make them redundant; instead, the clear pattern was for consultants to share just enough knowledge so that other colleagues would come calling for future projects. Second, the scarcity of spare time for documenting work meant that electronic knowledge management systems were often not up to date:

The system was totally redundant. I would use it but it needs to be usable, I mean I have tried to use it. The way that skills Yellow Pages would work would probably be me finding a record of a project that has been completed, then finding out who has been involved in our project. That is the way we would mostly do it in order to establish contact, but not through the profile database unfortunately (MC2 – Information Specialist).

So instead of using IT tools, consultants relied more on personal networks for sharing knowledge, as even those responsible for developing the IT tools acknowledged:

I had a huge suspicion that the way a lot of information was being got hold of was via the informal network. So you got into contact with people you knew, in different offices you knew were working on different projects and you kind of shared your understanding or your benchmarks with those individuals and completely cut out the formal processes (MC1 – Member of the Information Professional Team).

The industry context of consulting, in which local markets need to be served by highly autonomous, knowledgeable groups of employees, influences the organizational structure (flat hierarchy and decentralized) and creates natural incentives for the sharing of geographically distributed knowledge. Interviewees at both firms underlined the importance of informal networks as opposed to formal systems.

As we have a kind of internal market-platform, it is very important to become known within the company ... It is not self-evident that one will be recruited for a team. That is why it is very important to establish a network, to communicate with a lot of people, to try to get to know other colleagues working on other practices or in other units. This is one indicator of success (MC1 – Consultant). For me, the important things are the numbers on my mobile phone. Numbers of the people that I know, I need to talk to. The network is completely informal (MC2 – Associate Partner).

To the extent that more technical means existed, they functioned, just as one quoted interviewee put it, as “skills Yellow Pages” (MC 2 – Information Specialist).

Industrial Materials. The two companies producing industrial materials revealed a much lower level of cross-site knowledge-sharing intensity. Both firms were involved in the process of rationalizing production across worldwide sites, many of which were acquired. In both global companies, the high level of heterogeneity of conditions across sites posed a considerable challenge to knowledge-sharing efforts.

More developed cross-site knowledge-sharing practices were in place at Industrial Materials 2, where top management was interested in implementing such practices, than at Industrial Materials 1, where top management support was lacking. In Industrial Materials 2, knowledge sharing serves largely the function of benchmarking and best-practice sharing.

We implemented a benchmark database, where the different plants are compared to each other (IM2 – Member of Executive Board).

In theory, such a database is supposed to promote sharing of best practice, not just to measure performance.

People believe that [the company] is managed by financial targets and if you are not able to reach these targets, you have to bear the consequences of being jeopardized. Thus, we need to remove those fears, need to convince them that we are counting on them and that we are not just looking for results and that we need to use their know-how in order to be better than our competitors (IM2 – CEO).

Nonetheless, many subsidiaries were concerned about how such a system might be used, as reflected in the statement that: “The weakest 10 subsidiaries will be closed” (IM2 – General Manager).

In sum, cross-site knowledge sharing systems in Industrial Materials 2 were actively under construction but faced inherent difficulties stemming from fears about the actual purpose served by benchmarking. Progress at Industrial Materials 1 was slower, reportedly because of lack of top management support:

That is the problem, they [top management] are not really against it but they are not in support of it either. If they would support it, it would work (IM1 – Controller).

Nonetheless, cross-site knowledge-sharing initiatives in Industrial Materials 1 were reportedly becoming more frequent and were often organized by networks of executives on a functional basis:

The networks are to be found in R&D, IT, Human Resources. It is in manufacturing excellence where we promote networks and those networks have a formal face-to-face meeting at least once a year and then there are video and phone conferences probably on a monthly basis more or less (IM1 – Executive Vice President).

Both firms were decentralized in their operations. The degree of centralization was higher at the strategic level (especially in Industrial Materials 2), and it was at the strategic level that knowledge-sharing efforts were initiated. In addition to heterogeneity and latent competition among sites in the wake of global rationalization as obstacles to cross-site knowledge exchange, some production sites had been acquired from former rival companies, giving rise to a problem of conflicting organizational cultures.

High-Tech Companies. The two high-tech companies both turned out, upon closer investigation, to have contemplated systems for employees to engage in cross-site knowledge sharing without actually following through on them. Some interviewees were apologetic about the fact:

We have a bad information and knowledge culture. I recognize this because we do not have any information strategy and there is no platform, no instrument, where this culture exists (HT2 – Managing Director).

These and other statements suggested that cross-site knowledge sharing was definitely an issue at both High Tech 1 and High Tech 2, with some managers clearly in favor of them.

The company is generating so much knowledge that it would be wise to develop a system with access for all employees (HT1 – Controller).

In fact, both firms featured an array of highly developed IT tools for monitoring firm operations which could, in principle, have been made more accessible to a wider range

of firm employees beyond the top-level staff that essentially monopolized their use. Yet both firms, despite thinking actively about knowledge-sharing systems, had not acted to implement them.

Some interview statements questioned the utility of knowledge sharing, suggesting the costs outweighed the benefits in the eyes of top management.

Knowledge management was deleted from the project list on the highest level. There is an ABC-list and the topic 'knowledge management' is no longer kept as an official project (HT1 – Controller).

A lot of information and knowledge management goes just somewhere. Information is a difficult thing to deal with. In almost every company you can hear things like 'I get insufficient information' or 'the information-flow is bad'. But if you provide someone with all the information you have, he cannot profit at all because he cannot absorb it or deal with it. That is why such statements have to be put into perspective (HT2 – CEO).

Such findings make sense in view of these firms' decidedly centralized structure and top-down knowledge flow structure. Knowledge is highly codified at both firms.

You will find processes codified [*abgebildet*], forms, documents. We also use project tools for project communication and assessing progress, data, calendars, contracts -- there is little in the firm that has not been codified [*abgebildet*] (HT1 – HR Manager).

Knowledge is in drawings, the routines of manufacturing. It's not locked into one person, but in the whole company and that sets us apart from other companies (HT2 – Quality Director).

In other words, core knowledge is embedded in products and processes. These products and processes are masterminded and monitored by headquarters using sophisticated IT tools. Thus, knowledge codification and centralization of the core management processes are mutually reinforcing, mitigating the need for cross-site knowledge sharing while nonetheless frustrating employees on the periphery who would desire more insight and input into operations.

For these high-tech firms, product design and quality control were reported to be the strategically critical functions. Centralization of these functions is facilitated by

the fact that these firms serve electronics markets in which product specifications are rendered in a globally standardized and codified format.

Though not cultivating systems for employees to share their knowledge in any bottom-up kind of way, these firms do feature extensive IT systems to exchange technological information across organizational units: product blueprints, quality control data, etc. In fact, these systems are quite critical. Whether one wishes to qualify these as knowledge-sharing systems of some kind depends on one's standpoint within the organization. From the standpoint of subsidiaries, these systems process data rather than knowledge, casting subsidiaries largely in the role of "feeding" these systems with the requisite numbers according to well-defined processes that largely exclude learning or initiative at the subsidiary level.

From the standpoint of executives at headquarters, in contrast, these data-sharing systems are important knowledge-management tools for coordinating the basic engineering tasks of the company at both a design and implementation level. At a design level, these systems assist in codifying and integrating high-level executive decisions about how products will be designed and produced. In particular, product designers can coordinate and accumulate design knowledge using computer-aided design (CAD) tools. At an implementation level, these tools ensure that company operations actually adhere to top-level decisions made about products and processes while providing feedback from subsidiaries when they do not. Thus, quality controllers can embed quality control knowledge in computer-based tools implemented uniformly across the organization and imposed on the subsidiaries. To reiterate, while these firms' extensive IT systems for exchanging technological information across sites do not qualify as *knowledge-sharing* systems, they certainly do constitute *knowledge-management* systems that were included in the next step of analysis.

Analysis

The final step in analysis was to place these findings within a wider perspective. The disparate knowledge-sharing patterns of the three industries were examined through the lens of Mokyr (2002), Alder (1998) and other technology historians (listed

below) in the search for analogous systems in earlier eras of history. This interpretive step served two purposes. First, it focused attention on some of the core processes involved in knowledge sharing, thus helping to isolate the “signal” from the “noise” in the results. Second, parallels emerging in completely differing historical contexts raised the likelihood that the observed patterns could be generalized to settings beyond the specific firms and industries examined in primary research. As Kieser (1994, p. 612) puts it: "By confronting theories ... with historical developments, these theories can be subjected to a more radical test than they have to pass when merely being confronted with data on short-run changes."

In their review of research on knowledge management, Argote, McEvily and Reagans (2003) noted that most contributions tend to focus on one of three contextual issues relating to knowledge: 1) properties of organizational units, 2) properties of the relationships between units, and 3) properties of knowledge itself. Of these issues, it was upon the third, the properties of knowledge, that the research results cast the most light. Although the multinational firms in the sample featured entirely disparate knowledge-sharing systems, an emergent central finding pertained not only to the rather low volume of knowledge that these systems shared, but to the rather low level of knowledge that these systems were essentially *designed* to share. In different ways, these firms' knowledge-sharing systems condensed knowledge into parsimonious bits of information, a process one could term knowledge “thinning.”

To begin with the consulting firms, the “thinning” of knowledge these firms engaged in could be considered *topographical* in character. These firms availed themselves of a system that indicates the *whereabouts* of knowledge more than transmitting the actual *content* of knowledge. It will be recalled that the consulting firms' cross-site knowledge-sharing platform consisted primarily of a map of pointers to dispersed knowledge throughout the firm. The knowledge-sharing platform is really a preliminary means to facilitate the assembly of future project teams by indicating who knows what within the organization. To the extent that knowledge is transferred across sites, this usually occurs within the confines of specific projects involving individuals from different sites rather than via the knowledge-sharing platform itself.

A topographical knowledge-thinning system that facilitates the sharing of knowledge by indicating location usually points to specific individuals or groups rather than to a physical location. For example, beginning around 1800 and gathering steam in the 19th century, individuals placed personal ads in newspapers to advertise their skills; prior to this, posters were the primary medium for personal ads (Nevett, 1982). The Yellow Pages represent yet another historical illustration of a knowledge-thinning system that does not provide solutions to problems but indicates whom one might contact to obtain assistance with a solution.

Interviews underlined the importance of personalized knowledge in the consulting firms. And, in fact, a topographic system is especially useful for gaining access to personalized knowledge. As Mokyr (2002, p. 115) puts it:

ICT makes it easier to find the people who possess this [personalized] knowledge, and hire them, if possible, on an ad hoc basis. Technical consultants and subcontractors with “just-in-time” expertise have become pervasive. One reason, I suggest, is that modern ICT makes it easier to track down where this knowledge can be found (or, one step removed, easier to track down *who* knows where this knowledge can be found, and so on).

However, the “whereabouts” of knowledge can also refer to specific projects in which knowledge was acquired, including one’s own previous projects. As an illustration of this, Steinmueller (2000, p. 367) notes that ICT tools can be useful as a memory aid rather than as a comprehensive repertoire of knowledge:

Gains are likely to flow from the group use of ICT as a way of augmenting group memory ... For such gains to be realized, the codification of solutions does not have to be complete. Instead, the purpose of the collective memory is to ‘signal’ the availability of the previous work ...

In contrast to the topographical systems indicating the location of knowledge, two other kinds of knowledge-thinning systems listed in Table 5 – “statistical” and “diagrammatic” systems – achieve the thinning of knowledge by condensing its content. The industrial materials firms made use of a *statistical* knowledge-thinning principle. Whereas the starting point for knowledge sharing among consultants lies in individual experience, the knowledge-sharing process for industrial materials companies takes its

point of departure from site-specific performance statistics. From there the knowledge-sharing effort works its way down to identify specific practices that may be responsible for performance differentials.

In essence the industrial material firms had implemented a rudimentary performance management system (PMS). Such systems aim not only at evaluating what different units within the firm have achieved but even more at creating a platform for achieving greater companywide coherence in goals, strategies, and information feedback loops (Otley, 1999). The generation of performance statistics, in balanced scorecards and other PMS, is therefore intended to draw attention towards the firm's future rather than towards the past, the basic objective being to link a company's long-term strategy with its short-term actions (Kaplan & Norton, 1996).

INSERT TABLE 5 ABOUT HERE

Another type of system that thins knowledge through use of statistics is the price system underlying market exchange, as articulated eloquently by Hayek (1945). Hayek considered the sharing of detailed knowledge about idiosyncratic resources dispersed throughout the economy to exceed the capabilities of collectivist macro-economic planning; socialist centralization of "knowledge of the circumstances" he regarded as unfeasible (1945, p. 519). The virtue of market prices lies in the efficiency with which dispersed bits of complex knowledge embedded in specific local circumstances can be aggregated. The market, with its parsimonious price statistics, obviates the need for a heroically knowledgeable centralized agency. The efficiency of the market as a knowledge-sharing system lies precisely in the low level of knowledge that has to be transmitted and stored. Interestingly, Davenport and Prusak (1998) depict organizations as knowledge markets, with buyers (knowledge seekers), sellers (knowledge providers), and brokers (boundary spanners connecting those who need knowledge and those who have it).

Whereas in both the consultancies and industrial materials firms the rationale for cross-site knowledge sharing stemmed in large part from decentralized organization

and disparity of practice across sites, the high-tech firms featured much more centrally organized processes. Indeed, processes were so centralized and standardized as to relegate these firms' subsidiaries to a merely operational role. One of the key centralized processes was product design. Given the centrality of product design in the high-tech firms, the knowledge-thinning principle employed was – at least in part -- *diagrammatic*. CAD tools facilitate the centralization of the design process and, in combination with the standardized nature of product specification in these markets, minimize the need to integrate knowledge from subsidiary units. New product design constitutes one of the primary strategic tasks performed in the high-tech firms, with many other management functions largely subordinate to the prime objective of executing an effective design.

The technological ancestors of such CAD tools can be seen in the perspectival and projective drawing systems developed by French engineers in the 18th century. Progress in engineering, according to Ferguson (1992), has depended crucially on the development of such visualization tools to enable the sharing of representations that facilitate collective visual thinking about solutions to technical problems. Latour (1990) refers to such visual representations as “immutable mobiles” because of the way that knowledge so condensed can be circulated in printed form. In sum, technical drawing, like modern CAD tools, constitutes yet one more type of system for thinning and sharing knowledge.

The foregoing typology of knowledge-thinning systems makes no pretence of completeness. It does, however, help identify some key variables. Figure 1 plots the three industries studied in this particular research sample along two major dimensions of variation, namely the basic type of knowledge-thinning procedure (specification of location vs. condensation of content) and the distribution of strategically relevant knowledge within the firm (centralized vs. decentralized). As mentioned, the specification of location usually involves a pointer to specific individuals or groups rather than to a physical location. The resulting matrix stylizes the interaction of these two dimensions as organizational “configurations” of knowledge sharing: Central Brain (as in high tech), Scoreboard (as in industrial materials), and Dispersed Expertise (as in consultancies). Though one postulated configuration (Central Experts) is not

represented in the sample, it is easy to imagine a company with a large number of different specialists at headquarters indexed by some kind of topographical knowledge-management system. Not intended as a predictive framework, Figure 1 is offered merely as a visualization aid for comprehending the interaction of the way knowledge is distributed and the way it is “thinned.”

INSERT FIGURE 1 ABOUT HERE

Discussion

Although framed in historical terms, the phenomenon of “knowledge thinning” explored in this study clearly has practical and theoretical implications. The phenomenon covers a spectrum of potential methods for dealing with some of the obstacles firms face in the promotion of cross-unit knowledge sharing. Employees have little inherent incentive to share knowledge in ways that might make them redundant. Knowledge monopolies are valuable for those in power who want to stay in power. Potentially, then, knowledge-sharing systems that rely on “thin” forms of knowledge may encounter less passive resistance to their use. Yet as indicated at the outset of this paper, even in an ideal world where employees have no incentive to hoard knowledge, organizational members are limited in their time and cognitive ability to absorb new information and knowledge. Potentially, then, knowledge-thinning systems can help cope with problems of information overload and attention deficits (Simon, 1997).

As shown, knowledge thinning is not a unitary method or technique, nor is it a simple one. The typology of knowledge-thinning systems developed in the previous section underlines the fact that firms can choose from a variety of different means for sharing “thin” forms of knowledge, each with their own challenges and complexities. Thus, to say that certain firms engage in the sharing of “thin” forms of knowledge across sites is not to say that the knowledge-sharing systems of these firms are themselves thin, that is, rudimentary or underdeveloped. Knowledge-sharing practices that include processes for thinning knowledge may even require substantial investment, sophistication and habituation in use. Extensively developed knowledge-sharing

practices are compatible with a rather modest volume and richness in the knowledge actually shared across sites within firms. In five of the six firms interviewed in this study (the exception being Industrial Materials 1), substantial investment in knowledge-management tools had taken place.

The upshot of these findings is that highly developed knowledge-sharing systems need not involve extensive codification and recombination of personalized knowledge. Virtuous learning spirals featuring iterative “conversion” of personalized knowledge into codified knowledge and vice-versa (Nonaka & Takeuchi, 1995; Boisot, 1998) are sometimes touted as the normative function of knowledge management within the firm. In contrast, this study disclosed the reliance of several multinational firms on knowledge-sharing systems conceived with more modest objectives in mind. Such goals may include, for example, the diminution of existing barriers to knowledge sharing across units. Broadly speaking, study of the consulting and industrial materials firms supported the view of knowledge-sharing systems as an auxiliary tool for encouraging more extensive communication within the firm (Davenport & Prusak, 1998; Otley, 1999) rather than as a means of aggregating dispersed knowledge (Kogut & Zander, 1992; Kogut & Gittelman, 2003). As if to confirm this point, several interviewees in the high-tech firms, whose knowledge-sharing systems did not facilitate two-way interaction, expressed disappointment and the view that knowledge-sharing practices should be more highly developed. These remarks can be interpreted as the voicing of complaints about a vacuum of social communication more than underutilized knowledge *per se*.

Figure 2 endeavors to encapsulate the insight that knowledge thinning and knowledge codification are distinct, albeit related phenomena. The figure indicates that different knowledge-thinning techniques involve varying degrees of codification. Topographical knowledge-thinning systems codify knowledge the least and are particularly useful in situations where: 1) firm knowledge is primarily in a personalized form, and 2) the firm does not wish to invest in codification. While personalized knowledge can in principle be codified, codification can entail substantial costs (Cowan et al., 2000; Håkanson, 2007). In contrast to topographical knowledge-thinning systems, diagrammatic knowledge-thinning systems codify knowledge the most. Diagrams such as technical drawings can actually impart a substantial amount of

knowledge about physical objects, for example. “Statistical” knowledge-thinning systems, in contrast, codify knowledge to a more modest extent. Even when large volumes of numbers are exchanged, what is primarily exchanged is (context-poor) information rather than (context-rich) knowledge. Even more than diagrams, numbers require interpretation and follow-up analysis. As illustrated in the case of industrial materials firms, cross-site differentials in performance can be identified using comparative statistics; however, an understanding of the underlying drivers of these performance differentials will require follow-up investigation utilizing more personalized forms of knowledge exchange (Kaplan & Norton, 1996; Otley, 1999). The intermediate placement of “statistical” knowledge-sharing systems in Figure 2 reflects the idea that a statistically based component (e.g. benchmarking) will operate in conjunction with a more personalized component (e.g. transfer of best practice).

INSERT FIGURE 2 ABOUT HERE

Figure 2 also provides an opportunity to mention some limitations of our study. Neither the study nor the framework of Figure 2 authorizes predictions about the specific type of knowledge-sharing system that will be used in a given firm or industry context. For example, in our sample the consultants shared individual, largely “personal knowledge” (Polanyi, 1958); yet not all consulting firms do this, as some rely more heavily on codified knowledge (Hansen et al., 1999). Figure 2 merely suggests the probability of a topographical system being chosen when a firm that relies on largely personalized knowledge actually opts to employ knowledge-thinning methods in its overall knowledge-sharing system. However, such a firm may, on the contrary, decide to invest in a richer kind of knowledge-sharing system not represented in Figure 2. Similarly, Figure 2 suggests that knowledge-thinning systems of a more “statistical” or “diagrammatic” character might be appropriate for firms relying on more codified forms of knowledge, but issues no prediction as to whether a firm will actually choose to engage in knowledge “thinning.”

Conclusion

While confirming the longstanding conclusion that the promotion of intrafirm knowledge sharing faces a wide range of inherent cognitive, social, and motivational obstacles (von Hippel, 1994; Szulanski, 1996), the focus on the "thinning" of knowledge that emerged from this study points beyond just activity within firms. The thinning of knowledge is a hallmark of Western civilization since the Renaissance and indeed can be associated with some of the conceptual breakthroughs of the Renaissance itself. These include the blossoming of cartography accompanying the age of discovery (topological knowledge-thinning systems), the increasing mathematization of science instigated by Kepler and Galileo (statistical knowledge-thinning systems), and the discovery of perspective by Florentine painters (diagrammatic knowledge-thinning systems).

This historical perspective has a certain bearing on the much-discussed topic of knowledge codification. Condensing knowledge to the extent of making its representation feasible in numbers or two-dimensional visual space is not quite the same thing as codifying knowledge, even if it similarly facilitates knowledge transfer. The antithesis of codified knowledge is uncoded, that is, personalized or tacit, knowledge. In contrast, the antithesis of "thinned" knowledge is detail-rich contextual knowledge, which may or may not be codified. The "thinning" of knowledge addresses not only the problem that knowledge is unarticulated but also the problem that excessive amounts of it can result in cognitive overload (Simon, 1997; Hansen & Haas, 2001). Thus, while discussions of knowledge codification frequently underline the high costs of codifying knowledge (Cowan et al., 2000; Steinmueller, 2000), discussions of knowledge thinning are likely to emphasize the incentives and information-processing limitations of those who would engage in knowledge sharing.

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