Organizational Learning During International Technology Transfer

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Abstract

One of the issues in international technology transfer is that of organizational learning. Previous research has shown that communication technology facilitates the transfer of technology significantly, but implicit in a communication technology model is that of building a learning organization. This is an issue that affects all international firms as they attempt to integrate and organize their strategies and efforts worldwide. This paper focuses upon the steps of technology transfer and how organizational learning facilitates the process. Finally, implications for managers are discussed.

Introduction

*T*he ability of an organization to manage information strikes at the heart of its competitive advantage. Organizations recognize that managing information and knowledge is becoming increasingly complex as organizations do more business globally. The transfer of technology is but one kind of information that is managed by an organization and it is becoming more important to build an organization that is able to transfer technology smoothly, especially if it has divisions across the world. However, building a learning organization is not sufficient for developing a competitive advantage. Hamel and Prahalad (2002) say that the learning process must be translated into managerial competencies to allow greater efficiencies to take place and to enhance a competitive advantage.

The real challenge is to integrate the learning that occurs as technology is transferred within a firm. For instance, lessons learned as technology is transferred from Belgium to the United States should not have to be relearned if the technology is also transferred from Germany to Taiwan within the same firm. Bartlett and Ghoshal (1998) have advanced one of the more sophisticated models of a transnational organization's ability to manage information. They support an organizational model that is integrated across divisions, and envision an organization that is able to communicate smoothly across

The problem with Bartlett and Ghoshal's model is that of implementation. Most firms do not have the knowledge, the expertise, or the vision to be able to build an organization that is able to finely integrate its efforts that organizational learning occurs seamlessly. Knowledge transfer in intraorganizational networks is easier when the units are networked and can facilitate the diffusion of organizational knowledge (Tsai, 2001).

This paper outlines some of the real-life problems with transferring technology and presents some firms' efforts to implement a learning organization.

Technology Transfer and Organizational Learning

If a firm is to generate extraordinary value for its shareholders, it must be able to harness and apply its knowledge better than its competitors (Prokesch, 1997). The nature of the transfer in international business is generally perceived as the transfer of specialized know-how (Reddy and Zhao, 1990) more than the commercialization of technology. The transfer of the knowledge is either patented or non-patented, and flows from one enterprise to another.

The technical knowledge consists of the technology needed to produce the products, as well as the ability to master the processes needed to product the product using the transferred technology (Reddy and Zhao, 1990; Chesnais, 1986). The idea of technology transfer encompasses the technology transfer, but also the time needed to master the technology by the receiving unit. In other words, the technology that is to be transferred can be data, a machine, a process, a chemical formula, etc. A practical definition of technology for the purpose of this study is any idea, process, skill, perspective, know-how or physical object that is used to enhance the performance of the organization. Some authors have fretted over the definition of technology (Bozeman, 2000) without focusing upon the real issues with technology transfer: that of process and diffusion. How does a firm transfer its technology, and in the meantime, take advantage of the organizational learning that takes place?

Management theorists tend to think of technology as, "a firm-specific information concerning the characteristics and performance properties of the production process and of the product design." (Zhao and Reisman, 1992). In the management field, technology transfer and knowledge is viewed as a way to gain or sustain a competitive advantage, or to bring financial benefits to the firms involved. However, there are also challenges that accompany the benefits of international technology transfer. Hoetker (1997) theorized four such challenges: 1) Lack of familiarity and contact make it more difficult to find technologies and people, 2) Language differences, 3) Logistics of communication, and 4) Cultural differences. These challenges occur at all "stages" of technology transfer.

Successfully building an organization that is able to take advantage of its technology transfer and to leverage its organizational learning allows the firm to save costs (Teece, 1977). Transferring the technology is usually less costly than buying the technology. However, the costs of transfer can be tremendous, especially since many of the costs are hidden. The cost of transfer is especially higher when "the technology is complex and the recipient firm does not have the capabilities to absorb the technology" (Teece, 1977).

One of the challenges of technology transfer is to make it a routine process. This allows the firm to drive down its costs, as well. Developing a process that allows the knowledge to be codified and made routine allows economies of scale to be achieved (Scott, 2000; Teece, 1998). Tacit knowledge is difficult to codify (Scott, 2000), mainly because by its very definition, it has a more meaningful and complete dimension that is difficult to articulate, let alone translate into a digital form. Indeed, if knowledge is perceived to be highly tacit, this could indicate that the underlying system is not well understood (Teece, 1998). This limits learning because scientific principles cannot be systematically applied.

Methodology

Because this study was descriptive and exploratory in nature, qualitative inquiry was used to tease out the many complexities of the international technology transfer processes that were the focus of the study. There are some specific differences with respect to qualitative inquiry that must be addressed in order to discuss design of the research. One of the major issues was the choice of sample size. Researchers constantly struggle with the choice of sample size, particularly when the study is qualitative in nature. This issue was discussed in depth previously by Patton (1990) who said:

There are no rules for sample size with respect to qualitative inquiry. Sample size depends on what you want to know, the purpose of the inquiry, what's at stake, what will be useful, what will have credibility and what can be done with available time and resources.

The greatest issue in sample size is the need for breadth versus the need for depth. With larger samples, the researcher has a greater chance at understanding variation. With smaller, data-rich samples, the researcher is more likely to achieve greater depth of understanding. Unfortunately, according to Patton (1990),

…….the utility and credibility of small purposeful samples are often judged on the basis of the logic, purpose, and recommended sample sizes of probability sampling. What should happen is that purposeful samples be judged on the basis of the purpose and rationality of each study and the sampling strategy used to achieve the study's purpose.

The sample, like all other aspects of qualitative inquiry, must be judged in context - the same principal that undergirds analysis and presentation of qualitative data. Random probability samples cannot accomplish what in-depth, purposeful samples accomplish and vice versa.

Notable examples of the far-reaching impact of small sample studies include (1) establishment of the field of psycho analysis by Freud based on fewer than ten client cases, (2) contribution of a major breakthrough to our understanding of how children think by Piaget who observed his own two children at length and in great depth. More recently, Peters and Waterman (1982) used only 62 companies to develop their eight principles for organizational excellence - clearly a very small sample considering the universe of companies one might study (Patton, 1990).

The sample used in this study consisted of eight U. S. firms that have experienced international technology transfer during the last five years. Each firm is an international company that has divisions across the world. Further information about these organizations can be found in Table 1. The study used the maximum variation sampling technique of purposefully picking a wide range of variation on dimensions of interest. In so doing, the investigators were able to document diverse variations that have emerged given different conditions during the international technology transfer process. The reason for using this particular sampling technique was to identify important common patterns that cut across variations. (Patton, 1990)

Because this was an exploratory study with little prior empirical research results to guide the researchers, data were gathered using the long interview process. The long interview is "a sharply focused, rapid, highly intensive interview process that seeks to diminish the indeterminacy and redundancy that attends more unstructured research processes" (McCracken, 1988). It is used to gather data related to cultural categories and shared meanings. It uses open-ended interview questions designed to probe specific areas of interest to the researcher.

Each interview took place in the offices of the selected firms with participating managers. An interview guide was used by the researchers to facilitate comparison of the interviews and to assure that all areas of interest were covered in the interview. However, since this was exploratory research, the questions were open-ended and the participants were encouraged to go beyond the questions asked by the researcher in describing the technology transfer processes. All interviews were taped and transcribed. All eight firms requested, and were granted, confidentiality in reporting of results.

Data analysis was performed using two different forms of content analysis, (1) conceptual analysis and (2) procedural analysis. Conceptual analysis refers to the traditional technique of determining what words or concepts are present in a text (Carley, 1990). In this case, conceptual analysis identified the concepts most frequently mentioned by the managers in describing the technology transfer processes. Procedural analysis centers on the procedures that the author of a text uses to perform some task described in the text (Carley, 1990); in this case the processes for accomplishing the technology transfer described by the manager in each interview transcript. Investigator triangulation was developed by using three different researcher evaluators, none of whom was involved in gathering the interview data.

To facilitate analysis of the data, the researchers used QSR Nud*ist 4© software. This program manages data and documents and allows the researcher to create, manage, and explore ideas and categories within the data. It is designed to allow researchers to discover themes, construct and test theories, generate reports (including both text and coding patterns), and build models by linking with graphical display software.

Reproducibility, the extent to which classification produces the same results when the text is coded by more than one coder, was the most important reliability issue in this study. This problem was addressed by developing and using a dictionary of words, concepts, categories, and relationships in coding the qualitative data. Intercoder reliability checks were performed by having each of the three different researchers code all eight of the interviews. All the coders used the same computerized qualitative analysis software program. Differences in coding were discussed and full agreement was reached with respect to coding of the data.

There were two major limitations of this research design. First, the sample size was small making generalization to the larger population of firms difficult, if not impossible. Second, the study used retrospective accounts by the managers, which have sometimes been associated with errors of memory, as its primary source of data.

Findings

The following sections involve teasing out some of the themes, similarities, and inconsistencies in the interview data.

Identifying the technology

Although some researchers deny that a model of technology transfer can be built because the processes occur concurrently (Bozeman, 2000), this study was able to identify distinct stages of technology transfer (Table 1). An organization begins the process of technology transfer by identifying the technology that is needed in the receiving unit. The identification of the technology is usually done in response to a need within the business, and most firms analyzed the market and the effect the transfer of the technology would have upon the bottom line. However, one firm reported that a committee made up of managers across the world meets frequently throughout the year to discuss its technologies that it has developed at the firm's various plants, and then to decide how to diffuse the technologies throughout the organization. This same firm also would look at technology outside of the firm, and the technology committee would try to make a determination of whether the technology could be applied. Rather than trying to identify a problem within the organization, and then applying the technology to the problem, the reverse occurred in this firm. Technology was identified, and then the committee made a determination of where the technology could be applied and diffused.

So, although a rational decision making model can be used to identify the technology to be transferred by responding to a need within the organization, technology is sometimes applied through a 'garbage can' decision making model (Cohen, 1972). This is a rather unusual application of the decision making model, but reflects the reality of decision making and choice within an organization. The committee of the firm would purposely meet to discuss the technologies that were being developed, and then discuss the applications of the technology within the firm. The driving force behind the transfer of technology is to achieve the unit's and the firm's objectives. The process of this sort of diffusion of technology is probably more common than most academics think.

Most other firms in the study laid out a very rational process of identifying the technology as a response to market conditions or a need within the business environment. Although this is a very intuitive process of technology transfer, applying a 'garbage can' model of technology transfer or decision making reflects a highly sophisticated organization that is able to see opportunities for its technology to be applied elsewhere in its divisions. In fact, if the firm's committee would meet so regularly and coordinate so tightly throughout the year using information technology, it is doubtful that the managers on the committee would be so highly aware of the activities of the other divisions, and to see the opportunities of applying one division's technology to another division. The high degree of organizational learning in the firm allowed it to apply a non-rational process of technology identification and transfer.

Pre-transfer fact finding

Once the decision has been made to transfer the technology and the technology has been identified, a process to review facts takes place. This stage involves creating the parameters of the technology transfer. This is also the stage at which the receiving unit and the sending unit start communicating. Organizational factors such as culture are a large influence at this point. Both units may also be in contact with a customer who is requiring the technology to be transferred in the first place. One needs to keep in mind at this point that communication and management skills are highly important. Applying structure to an ambiguous situation is difficult, but to begin the process on the right foot requires some good management skills by the project leader. Most of the people involved in the process have good technical skills and are accustomed to communicating through the language of technology.

Working through people to complete the task is important in this stage, since this sets the tone for the rest of the project.

Most firms in the study had some problems at this stage. Visits to each other's units may occur at this stage, as well as other communication and coordination. People began to experience some culture clashes, both at the organizational and national levels. Setting the parameters of the project often requires some negotiating between the receiving and sending units. Any misunderstanding or misperception because of differences in culture tends to magnify the problems during the discussions between the groups.

Some of the smaller firms had the most difficulty at this stage. They were inexperienced at technology transfer, did not have people with the right combination of skills to work on the project, and had the most problems setting the parameters of the project. These kinds of firms have the most problem completing the technology transfer, let alone setting aside organizational resources in order to creating a learning organization to facilitate technology transfer.

The larger firms that had more experience in technology transfer had fewer problems with the management of the project, although it seemed that the most common problem was that of national culture. If the project team members had experience dealing with people from other cultures, communication tended to be a bit smoother. However, for the employees who had little contact with other national culture, some misperceptions tended to exacerbate communication difficulties. For instance, employees in a U.S. firm in the study misinterpreted the training that a German engineer had. Since the German engineer had not gone to a 'university' for training, they assumed that the engineer had inadequate training and skills to complete the project. Part of organizational learning also involves learning to negotiate and communicate with people from other cultures, and that involves learning about other cultures.

Review technology

The design of the technology transfer is nearly complete at this stage. Firms define the details of the project and even go back to the customer or other factor that spurred the technology transfer to verify that the project will meet objectives. Primary research into the transfer of technology is also being done at this point to make sure that objectives will be met when the technology is transferred. Most firms seemed to go through this stage rather implicitly, although some firms do address this stage explicitly. However, the firms that seemed to address the review of technology explicitly had more problems with the project at this point. As one firm's manager said,

"It may take years to untangle something if it's really "tweaky." You may have to declare an end to the issue and say, "OK, I will just have to lose this customer, he only represents 4% of my total output. It is not worth what I have to do for him." Then you can declare an end to the issue."

As the firm undergoes the final details of the transfer of technology, some firms have learned to walk away from the project if it is not going to represent a good return on investment of organizational resources. Even after having done considerable research and coordination, an escalation of commitment will not necessarily create an effective and successful technology transfer. Part of the organizational learning process is learning when to walk away from the project.

Although it was not found within the interviews in this study, it would be assumed that previous definition of the project and its specific parameters would aid in the project's success at this stage. If a firm is still 'tweaking' at this stage to satisfy a customer's requirements, perhaps the parameters were not successfully defined earlier in the project.

Package technology

This stage very clearly uses organizational learning, although the firm may not be aware of this process. Packaging the technology can take place in several forms, including inputting data into a computer; writing manuals;

running simulations and documenting the results; developing software; and generally building a codified library that allows the technology to be successfully transferred. One firm even referred to it as its 'bible', and made regular reference to the package as the technology was transferred.

Organizational learning at this point consists of codifying the knowledge and making it as routine as possible so that the technology could be implemented easily. Earlier in the process, project managers were dealing with imposing structure on an ambiguous project: identifying the technology; pre-transfer fact finding; and review of the technology. Each of these previous stages becomes easier as the firm gains more experience with technology transfer. However, at this stage, packaging technology, even firms with little experience with technology transfer begin to feel the results of their efforts. They see the data that can actually be given to the line-level employees as a way to help them implement the technology.

Standards are also verified at this point. Obviously when data is transferred from one country to another, differences is measurement standards exist. Translating the data from the metric system to the U.S. system requires that all the data is verified and all procedures are carefully reviewed.

Training/Receiving

The final stage of international technology transfer is that of training and receiving the technology. Organizations seem to find this stage energizing, as both experienced and inexperienced firms are able to see the tangible results of the international technology transfer process. The sending unit often sends an engineer or technician to the receiving unit to verify the training is taking place. One manager recalled,

"The final thing that we did when working with the Japanese engineers was to get written and visual operation instructions for every machine. Written procedures for every part of the operation. And then we went through and qualified that to make sure we are doing what we said we are supposed to be doing. Are we exactly following these steps? Of course, in fact, we were. The final thing that they presented me with was a set of laminated sheets which we put in each operation. They said, "Yes, Mr Parker, we verified that you are doing these."

This stage is the most obvious application of organizational learning. Firms see employees are learning and applying the technology. Tangible reminders, such as the laminated sheets, are posted to make sure that employees are following the procedures in the technology transfer package.

Training can take place in several different forms, as well (Table 3). All firms use the documentation that has been already packaged in a previous stage, and all firms use on-site training to ensure that the transfer takes place effectively. The use of simulations, computer training, or exchanging trainers and trainees between the sending and receiving units are not done among all firms. However, more experienced firms tended to exchange engineers and technicians between the sending and receiving units as a method to transfer the technology and facilitate organizational learning at a more in-depth level.

Implications

A summary (Table 5) indicates that organizational learning is leveraged differently and occurs differently in firms that have varying levels of experience in international technology transfer. One interesting and surprising finding is that firms with more experience in technology transfer and have developed a learning organization are more likely to implement a non-rational decision making model when identifying technology. Rather than identifying a problem or an environmental gap first, and then identifying technology that will solve the problem and fill the gap, firms that have had considerable experience in international technology transfer were much more comfortable examining their technology projects, and then determining where they may fit. Active research and development departments in a firm may be developing new technology that can be applied within a division, but once that technology has been applied in one division, it can then be applied to others.

The organizational learning process that takes place in firms with more experience in international technology transfer is obviously more sophisticated and complex. As Tsai (2001) suggests, firms that are already highly integrated and implement a networked organization to facilitate organizational learning are much better positioned to achieve a competitive advantage. These firms see the technology diffusing throughout the organization more freely, partly because of the seemingly non-rational model of decision making of where the technology is to be placed. However, these firms that employ the 'non-rational' model seem to be poised to achieve a sustainable competitive advantage because of the intangible competencies that have been developed in the organization.

Further research on this topic would include empirically documenting firms that employ a garbage can model of decision making when it comes to the transfer and diffusion of technology in a firm. Part of the reason that it seemed that most firms seem to employ a more rational model is that this study relied upon the recollections and memory of managers in the long interview process. These managers may be more likely to remember the process as being more logical and rational. However, the candid interview with the manager from the firm that had considerable experience with technology transfer and employed an integrated, networked structure in its organization revealed a process that may be closer to reality.

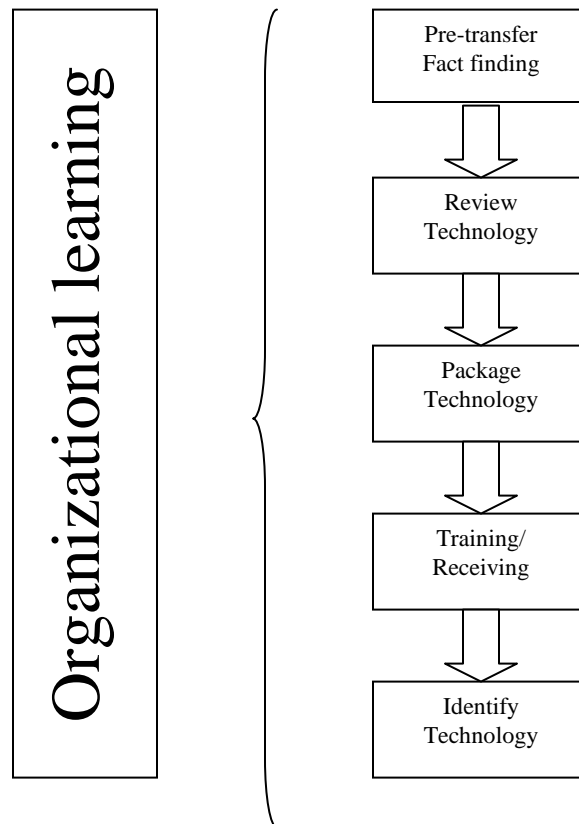**Table 1: Organizational learning during technology transfer**

Table 2. Organizations in the Study

Firm	Size	Corporate Structure	Product or Process
A	300 employees	Business units	Infrared testing materials
B	500 employees	Business units	Intermediate chemical product
C	135 employees	Joint venture	Polymers
D	500+ employees	International units	Synthetic materials
E	N/A	International units	Polymers
F	500 employees	Team based structure	Abrasives
G	600 employees	Team-based structure	Chemical materials
H	5 employees at this plant	Subsidiary of large foreign firm	Waste conversion

Table 3. Training methods employed to effect international technology transfer

Company Method	A	B	C	D	E	F	G	H
Documentation from sending unit	+	+	+	+	+	+	+	+
On-site training	+	+	+	+	+	+	+	+
Training at sending-unit or other foreign facility	+	+	-	+	+	+	+	-
Computer-based training	+	+	+	+	+	-	-	-
Simulation	-	+	-	+	-	-	-	-
Classroom training	-	+	-	+	-	-	-	+
Trainer from sending unit at receiving site	+	+	-	-	+	+	+	+

Key: (+) = Training method present in data

(-) = Training method not present in data

Table 4. A Model for Organizational Learning

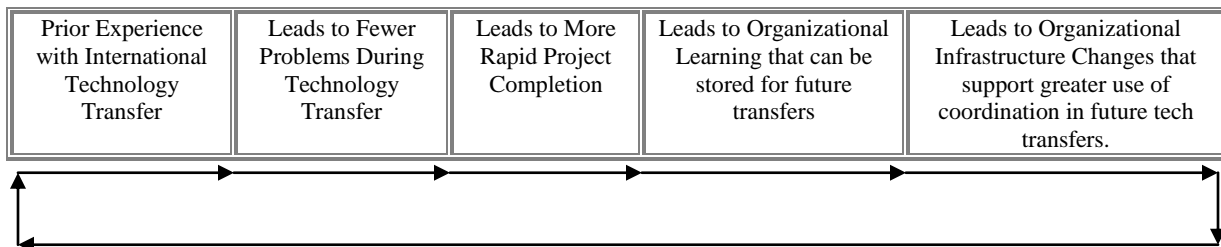| Prior Experience with International Technology Transfer	Leads to Fewer Problems During Technology Transfer	Leads to More Rapid Project Completion	Leads to Organizational Learning that can be stored for future transfers	Leads to Organizational Infrastructure Changes that support greater use of coordination in future tech transfers.

Table 5. Summary of technology transfer stages and experience with organizational learning

Stage of technology transfer	Less experience with technology transfer	More experience with technology transfer
Identify technology	Technology identified in rational response to environment	Non-rational response: technology is identified and then applied to an environmental gap
Pre-transfer fact finding	More difficulty dealing with organizational coordination/integration issues; national culture clashes	Integration easier; national culture not an issue
Review technology	Problems in previous stages require firm to go through this stage explicitly	Experience in technology transfer allows firm to take advantage of organizational learning and identify parameters more easily
Package technology	Firm has codified data and explicitly identifies feedback from organizational learning for the first time	Firm continues to strengthen organizational learning
Training/receiving	Reliance upon documentation and on-site training	Exchanges between sending and receiving units facilitates organizational learning

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Notes