Transferring Collective Knowledge: Teaching and Learning in the Chinese Auto Industry

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Abstract

Collective knowledge, which consists of tacit group-embedded knowledge, is a key element of business capabilities. This study undertakes a multiple-case study of the transfer of collective knowledge, guided by a set of tentative constructs and propositions derived from organizational learning theory. By focusing on the group-embeddedness dimension of collective knowledge, we direct our attention to the knowledge source and recipient communities. We identify two sets of strategic choices concerning the transfer of collective knowledge: cooperative vs. individual teaching, and integrated vs. discrete learning. The empirical context of this study is international R&D capability transfer in the Chinese auto industry. Based on twenty-four interviews at four ventures in China, we find expected benefits of cooperative teaching and integrated learning, and also discover additional benefits of these two strategies, particularly the creation of a bridge network communication infrastructure. The study also disclosed conditions underlying the choice of strategies of transferring collective knowledge, including transfer cost conditioned by the level of group-embeddedness of the knowledge to be taught or re-embedded. The paper provides a group-level perspective in understanding business capabilities, as well as a set of refined constructs and propositions concerning the strategic choices of transferring collective knowledge. The study also provides a rich description of the best practices and lessons learned in transferring capabilities.
Transferring Collective Knowledge: Teaching and Learning in the Chinese Auto Industry

This paper studies teaching and learning mechanisms that facilitate the transfer of collective knowledge between firms. Empirically, we focus on the transfer of R&D practices from multinational enterprises to businesses in emerging economies. Collective knowledge is knowledge that is both tacit and involves substantial group-wide activity. Inter- and intra-firm transfer of collective knowledge helps firms adapt and grow in expanding markets. Owing to the tactitness and group-embeddedness, however, collective knowledge is difficult to transfer (Cook & Brown, 1999; Kogut et al., 1992; Spender, 1996; Thompson, 1967). Recent studies have examined the intra-organizational spread of best practices (Gupta & Govindarajan, 2000; Kostova, 1998; Szulanski, 1996), cross-border transfer of R&D management practices among multinational firms’ subsidiaries (Inkpen & Dinur, 1998), and inter-alliance partner transfer of know-how (Brewer & Nollen, 1998; Singh, 1995). Most such studies focus on how contextual constraints such as absorptive capacity, transfer intent, relational capital, and country-level factors affect the outcome of transfer activities. By contrast, few studies have examined the mechanisms by which firms transfer capabilities containing high levels of collective knowledge. This issue is especially salient in the context of transferring knowledge to firms in emerging economies, which require new business skills in order to compete effectively in global markets.

Our research approach is a theory-guided exploratory study of four international joint ventures. We start with epistemological discussions of collective knowledge and the requirements for its transfer, developing initial orienting propositions for the study. We argue that cooperative teaching and integrated learning will be more effective than individual teaching and discrete learning for transferring collective knowledge. We then report field investigations that build on the orienting propositions and help develop an understanding of the factors that facilitate effective transfer of collective knowledge. This approach combines deductive insights from previous studies with inductive findings based on more than twenty detailed interviews.

The empirical setting is the transfer of R&D managerial practices activities from American and European multinational enterprises (MNEs) to joint ventures with Chinese auto firms. Several inductive insights emerged from the study, refining our initial notions of cooperative teaching and integrated learning, and identifying key dimensions of knowledge transfer that cooperative teaching and integrated learning facilitate. In addition, the cases identified the creation of bridge networks as an important long-term indirect communication
outcome of cooperative teaching and learning. The case studies showed that transfer costs affect the use of cooperative and individual teaching, arising as a function of the level of group-embeddedness of the knowledge.

THEORETICAL FOUNDATION

Our goal is to identify factors that influence the effectiveness of the inter-organizational transfer of capabilities that have a high degree of collective knowledge. This goal encompasses several key concepts, including capabilities, inter-organizational transfer, transfer effectiveness, and collective knowledge. Capabilities are the processes by which firms use physical and knowledge-based factor inputs to create goods and services (Richardson, 1972). R&D capabilities, for instance, are the processes by which firms create new products and production systems. By inter-organizational transfer of capabilities we mean that a recipient organization adopts capabilities that a source organization possesses (Baum and Ingram, 1998). By transfer effectiveness, we mean the degree to which the recipient organization is able to use the capabilities for its own purposes, through replication of the source’s capabilities and/or through adaptation of the capabilities to the recipient’s context (Darr, Argote and Eppele, 1995; Winter and Szulanski, 2001). Relevant dimensions of effectiveness include the cost, speed, and accuracy with which a recipient can accomplish a task that requires the transferred capabilities.

The definition of collective knowledge arises from the general discussion of knowledge contained within firms, where knowledge is a firm’s stock of information, technology, know-how, and skills (Spender and Grant, 1996). Management research has identified two salient dimensions of firms’ knowledge: tacit vs. explicit and individual-carried vs. group-embedded (Cook et al., 1999; Kogut et al., 1992; Nonaka et al., 1995; Spender, 1996; Thompson, 1967).

We follow Spender (1996) in referring to knowledge that is both tacit and embedded in intra-firm group activities as collective knowledge (Spender uses on a “individual/social” distinction). Cook and Brown (1999) use the term organizational genres in a similar vein. Collective knowledge takes many forms, such as norms, values, and mental maps (Hedberg, 1981; Levitt and March, 1988), uncodified routines (Nelson and Winter, 1982), organizing principles (Argote and Ingram 2000; Kogut and Zander, 1992), uncodified architectural knowledge (Henderson & Clark, 1990), and transactive memory or collective interpretive schemes (Daft & Weick, 1984; Fiol & Lyles, 1985; Levitt et al., 1988; Wegner, 1987).
Collective knowledge is common in practice. Concurrent R&D management processes that jointly control timing, budgeting, and personnel movement, while incorporating market research, concept design, quality control, finance, purchasing, and manufacturing are examples of capabilities that contain high levels of collective knowledge. Similarly, modern lean production systems that require coordinated activities and adjustments involving many people contain high levels of collective knowledge.

Collective knowledge often has high strategic importance. Among the four knowledge combinations that the tacit vs. explicit and individual-carried vs. group-embedded dimensions categorize, collective knowledge is the hardest to imitate, due to its tacit and group-embedded nature, and is the hardest to transfer. A firm’s knowledge, such as R&D capabilities, includes a mixture of all four knowledge combinations, but the collective knowledge gives the most competitive advantage due the difficulty that other firms face in imitating collective skills (Amit & Schoemaker, 1993; Dierickx et al., 1989; Penrose, 1959; Conner & Prahalad, 1996). Moreover, despite the transfer difficulty, transferring capabilities with collective knowledge is important for firms that want to expand their activities into new areas, such as emerging markets, because collective knowledge underlies important aspects of their business activities.

Both the tacitness and the group-embeddedness aspects of collective knowledge influence the effectiveness of inter-organizational capability transfer. Tacitness has received most attention. Transferring tacit knowledge benefits from stable and close contacts between the transferor and transferee. This usually calls for the transferor and transferee to use shared practices or joint projects, which facilitate close person-to-person contacts and learning-by-doing (Arrow, 1962; Argyris & Schon, 1978; Brown and Duguid, 1998; Levitt et al., 1988; Nonaka et al., 1995; Polanyi, 1962). In order to transfer tacit R&D knowledge, both the source and recipient organizations often engage in joint R&D projects that serve as platforms for transferring capabilities that the firms cannot fully convey with verbal or written media (BIC, 1992; Zhao, Anand and Mitchell 2000). Nevertheless, learning-by-doing through joint projects is only a necessary condition for transferring collective knowledge, not a sufficient condition, because this mechanism alone does not resolve the difficulty of transferring group-embedded knowledge. Group-embeddedness has received less research attention.

The key issue underlying the transfer of group-embedded knowledge is that the knowing entity of group-embedded knowledge is a community, rather than an individual or the simple
sum of individuals. Collective knowledge involves systems of coordinated relationships among members of the knowing community in which people interact to carry out routines or solve problems (Fiol et al., 1985). Collective knowledge is partly independent of the individual members who execute the systems (Levitt et al., 1988; Nelson et al., 1982). As Cook and Brown (1999: 386) point out, “the body of [collective] knowledge is possessed by the group as a whole and is drawn on in its actions, just as knowledge possessed by an individual is drawn on in his or her actions”. Thus, the transfer of collective knowledge is an inter-communal activity, rather than simply interpersonal knowledge transfer (Brown et al., 1998).

Two focal communities are relevant for the transfer of collective knowledge: the source community, which is the knowing entity of the targeted collective knowledge, and the recipient community, which is the knowing entity in which the collective knowledge will be re-embedded. Although some knowledge can transfer through vicarious imitation, with little or no active teaching and learning, recent research suggests that knowledge transfer benefits from active teaching and learning processes (e.g., Darr, Argote, and Epple, 1995; Baum and Ingram, 1998; Argote and Ingram, 2000; Mitchell, et al., 2002). The source and recipient communities serve as teachers and learners in the knowledge transfer process.

Teaching and learning processes have many dimensions, such as costs, the number of teachers and learners, the locations in which teaching and learning take place, intensity of interaction of teachers and learners, and synchronization of learning opportunities. In general, teaching and learning are complex phenomena that cut across multiple theoretical and empirical perspectives, particularly in the context of transferring capabilities to firms in developing economies. Therefore, we will start our discussion by addressing focal dimensions of the teaching and learning processes that arise across multiple theories and are likely to be empirically robust. We will use the initial discussion to develop orienting propositions concerning how cooperative vs. individual teaching and integrated vs. discrete learning influence the outcomes of knowledge transfer. We then use the field research both to explore the orientating propositions and to identify other relevant aspects of teaching and learning in emerging economy settings, which we will relate back to relevant theories when appropriate.

**Cooperative Teaching vs. Individual Teaching**

The source community can use different teaching mechanisms for transferring collective knowledge to the recipient community. In particular, we distinguish between cooperative
teaching and individual teaching. Our preliminary definition of cooperative teaching is that cooperative teaching involves joint effort by multiple members of the source community, who either teach recipients at the source location or, less commonly, travel as a team to the recipient location. By contrast, individual teaching uses individual members of the source community as teachers, either by traveling to the recipient location or by teaching recipients who travel to the source site. We will expand the definitions of cooperative and individual teaching in our discussion of the field studies, which help us refine these concepts.

Empirical studies offer cases in which firms used a mixture of cooperative and individual teaching mechanisms to transfer capabilities. For example, Brewer and Nollen (1998) described four teaching mechanisms that an HCL-HP (India) joint venture used to transfer tacit and group-embedded process knowledge: (1) teams of personnel at HP’s European headquarters in Germany worked with engineers from the Indian joint venture, who regularly spent 3 to 12 month periods at the German location, (2) a senior HP manager was the head of manufacturing at HCL–HP for 3½ years, (3) an HP expatriate was head of R&D at HCL–HP, and (4) several HP technical experts worked as individuals at the joint venture in India and with Indian personnel who traveled to Germany. Among these mechanisms, the first is cooperative teaching, the rest fall into the category of individual teaching.

We expect cooperative teaching to be more effective than individual teaching in transferring capabilities with high levels of collective knowledge. The key feature of cooperative teaching is that groups of people from the source organization can work together to demonstrate the basis of the collective knowledge to people from the recipient community. In this process, cooperative teaching provides opportunities for the recipient community to observe and participate in the activities of the source community, which helps each learner to absorb knowledge embedded among members of the source community, as well as knowledge carried by individual teachers. Providing a cooperative teaching environment also helps socialize learners with the source community’s coding scheme, value system, norms, and mental maps.

Several literatures suggest that cooperative teaching facilitates transfer of collective knowledge. Cooperative teaching is similar to Lave and Wenger’s (1991) notion of legitimate peripheral participation and to Nonaka and Takeuchi’s (1995) concept of the spiral of organizational knowledge creation, in that teaching involves participation by a community of practitioners. Honda’s guest engineer program is an example of cooperative teaching, in which
teams of Honda’s product designers work with suppliers’ engineers on issues such as design for manufacturing (MacDuffie & Helper, 1997).

In contrast to cooperative teaching, individual teaching implies that individual members of the source community instruct or supervise members of the recipient community. In multinational cases, this commonly means that individual expatriates travel from the source to the recipient location. With individual teaching, members of the recipient community do not participate actively with groups of source community personnel. Individual teaching by members of the source community often struggles to bring collective knowledge to the recipient community. As Teece (1986: 20) notes, “…it will often not suffice to transfer individuals [to transfer collective knowledge]. While a single individual may sometimes hold the key to much organizational knowledge, group support is often needed, since organizational routines may need to be transferred.” The following proposition helps orient the field investigations.

**Orienting Proposition 1**: Cooperative teaching is more effective than individual teaching for inter-organizational transfer of capabilities that have high levels of collective knowledge.

**Integrated Learning vs. Discrete Learning**

We distinguish between two types of learning by the recipient community: integrated learning and discrete learning. We define discrete learning as a process in which members of the recipient community learn skills as individuals but do not share what they have learned with the recipient community. By contrast, integrated learning occurs when members of the recipient community share their individual learnings with the recipient community.

Learning in an organization can happen at two different levels: individual and group (Inkpen, 1997; Tiemessen, Lane, Crossan, & Inkpen, 1997). Individual-level learning means that single people gain new skills. By contrast, group-level learning implies adapting and embedding individual-level skills into routines, norms, rules, procedures, conventions, frameworks, paradigms, codes, cultures and technologies, around which organizations are constructed and through which they operate (Levitt et al., 1988; Araujo, 1998; Lave & Wenger, 1991).

Researchers have tended to focus on the individual level of learning, while under-emphasizing the group perspective (Argote, Ingram, Levine, & Moreland, 2000b; Tiemessen et al., 1997:383).

We expect integrated learning to be more effective than discrete learning for transferring capabilities containing collective knowledge. Just as collective knowledge involves shared processes at the source organization, the knowledge will need to embed in shared processes at
the recipient. Kasl, Marsick, & Dechant (1997) note the importance of synergetic team learning, in which members create knowledge mutually and integrate divergent perspectives through dialectical processes that create shared meaning schemes. We note that integrated learning by the recipient community may occur while the source community engages in either cooperative teaching or individual teaching. In other words, cooperative teaching and integrated learning are two orthogonal strategic options that influence the transfer of collective knowledge.

In contrast to integrated learning, discrete learning provides a learning strategy in which the formal learning process ends once members of the recipient community have learned as individuals. Most often, discrete learning means that recipients learn over different periods and/or in different places. In addition, discrete learning may also occur when recipients learn in the same location at the same time, but do not work together subsequently to share their learnings with each other or with the rest of the recipient organization. The notion of discrete learning is similar to Kasl et al.’s (1997) definition of the fragmented mode of team learning, in which individuals learn separately but the group does not learn as a holistic system. Most technology transfer agreements state the provision for training of the members in the recipient organization in measures such as person-months of on-site training, without requirements for cooperative education (Reddy & Zhao, 1990). Previous studies suggest that many practitioners have adopted discrete learning for inter-organizational knowledge transfer (Liebrenz, 1982).

Although discrete learning typically is faster and less expensive than integrated learning, discrete learning creates problems in transferring collective knowledge. Learning as individuals is a necessary first step to transferring knowledge, but full transfer of collective knowledge requires that the individual skills then mesh together to form the intertwined routines and shared understandings that are at the heart of collective knowledge. Some previous studies of group learning suggest the benefits of integrated learning for collective knowledge. Liang, Moreland, & Argote (1995), for instance, found that training employees as a work group is more effective than training the employees individually. The study suggests that integrated learning can foster collective memory and enable the development of collective knowledge more effectively than discrete learning. The following proposition helps guide the field investigations.

**Orienting Proposition 2:** Integrated learning is more effective than discrete learning for inter-organizational transfer of capabilities that have high levels of collective knowledge.
The orienting propositions serve as starting points for the field studies. The fieldwork will help us refine the concepts of cooperative teaching, individual teaching, integrated learning, and discrete learning. The cases will show how the concepts apply in practice and identify contingencies that affect their relationship with transfer of collective knowledge. The studies will also identify elements of teaching and learning mechanisms that influence knowledge transfer.

**METHODS**

The Chinese auto industry setting offers several strengths for this study. First, auto R&D management includes substantial collective knowledge. Second, there is growing incidence of transferring R&D practices from MNEs to Chinese-based auto facilities. Third, evidence from preliminary fieldwork suggested substantial variation in cross-case choices of collective knowledge transfer mechanisms. Fourth, there are substantial cultural, technical, and managerial differences between recipient organizations in China and MNE source units (Beamish, 1993; Child and Yan, 2001), thereby providing similar cross-case contextual settings. Finally, the use of a single industry helps control for industry-level factors, but we expect generalizability of the conclusions to go beyond this industry setting because the constructs are not industry-specific.

**Research Design**

The research design of this study is a multiple-case study for theory building based on the blueprints of *a priori* constructs and orienting propositions, derived from literature review and previous field visits (Yin, 1994). The inductive case method suits research that poses “how” or “why” questions, involves complex causal links, or seeks to generate novel theory that is empirically valid and testable (Eisenhardt, 1989). The multiple-case design also permits analytic generalization and logical replication (Yin, 1994). The case study approach can be especially revealing for knowledge-based research topics, because of its ability to reach the depth and cover the breadth of managerial intentions and mechanisms related to organizational resources and capabilities (Almeida & Grant, 1998; Brewer et al., 1998; Inkpen et al., 1998; Leonard-Barton, 1992; Rouse & Daellenbach, 1999).

The transfer of individual R&D practices is our unit of analysis. R&D capabilities contain both collective and non-collective knowledge. We solicited relevant field data by probing the interview questions to distinguish between collective knowledge and other knowledge aspects.
**Data Collection**

Case selection of this study derived from three principles: (1) theoretical sampling, i.e., choosing cases for replication or extension of the emergent theory, not for statistical randomization purposes (Eisenhardt, 1989), (2) obtaining variance in constructs, and (3) capitalizing on personal relationships between the first author and respondents to ensure interview access and data quality (Inkpen, 1997).

We collected data in two stages. During the first stage, in the summer of 2000, the first author conducted a field study involving open-ended interviews with thirty-one respondents from nine companies in the Chinese auto industry. These companies are international joint ventures that had conducted R&D capability transfer. The respondents in this stage included personnel from source and recipient communities. The purpose of this stage was to understand the context, as well as develop initial framing for constructs and relationships. The interviews took place in either Mandarin or English, depending on the first language of the respondents.

The second stage was an in-depth case study. We administered semi-open questions with twenty-four respondents from four companies during summer 2001. Each interview section, which took place in Mandarin, lasted from 2 to 5 hours. We then verified the case write-ups with the respondents and asked clarification questions by telephone during the fall of 2001. Each of the four companies had conducted multiple R&D capability transfer events involving collective and non-collective knowledge, and applied all four types of transfer strategies (i.e., cooperative and individual teaching, integrated and discrete learning). Among these four companies, two are OEM joint ventures (Shanghai-VW and Beijing Jeep), one is a set of auto component joint ventures (Delphi-China), and the other is an R&D joint venture (PATAC). The cases represent a significant range in group-embeddedness of R&D capabilities. The R&D capabilities that OEM joint ventures transferred usually are more group-embedded than those that component joint ventures transferred. Similarly, the R&D capabilities to be transferred in a component joint venture that produces complex products are more group-embedded than those to be transferred within a component joint venture that makes simple products. The number of R&D capability transfer events among these four companies is sufficient for an in-depth theory-building multiple-case study (Yin, 1994). Table 1 summarizes the companies. On request, we can also provide more detailed information about their operations and capability transfer practices.

***** Table One here *******
We used multiple sources of evidence to achieve construct validity. We used multiple data collection methods, including face-to-face interviews, field observations, telephone interviews, and secondary sources of information about the company and their R&D projects. At each site, multiple respondents ranging from engineers to top managers were interviewed individually to allow multiple perspectives on the same cases of R&D capability transfer. The respondents have extensive experience with multiple R&D capability transfer events and all four knowledge transfer strategies. This is especially valuable because it permits the respondents to compare various strategies their firms used to transfer R&D capabilities.

All interviewees in the second stage of this study work for Chinese recipients of the R&D capability transfer. Respondents from the recipient community had a deep understanding of their firms’ learning needs and results. In addition, the recipient respondents had substantial knowledge of the source firms because they typically had received training at source facilities. Thus, they could provide credible information about teaching and learning because they were observers of teaching as well as learners. Moreover, our earlier discussions with members of the source communities found substantial convergence with the recipients’ views.

Each interview followed the same protocol to ensure reliability (Yin, 1994). The protocol consists of four parts. First, the interviewer explained the purpose of the research, to ensure that the respondents understood the key concepts and goals of the research. Second, the interviewee provided personal background and her/his perception of the development and status of R&D capabilities of the company. Third, the interviewee provided a detailed chronologies of particular R&D project(s) he/she participated in that involved transferring R&D capabilities from the source community to the recipient community. Fourth, the interviewer asked more specific and probing questions to acquire the interviewee’s personal opinions about knowledge strategies with regard to the effectiveness of transferring the collective knowledge involved in R&D capabilities. The interviewer took notes during the conversations and then transcribed the notes into a more formal format within 24 hours.

**Data Analysis**

The main purposes of data analysis in theory-building case studies are sharpening constructs and shaping propositions (Eisenhardt, 1989). To achieve these purposes, we used both within-case analysis and cross-case comparisons to analyze field findings. We first refined the constructs concerning cooperative and individual teaching, and then derived propositions relating
how these mechanisms affected the perceived effectiveness of capability transfer activities. We next repeated these steps for integrated and discrete learning.

Under each discussion topic, we analyzed related case findings and interview transcripts that explored the orienting propositions. We accomplished within-case analysis by pooling responses of different respondents about one case, and then generating an encompassing view of the case. We conducted cross-case analysis by assessing how the respondents compared various R&D capability transfers and knowledge transfer strategies they had experienced personally. We also compared relevant literatures to our findings to strengthen literal validity and widen generalizability (Eisenhardt, 1989). The analytical process was highly iterative between cross-case analysis and the generalization of constructs and propositions. For clarity, we focus on the conclusion of the analytical process rather than present each iterative step.

**FINDINGS**

We first describe the R&D projects that led to the need for transferring collective knowledge at our case firms. We then present the findings in two major sections, strategies of transferring collective knowledge from a (1) teaching perspective and (2) learning perspective. In each section, we first present representative case findings, which we derived through iterative within-case and cross-case analysis. The findings include assessment of our orienting propositions, followed by extensions and contingencies that arose during the field studies. We then describe relevant literatures to which the case findings apply. Finally, we arrive at a set of general propositions that emerge from the case findings.

**R&D Capabilities**

The R&D projects in the companies we studied emphasized intermediate- and final-stage R&D (Buckley & Casson, 1976). Most of the projects involved modifying styling to meet local tastes or modifying peripheral component design based on the vehicle platform designed by the source partner, in order to adapt local road conditions, safety, and environment regulations.

The projects included a range of knowledge characteristics. Some projects focused on individual and/or explicit skills, such as use of CAE workstations and design software. Others encompassed collective knowledge, such as architectural knowledge, group-embedded R&D procedural knowledge, and product-specific design language.

We identified capabilities containing high levels of collective knowledge by asking the respondents to identify processes that involved extensive uncodified activities (tacitness) that
required shared understandings of many people (group-embeddedness). Examples included the ability to undertake auto platform redesign for the local market, as well as the ability to redesign substantial vehicle components such as braking systems.

Although the local R&D does not involve full-scale auto platform design (a platform usually takes billions of dollars to develop and requires a volume of over one million vehicles a year to offset the research cost), the work involves many stages of R&D from market research to concept design to prototyping and validation. A Chinese top manager in product development in Shanghai-VW described the typical understanding about what R&D capabilities mean from the perspective of Chinese R&D managers, “R&D capabilities from my perspective include how to translate initial design ideas from marketing research into a systemic product design proposal, which guilds the various tasks, timelines, budgeting and specifications for different function groups and coordination among these groups. R&D capabilities also imply how effectively we implement the product design proposal at various stages of the design process. A large part of these capabilities lies in the experience of managers and engineers.” Thus, many of the R&D capabilities that the firms want to transfer to the local operations contain collective knowledge.

**Teaching Strategies for Transferring Collective Knowledge**

*Cooperative and Individual Teaching*

We initially tentatively defined cooperative teaching as joint teaching effort by multiple members of the source community, in contrast with teaching by individual members of the source community. The respondents recognized this distinction and thought that it was meaningful, but explained that we needed to incorporate additional ideas within the concept of cooperative teaching. The discussions led us to refine our definition of cooperative teaching.

The refined definition of cooperative teaching includes two aspects, both relating to the involvement of the recipients with the teaching community. First, cooperative teaching requires that the source community provide the individual members of the recipient community with access to the source community’s day-to-day working environment and opportunities to observe their ways of conducting business. Second, the individual members of the recipient community, upon given such access, must have enough communication ability to interact with the members of the source community, while observing and reflecting on what and why they do about their business. That is, it became clear in the interviews that cooperative teaching requires active participation by members of the learning community in the teaching process.
Thus, simply using multiple teachers might not provide cooperative teaching. For example, a Delphi joint venture assigned several U.S. engineers to teach Chinese engineers who traveled to Delphi’s home base in the U.S. for three-month in-class training. Two issues concerning both refinements of cooperative teaching arose in this example. First, during this training, many Delphi experts provided the Chinese trainees with instructions, but often did not provide access to the day-to-day working environment of the source community. This kind of teaching falls into the category of individual teaching, even though there were many teachers, because the Chinese engineers interacted with individual Delphi personnel, rather than working with groups of Delphi staff members in their day-to-day environment.

Second, even when the source community offered full access to the working environment, many Chinese trainees lacked communication abilities and were not able to participate fully with the teachers. A Chinese manager from Delphi-China who went through on-the-job training in Delphi’s home base in the U.S. had the following observation, “Some Chinese engineers did not learn much during the overseas on-the-job training because of their language problems or lack of inter-cultural communication skills. Whereas some others learned a lot by asking questions of their American colleagues and observing how they handle various issues.” She further commented on her own experiences, “Although I came to the US to learn manufacturing technology, I was driven by curiosity and the demands of work to ask many non-manufacturing questions. And I was surprised by their willingness and capabilities for answering my questions. I also learned a great deal about how people from different areas interact and coordinate with each other by observing the project team meetings. I would not have learned these important things, had I not worked in the US with so many American colleagues.”

From this and similar examples, we revise our definition of cooperative teaching. We now view cooperative teaching as an education process in which teams of teachers expose trainees to the working environment of the source community and encourage them to interact with relevant members of the source community. As a polar opposite of cooperative teaching, we define individual teaching as an education process in which individual members of the source community provide instructions and coaching without exposing trainees to the working environment of the source community.

We found that each company in our study used both individual and cooperative teaching to transfer R&D capabilities. Indeed, individual teaching was the “base option” for transferring
R&D capabilities in almost all cases. Nonetheless, the practice of cooperative teaching exists in all the companies we studied, although to different degrees. Upon request, we can provide examples of cooperative teaching beyond those that we discuss here.

**Effectiveness of Cooperative and Individual Teaching for Transferring Collective Knowledge**

We expected cooperative teaching to be more effective than individual teaching in transferring capabilities with a high level of collective knowledge. The cases support this view.

Shanghai–VW’s overseas training program, which cost 1.8 million German marks, provides a good example of cooperative teaching. The goal of this project was to develop state-of-the-art R&D capabilities that span all stages and aspects of the vehicle development process. The program involved a team of 41 young managers and engineers, who Shanghai-VW’s human resource department selected on the basis of skills and communication ability. Twenty of the managers went to Germany for training in August 1998. A second group of 21 personnel went to Germany in September 1999. Upon their arrival in Germany, the trainees first engaged in a six-month study of the German language and their own specialty in a German university. They then transferred to VW AG’s vehicle development department to receive training from a team of VW personnel. As part of the training, they participated in R&D projects including development of complete vehicles, styling, chassis, engine, and body, as well as computer-related projects. Many of these capabilities required for these projects involved extensive tacit and group-embedded information, making them prime examples of collective knowledge. This on-the-job training in Germany lasted for one year. Then the trainees then returned to Shanghai-VW and worked on local projects for a year. After that, they then returned to VW AG in Germany to finish the last half year of the three-year training program. Before being sent to Germany, every trainee signed a 15-year employment contract with Shanghai-VW.

When asked to compare the effectiveness of cooperative and individual teaching for transferring R&D capabilities, respondents from different companies gave several advantages of cooperative teaching. From these data, we used an open coding process (Strauss & Corbin, 1990) to identify three criteria for knowledge-related transfer: (1) tacit procedural knowledge within a single function, (2) tacit procedural knowledge across multiple functions, and (3) communal culture and mindset. The three categories span the conceptual underpinning of collective knowledge, encompassing both tacit and group-embedded dimensions.
Cooperative teaching improved the effectiveness of each knowledge-related criterion. For the first criterion (tacit procedural knowledge within a single function), respondents noted that cooperative teaching helps ensure that teachers have a common engineering language with their trainees, helps teachers provide better views about specific engineering problems, and helps teachers provide situational understanding about solving problems in product design. For the second criterion (tacit procedural knowledge across multiple functions), cooperative teaching allowed trainers to teach methods of cross-functional coordination and provide the overall framework of R&D processes. For the third criterion (communal culture and mindset), the respondents reported that the teaching process addressed company and group culture, as well as the mindset and heuristics underlying team decision-making.

In addition, an interesting finding from the field work is that cooperative teaching helps identify which parts of the collective knowledge are idiosyncratic to the source community’s context before recipients attempt to transfer that knowledge back to the recipient community. As a Chinese engineering manager from Delphi-China observed, “A lot of product development practices are not based on pure science. There are a lot of contextual and situational elements that are idiosyncratic to our foreign partner and are not suitable to our environment back in China. For example, some steps of a product development procedure were developed in the U.S. based on the capacity limits of a particular plant. Through interacting with many American engineers who understand the original intention of this procedure, we were able to identify these steps and removed it before the procedure was transferred to China.”

In some cases, respondents claimed that cooperative teaching is not just advantageous, but indispensable. A Chinese manager in the product development area of Shanghai-VW who participated the training program commented, “At the beginning, we did not know a lot about VW AG’s R&D process, we encountered a lot of difficulties in the learning process. What were written in the training materials and operation manuals are not detailed enough to cover all possible situations in the design process. And even if the written procedures cover everything, each German engineer seems to have his own personal way in interpreting these procedures. What we really need to learn is not the procedures, but the way of interpreting and applying them. This type of knowledge would be impossible to obtain had we not come to VW AG and work with German engineers on a daily basis.” Similarly, a Chinese manager from Delphi-China mentioned, “Training overseas is absolutely necessary for Chinese employees. Had we not gone
to US for on-the-job training, we would never get to know organizational structures and the way things work in Delphi. Training overseas is not only important for managers but also for mid-level and lower-level engineers.” A Chinese engineering manager at PATA expressed the same idea, “If we did not send Chinese engineers for overseas training, we may learn from US expatriates here in PATA, but the learning would be much limited because individual teaching cannot cover various contingencies and situations.” A Chinese senior manager at Beijing Jeep also claimed that every Chinese engineer needs to go the foreign partner’s home base to receive on-the-job training, and each training section should last long enough with teams of teachers for the trainees to gain deep understanding about the how to conduct a full-scale design project.

Thus, the fieldwork provided four initial implications concerning cooperative teaching. First, active participation by trainees with teams of teachers is a key part of teaching about capabilities with high levels of collective knowledge. By active participation, we mean that the trainees need to participate in the teachers’ working environment and must have communication abilities that allow them to participate. This feature arises from the combination of tacitness and group-embeddness that is the defining feature of collective knowledge. Second, cooperative teaching helps provide understanding of tacit procedural knowledge within and across functions, as well as understanding of communal cultures and mindsets. Third, cooperative teaching helps identify context-specific aspects of collective knowledge. Fourth, parallel to the first point, teaching location is an important part of cooperative teaching. That is, teachers often need to teach on their own turf, where they can demonstrate how their capabilities work in action.

**Creation of Bridge Networks**

The fieldwork provided an additional striking implication concerning the long-term impact of teaching processes. In addition to the immediate transfer of collective knowledge, the interviews revealed that cooperative teaching helps create an inter-communal network between the source and recipient communities during the on-the-job training process. We refer to this network as a *bridge network*. Bridge networks provide a means for facilitating ongoing transfer of both individual and collective knowledge.

The fieldwork suggests that teaching processes in which members of the recipient community work in the source community even for a short period create opportunities to interact with experts at the source community. These interactions during cooperative teaching can build two key elements for sustainable, high quality, and timely communication between the source
and the recipient communities: inter-personal trust and know-who, i.e., the understanding of who does what better and who is most willing to help. Trust based on personal contact can enhance the quality of knowledge flow (Kale, Singh, & Perlmutter, 2000) and the sustainability of the network, whereas know-who can optimize and shorten the route of inter-communal information search. Therefore, cooperative teaching fosters a trust-based and path-optimized bridge for ongoing knowledge transfer between the source and the recipient communities.

A Chinese manager of Shanghai-VW who participated the training project brought up the issue of the bridge network as one of the key benefits of doing the overseas training, “In order to continuously acquire R&D knowledge, knowing who knows what and who has the authority to answer various questions is very important. If everyone from the team of 41 persons knows 10 different VW experts, we would develop a network involving about 400 German experts at the end of the 3-year training. As the training coming to the end and most trainees returned to Shanghai-VW, the benefit of this network started to show. Trainees, working in relevant positions now in Shanghai-VW, communicate frequently through this network via e-mail and telephone with their German colleagues.”

In another case, a Chinese engineer of Delphi-China described the knowledge transfer importance of inter-personal trust and the bridge network, “Human beings are emotional creatures. Knowing each other through face-to-face contact, even in a very brief manner, can qualitatively change the nature of information exchange. Overseas training only helped us to start. In our everyday work here, new products, new customers and new processes keep coming up. We have to keep a close contact with American engineers to operate properly. If I don’t have this network, my work would be much tougher.”

In a similar vein, a Chinese manager at PATAC gave high marks to the value of bridge networks, “Overseas training gives us a windfall – a network connecting us and foreign experts. You just cannot imagine how much easier it is for us to get information we need from American personnel when we have personal relationship with them. It’s interesting that in the US, people also go about their work based on guanxi. A good guanxi between a Chinese and an American personnel means a informal and high quality information channel between them” [guanxi is the Chinese word for “personal relationship” (Tsui & Farh, 1997; Luo, 1997)].

A Chinese senior manager of Beijing Jeep also put great emphasis on inter-communal communication channels, “It is very important to know whom you should contact across the
Pacific when a specific issue arises. Many solutions to technical issues can be boiled down to the communication between a Chinese engineer and an American engineer. If you don’t know who is the best person to talk to for a specific issue, you are in big trouble”. That is, the existence of a bridge network that results from cooperative teaching can help a recipient gain access to individually held knowledge.

Ties between members of source community and members of recipient community can form in many ways. Mechanisms include long-term assignment of expatriates from the source community to the recipient community, exchange of short-term visits by source and recipient community members, and on-site training of the members of the recipient community. Nonetheless, the interviews suggested that the ties formed during on-site training during cooperative teaching programs are the most extensive, sustainable, and tailored to the knowledge needs of the members of a recipient community.

A bridge network differs from an alternative communication mechanism, which relies on inter-communal boundary-spanners. Boundary spanners are strongly linked to their colleagues and have extensive links outside their subunits (Tushman & Scanlan, 1981). They provide a person whom members of the recipient community can contact in order to connect with relevant experts of the source community. In the cross-border cases that we studied, a boundary spanner is usually an expatriate from the source community who has broad relations with various experts in the source community and works in the recipient community either as a manager or as a trainer. A bridge network differs from a boundary-spanning individual in its flatness and short path distance between the person who holds the knowledge and the person who inquires about the knowledge. With a bridge network, members of the recipient community can form direct ties with experts of the source community, rather than go through the boundary spanner.

The different teaching strategies that found in the cases tended to lead to different communication infrastructures. Cooperative teaching tends to create bridge networks. By contrast, individual teaching tends to create boundary spanners.

Boundary spanners and bridge network co-existed in almost all the cases. As an engineer from Delphi-China explained, “In my daily work, for the most of the time, I communicate with my American colleagues through email and telephone without going through any intermediate supervision. Sometimes I ask my American supervisors here in Delphi-China (expatriates) to help me locate the right person in the US to answer my questions or help to solve my problems.”
Comparing the two types of boundary-spanning infrastructure, this engineer commented, “Certainly, the bridge network is more effective, because it is very important to know who is the best person to ask for help. My American colleagues have a very finely defined division of labor. If I did not find the right person to answer my question at the first time, chances are the question would be passed on to the second or even the third person. The more persons the question must pass through, the less the motivation to answer it, and thus the less likely it will be answered. If the question is presented to a wrong person, you may either get a wrong answer or get no answer at all. So, if you have a bridge network, you would always get a right and prompt answer. Our American supervisors here in China have too many things to handle. In many cases they could not offer help or did not know the right person they could refer us to for help.”

Thus, a bridge network often is superior to boundary spanners not only because it is structurally flatter and shorter in path distance, but also because its ties are supported by stronger inter-personal personal trust and optimized by know-who developed during the cooperative teaching process. Moreover, bridge networks help recipients engage multiple contacts at the source, which helps transfer group-embedded collective knowledge.

Organization scholars have long argued that key individuals are more cost effective than a widespread communication across organizational or communal boundaries (Arrow, 1974; March & Simon, 1958). With the help of information technology that facilitates ongoing contact, though, a bridge network has become almost as affordable as or even more cost effective than boundary spanners. As the net benefit of flat communication over indirect communication becomes more significant, organizations become flatter internally, and so do the inter-communal boundary spanning infrastructures.

Nonetheless, boundary spanners play valuable roles in knowledge transfer. In particular, boundary spanners provide access to people who do not fall within a recipient’s bridge network. Thus, there are benefits to creating both ongoing communication mechanisms, which will tend to happen at firms that use both cooperative and individual teaching mechanisms.

*Situations Where Cooperative Teaching Is Not Preferred*

The above discussion established that cooperative teaching is superior to individual teaching for two reasons: teaching collective knowledge embedded in the source community, and creating a bridge network between the source and the recipient community. Surprisingly, however, some cases reveal situations in which cooperative teaching is *not* preferred over
individual teaching. In attempting to understand this seeming contradiction, we found it is in fact an extension to our tentative expectation of the superiority of cooperative teaching.

We found a primary reason in situations where cooperative teaching is not preferred: low transfer cost, resulting from group-embeddedness of R&D capabilities to be transferred. Obviously, when managers formulate knowledge transfer strategies, they must evaluate the financial cost and human effort of transfer (Teece, 1976), as well as the benefits of a particular strategy (Mason, 1980; Schwartz, 1982). We define transfer cost as the sum of financial cost and loss of work hours from both the source and the recipient communities due to carrying out a certain capability transfer strategy. The benefit or need of using cooperative teaching increases with the level of group-embeddedness of the R&D capabilities to be taught. When the extent of need exceeds the level of cost, firms will adopt cooperative teaching. When the level of group-embeddedness is low, the benefit for cooperative teaching is low and using cooperative teaching to achieve the same objective of knowledge transfer that individual teaching can achieve is uneconomical. This relationship holds even in the face of tacitness, so long as the tacitness involves a single person, who can teach as an individual. When group-embeddedness is high, by contrast, using individual teaching to attempt to transfer knowledge will incur higher transfer cost than using cooperative teaching or may, in fact, simply not be possible at any cost. Thus, the higher the level of group embeddedness, the more likely cooperative teaching is justified.

Two Delphi-China joint ventures provide contrasting examples. One venture produces electric wiring harnesses in China, which have low group-embeddness because the products are simple, while design and manufacturing processes are not cross-functional or architectural. The training of Chinese engineers for the wiring harness venture is done entirely in China, by individual teachers from Delphi. In contrast, another joint venture of Delphi-China produces steering systems, which are more technically sophisticated and demand cross-functional coordination in their complex development processes. In this case, the R&D capabilities involve high group-embeddedness. Delphi undertook cooperative teaching in this case, sending the Chinese employees of the division to Delphi’s U.S. home base for on-the-job training.

Several propositions emerged from the discussions of cooperative and individual teaching. We first restate the initial orienting proposition and the revised definition of cooperative teaching, and then provide several refinements.
Orienting Proposition 1: Cooperative teaching is more effective than individual teaching for inter-organizational transfer of capabilities that have high levels of collective knowledge.

Refined Definition. Cooperative teaching is an education process in which teams of teachers expose trainees to the working environment of the source community and encourage them to engage in deep and broad interactions with relevant members of the source community.

Proposition 1a. Cooperative teaching helps recipients understand a source organization’s tacit procedural knowledge within functions and across multiple functions, as well as the source’s communal cultures and mindsets.

Proposition 1b. Cooperative teaching helps recipients identify context-specific aspects of collective knowledge.

Proposition 1c. Cooperative teaching helps establish bridge networks, which provide direct communication channels between members of the source and recipient communities. In contrast to cooperative teaching, individual teaching fosters individual boundary spanner infrastructures, which create indirect communication channels.

Proposition 1d. The greater the group-embeddedness of the capabilities to be transferred, the greater the cost-effectiveness of cooperative teaching relative to individual teaching.

Building on organizational learning theory, we expected cooperative teaching to be more effective than individual teaching for transferring collective knowledge from a source community to a recipient community. The case evidence supports this expectation, while leading us to refine our definition of cooperative teaching. Moreover, the case study identified key dimensions of knowledge transfer that cooperative teaching facilitates (P1a) and helps identify (P1b). In addition, the cases identified the creation of bridge networks as an important benefit of cooperative teaching (P1c). The case studies extended the initial expectation by showing that transfer costs will affect the use of cooperative and individual teaching, arising as a function of the level of group-embeddedness of the knowledge (P1d).

Learning Strategies for Transferring Collective Knowledge

Integrated and Discrete Learning

Teaching strategies address how the source community transmits knowledge to individual members of the recipient community. By contrast, learning strategies for collective knowledge address whether the individual recipients who learn information from the teachers then integrate and re-embed the knowledge into the recipient community in order to form new collective knowledge relevant to the context of the recipient community.
Initially, we defined two categories of learning strategies, integrated and discrete learning, where integrated learning meant a learning process in which trainees share what they have learned as individuals with the recipient community while discrete learning involved processes in which recipients learned only as individuals. A question arises at this point, concerning the nature of integrated learning. Does learning as a group necessarily mean integrated learning? In particular, all the companies we studied have sent groups of their employees for in-class training or seminars for engineering or managerial courses. Is this training mechanism a type of integrated learning, simply because several students are together in the same classroom? The interviews suggested that the answer is no, because there is no assurance that individual learners will share and build on what they have learned.

The respondents suggested two additional aspects of the concept of integrated learning: contemporaneous learning and intense interaction among trainees during the training process. Contemporaneous learning means that trainees learn together at the same time, rather than attend training sessions at different times, and provides opportunities for trainees to observe and interpret similar information. Intense interactions among members of a recipient community, meanwhile, lead to a shared understanding of what they are learning. This notion is similar to the ideas of transactive memory (Argote et al., 2000; Wegner, 1987), interpretation schemes (Daft et al., 1984; Levitt et al., 1988), common language, and other group-level knowledge (Brown et al., 1998; Cook et al., 1999). Therefore, we refine the definition of integrated learning, as a learning process in which trainees learn contemporaneously as an interactive group. As a polar opposite of integrated learning, we define discrete learning as a learning process in which trainees lack contemporaneous learning and/or significant interaction among learners.

**Effectiveness of Integrated and Discrete Learning for Transferring Collective Knowledge**

To avoid confounding the effects of teaching strategies and learning strategies, we asked the respondents to compare integrated learning and discrete learning among cases that adopted cooperative teaching, i.e., cases in which local employees went to the home site of the source community for on-the-job training. Our goal is to see whether sending local employees for overseas training at the same time and on the same project and with significant interaction among themselves (i.e., integrated learning) is better than sending them for overseas training at different times, or on different projects, or without significant interaction among themselves (i.e., discrete learning). Building on organizational learning literatures, we expected integrated
learning to be more effective than discrete learning in transferring collective knowledge. As Kogut (1992: 389) has argued, “the teaching of know-how and information requires frequent interaction within small groups, often through the development of a unique language or code. Part of the knowledge of a group is simply knowing the information who knows what. But it also consists of how activities are to be organized, e.g., by Taylorist principles”. The evidence of the case study enriched this tentative proposition by identifying several benefits of integrated learning, as well as identifying conditions under which firms prefer discrete learning.

The strongest instance of integrated learning among the cases is Shanghai-VW’s overseas training project, which sent two large groups of trainees to Germany (about twenty people in each group). A Chinese participant of this program described integrated learning using a metaphor of “the coupling of two pyramids”, saying that “Suppose that the R&D team of VW AG is like a pyramid, each building block representing a particular function and each layer of blocks representing a particular managerial level, we [i.e., the two teams of trainees] have trainees from each building block at each layer work in the corresponding block and layer of VW AG during our overseas training. It is as if our pyramid is coupled with theirs.” In this project, Chinese trainees not only worked in the unit of their specialty in VW AG with the German experts, but also communicated frequently with other Chinese trainees to coordinate related problems from the adjacent functions in the R&D process or to work on architectural or systemic issues in R&D, such as data structure of the entire design, and body/exterior dimensions, which affect the dimensions and mounting locations of sub-assemblies and components.

Besides the formal job-related interactions during the work time, the Chinese trainees in the Shanghai-VW program informally interacted with each other to share their learning and discuss problems after work hours. Living in the same apartment building, coming from the same cultural background, and speaking the same mother tongue promoted this informal interaction among Chinese trainees. To enhance the integrated learning during the overseas training, the Chinese trainees also organized weekly meetings, to review what each one had learned in that week. “We share knowledge learned and help each other to understand things from different perspectives. We discuss especially how German engineers interpret situations and solve problems, in other words, the things that are not written in manuals. The discussion among us really helped me to understand my part of the business and what my Chinese colleagues are doing in their parts of business”, explained one Chinese trainee.
Upon returning to Shanghai-VW, the groups of trainees then formed the core of the local R&D force, to integrate what they had learned with the larger recipient community. The product development manager credited the recent success in developing many local variations of the new vehicle platform to the group-embedded R&D capabilities acquired from the training project.

In other cases, respondents acknowledged the advantages of integrated learning in cultivating community knowledge. For example, respondents from both Delphi-China and PATAc noted that integrated learning had helped them to cultivate cross-functional collaboration among Chinese trainees. A respondent from PATAc commented that integrated learning helped to develop a new culture that is neither Chinese nor American, but PATAc-specific. Respondents also noted that if the trainees went overseas at the same time but participated in different R&D projects, the coordination and development of a shared understanding among the trainees was not as strong as when they went for same project, further reinforcing the importance of intense interactions.

The interviews suggested benefits of the concurrency aspect of integrated learning. In particular, if trainees went for overseas training at different times, there would be instances when people who had received training needed to work with people in the recipient community who had not received training. Although this might appear to create opportunities to transmit the knowledge that they had acquired, many respondents complained about the difficulty of sharing knowledge when this happened. People who had completed overseas training commonly found it difficult to diffuse their new ideas and mindsets into the rest of the recipient community, who had not acquired the mental framework that would help them understand the new knowledge. A Chinese manager from Beijing Jeep (BJC) noted, “The reason that we haven’t achieve the level of R&D capability that we should have achieved after so many years of effort is that we didn’t cultivate the ‘team mindset’ about R&D among all engineers and managers. When those who have been trained overseas came back to BJC, they usually found that it was difficult to diffuse what they learned to their Chinese colleagues who had not gone overseas. Some aspects of R&D management cannot be communicated and promoted unless everyone understands the logic behind them.”

To sum up, if several engineers and managers are sent to the training at the same time and on same project, not only will they gain group-level knowledge through their interaction with each other, but they also will reduce knowledge diffusion friction that arises from asynchronous
discrete learning. They can then use their shared understanding to help re-embed the collective knowledge in the large recipient community after the training period is over.

Situations Where Integrated Learning Is Not Preferred

Notwithstanding benefits of integrated learning, no other company in this study has adopted an integrated learning strategy on as large a scale as the Shanghai-VW program. PATAC, Delphi-China, and Beijing Jeep typically have sent their Chinese employees for on-the-job overseas training either individually or in pairs, taking more of a discrete learning approach. The main factor that affects the selection of learning strategies, according to the respondents, is transfer cost. Sending a sizable group of a local work force to another location for training as a team not only incurs training and travel related costs, but also the loss of local productivity. As a Chinese manager from PATAC explained, “We know that it would be ideal to get all of our engineers trained at the same time, but we cannot afford it. We have to take a second best option, which is to take a more incremental and long-term approach in training our local employees.”

In addition to transfer cost, the cases also suggested another factor that affects the choice of learning strategies. This factor is the need for future coordination among members of the recipient community, i.e., the degree of group-embeddedness of the collective knowledge to be transferred to the recipient community. As a Chinese manager from Delphi-China commented: “It is really costly to do integrated learning. However, if future collaborations among a group of R&D engineers are really important, a group-wide overseas training may be justified. In our case, though, each engineer is responsible for one project, and communicates with his customers or American counterparts more than he does with his Chinese peers. The cross-personal interaction among us is not very high. So we do not feel necessary to do a group-wide overseas training.” That is, this case involved projects with relatively low group-embeddedness.

This discussion parallels our earlier discussion of how transfer influences the choice of teaching strategies. When group-embeddedness is low, the incremental benefit of integrated learning is low relative to discrete learning, so that using integrated learning to transfer knowledge is uneconomical. As in the teaching case, this relationship holds even for high levels of tacitness, because firms can transfer highly tacit knowledge that is not group-embedded (i.e., is held by individuals) through person-to-person contact, rather than through the more complicated and costly processes of integrated learning. As group-embeddedness increases, the benefit of integrated learning also increases while using discrete learning to achieve knowledge
transfer will incur high transfer costs or simply be ineffective at any cost. Thus, the higher the level of group-embeddedness, the more likely firms will use integrated learning.

These differences arose in our cases. For example, most Delphi joint ventures emphasize transfer of relatively simple knowledge to the local facilities. The teaching and learning strategies in such cases focuses on enabling Chinese engineers to coordinate effectively with their foreign counterparts, rather than developing complex local R&D capabilities in China. In these cases, the level of group-embeddedness is low and the joint ventures do not engage in integrated learning. In contrast, Shanghai-VW has set a clear objective of developing indigenous capabilities of developing and localizing vehicle designs. These capabilities have high levels of group-embeddedness. The Shanghai-VW venture adopted integrated learning for these projects, sending teams of Chinese R&D engineers to Germany for on-the-job training.

Several propositions emerged from the discussions of integrated and discrete learning. We first restate the initial orienting proposition and the refined definition of integrated learning, and then provide several refined propositions.

**Orienting Proposition 2**: Integrated learning is more effective than discrete learning for inter-organizational transfer of capabilities that have high levels of collective knowledge.

**Refined Definition.** Integrated learning is a learning process in which trainees receive contemporaneous training as an interactive group.

**Proposition 2a.** Integrated learning helps trainees develop shared understandings of the tacit and group-embedded aspects of collective knowledge.

**Proposition 2b.** Integrated learning helps trainees develop a critical mass of shared understandings required for embedding collective knowledge within the recipient community.

**Proposition 2c.** The greater the group-embeddedness of the capabilities to be transferred, the greater the cost-effectiveness of integrated learning relative to discrete learning.

We expected integrated learning to be more effective than discrete learning for transferring collective knowledge from a source community to a recipient community. The evidence supports this expectation, while leading us to refine our definition of integrated teaching. Moreover, the case study identified key dimensions of knowledge transfer that integrated learning facilitates during training (P2a) and at the recipient location (P2b). The case studies also showed that transfer costs and group-embeddedness jointly affect learning modes (P2c), just as they did teaching modes.
As well as consistencies, we found divergences between firm practices and the apparent benefits of teaching and learning transfer mechanisms. Seemingly wrong choices may arise because firms faced time pressure and lack of resources needed for the “right” modes. In addition, as the next section discusses, divergence may arise if firms under-estimate the need for cooperative teaching and integrated learning in transferring collective knowledge.

DISCUSSIONS AND CONCLUSIONS

This study explores inter-communal transfer of collective knowledge, using a group-level perspective (Cook et al., 1999). Aligned with the group-embeddedness dimension of collective knowledge, the group-level perspective directs our attention to both the source and recipient communities, and further leads to two sets of strategic choices concerning the transfer of collective knowledge: cooperative vs. individual teaching, and integrated vs. discrete learning. We take a theory-guided inductive approach to obtain a solid connection among initial theoretical expectations, empirical findings, and a refined theoretical framework. Although the research setting is country and industry-specific, our use of analytic generalization (Yin, 1981) and literature enfolding (Eisenhardt, 1989) suggest that the results apply to more general issues of enabling factors for effective inter-communal transfer of collective knowledge.

Transferring capabilities with high levels of collective knowledge across firm boundaries implies two essential aspects: (1) individual learners from the recipient community must acquire group-embedded tacit knowledge of the source community, and (2) the individual learners must then integrate and re-embed the learning among themselves and among the larger recipient community. Different teaching and learning strategies address different ways of accomplishing knowledge acquisition and integration. Although we discussed teaching and learning strategies separately for the clarity in conceptual development and empirical explanation, in practice every capability transfer event involves both knowledge transmission and knowledge integration, and thus requires a combination of teaching and learning mechanisms.

Table 2 depicts four different configurations of teaching-learning strategies. The choice of teaching strategies is orthogonal to that of the learning strategies. In other words, adopting cooperative or individual teaching in a capability transfer project does not necessarily demand the adoption of integrated or discrete learning in the same project. The figure lists typical examples of mechanisms. For a capability transfer event, depending on the extent of group-embeddedness of the collective knowledge to be taught and re-embedded in the recipient
community, firms will tend to select teaching and learning strategies based on the transfer cost required for the configuration.

***** Table 2 here *****

Four sets of general findings stand out in the study. First, as we expected, both cooperative teaching and integrated learning facilitate the transfer of capabilities containing high levels of collective knowledge. At the same time, though, the work led us to refine our understanding of the teaching and learning concepts. The interviews stressed that learners must engage in the teachers’ working environment as part of cooperative teaching, and highlighted the need for intense concurrent interaction among learners as part of integrated learning.

Second, the interviews helped us refine our understanding of the benefits that cooperative teaching and integrated learning provide for the transfer of collective knowledge. Cooperative learning helps provide tacit functional and procedure knowledge, within and across functions, as well as information about a source-firm’s communal culture and mindset. In addition, cooperative teaching helps provide information about which aspects of source-firm knowledge are specific to the context of the source firm, which recipients will not be able to replicate in their own environment. Integrated learning, meanwhile, helps develop shared understandings among learners, which in turn help learners diffuse their new knowledge in the recipient firm.

Third, the interviews noted the role that teaching mechanisms play in creating long-term communication infrastructures between source and recipient firms. Cooperative teaching tends to lead to the creation of bridge networks, in which many individual members of the recipient community are connected directly to members of the source community, with whom they can communicate as problems and opportunities arise. By contrast, individual teaching tends to lead to the creation of boundary spanner infrastructures, in which members of the recipient community connect to the source community only through focal contact people, who provide indirect links to knowledgeable people within the source firm. Each of these mechanisms has advantages and disadvantages. Bridge networks provide direct access to source personnel who recipients know and trust, but may have limited span of contact depending on who the recipient personnel worked with during their training period. The indirect links via boundary spanners may incur slower communication channels that are less tailored to the needs of the knowledge recipients than bridge networks, but may provide access to new people and ideas. Thus, a firm that uses both cooperative and individual teaching mechanisms may be able to create both types
of communication infrastructure. This finding leads to a recombination of epistemology and network arguments, and suggests that when studying the outcome of knowledge transfer activities, one should consider for both knowledge-related and communication-related outcomes.

Fourth, the case studies highlighted the importance of transfer cost in determining a firm’s choice of teaching and learning mechanisms. Cooperative teaching and integrated learning tend to be more expensive than individual teaching and discrete learning. Firms will tend to use the more expensive modes when they have the greatest benefit, which primarily arises from the group-embeddedness aspect of collective knowledge, and rely on less expensive modes when knowledge is more individually-embedded.

The empirical setting of this study also bears significance in its own right. The auto industry is the pillar industry of China and the Chinese auto market is the largest growing market in the world. With China’s WTO entry, one of the urgent items for multinational firms’ operations in China is to develop local R&D capabilities. Previous empirical studies have shown that personnel from less developed countries need not only a specific knowledge of various stages and aspects of project preparation, implementation, and operation, but also need a higher level understanding of why things are managed in certain ways (Marton, 1986). This study provides practitioners with a rich description of capability transfer practices and a framework that can help them to formulate their own strategies for transferring capabilities.

The empirical implications of this study lie in two aspects: explaining the success or failure of the past events of capability transfer, and providing guidelines for practitioners to formulate future capability transfer strategies. Both practitioners and theorists have realized the enormous difficulties and high rate of failures in transferring capabilities across organizational boundaries. The study indicates that root causes of transfer failure lie in the areas of knowledge acquisition and knowledge integration. If firms formulate teaching and learning strategies with an understanding of the extent of collective knowledge involved in the capabilities they want to transfer, the chance of failure will decline.

This gives rise to the issue of why firms sometimes appear to choose the “wrong” teaching and learning modes. In part, poor choices arise from time pressure and lack of resources needed for time-consuming and expensive cooperative teaching and integrated learning. Firms sometimes lack the financial resources they need to undertake these mechanisms. Perhaps more
often, the missing resources are human resources, in which the firms lack teachers and trainees with the skills needed for cooperative teaching and integrated learning succeed.

In addition, though, poor choices also arise because of a lack of understanding of the critical role that collective knowledge plays in successful transfer of many capabilities. As a result, firms may under-estimate the need for cooperative teaching and/or integrated learning in transferring capabilities between firms. Firms too often over-emphasize the “technical” aspects of transferring capabilities, emphasizing teaching people how to use specific equipment or carry out specific tasks. While this approach is appropriate for capabilities that rely on explicit information and individually focused skills, much of the activity of modern business relies extensively on tacit understandings and group-wide routines. Although many managers will recognize this issue as a general factor, time pressures and lack of analysis often lead them to ignore collective knowledge in detailed practice, resulting in failed transfer. By contrast, technology transfer is most likely to succeed when firms incorporate an understanding of collective knowledge into their detailed activities.

Moreover, it is easy for firms to under-estimate the indirect effects of different capability transfer mechanisms in influencing the types of communication infrastructures that emerge. The ability to draw on the skills of people throughout organizations is central to business change. Firms often create formal communication systems to facilitate such contact, but practice suggests that informal communication systems play as great or greater a role in facilitating inter- and intra-organizational contact. Our finding that the creation of different types of communication networks, with different strengths and weaknesses, is an endogenous outcome of the choice of teaching and learning mechanisms speaks to the complexity of the capability transfer choice and the importance of considering both immediate and long-term outcomes.

Clearly, there is room for future work. First, future research can sharpen measures of transfer cost, cooperative teaching and learning, and the level of group-embeddedness of knowledge. Second, research can investigate situations in which tacitness and group-embeddedness change after crossing organizational boundaries, either increasing or decreasing. Third, it would be valuable to examine how variation in socio-cultural distance might moderate the teaching and learning strategies. Fourth, it would be helpful to examine the joint effects of different configurations of teaching strategies and learning strategies.
REFERENCES


### Table 1. Summary Of The Companies Studied

<table>
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<tr>
<th>Chinese Partner</th>
<th>Foreign Partner</th>
<th>Initial Capital</th>
<th>Initial Investment</th>
<th>Equity Share</th>
<th>Year Established</th>
<th>Length of JV Contract</th>
<th>Location</th>
<th>Main Product</th>
<th>Annual Capacity</th>
<th>Number of Interviewees</th>
<th>Sources: “Summary &amp; Guide of Foreign Enterprises in China Automotive Industry” (1998); some performance data use 1996 figures.</th>
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<td>Pan Asia Technical</td>
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<td>Shanghai-VW Pan Asia Technical Automotive Center (PATAIC)</td>
<td>9 Chinese auto suppliers</td>
<td>5 5 12 2</td>
<td>Beijing Auto Work</td>
</tr>
<tr>
<td></td>
<td>Automotive Center</td>
<td>$19 million</td>
<td>$119 million</td>
<td>SAIC: 25%</td>
<td>1985</td>
<td>25 years</td>
<td>Shanghai</td>
<td>VW brand compact vehicles and auto components.</td>
<td>300,000 vehicles</td>
<td></td>
<td>1998; some performance data use 1996 figures.</td>
</tr>
<tr>
<td></td>
<td>(PATAIC)</td>
<td>$50 million</td>
<td>$50 million</td>
<td>Bank of China: 15%</td>
<td>1997</td>
<td>30 years</td>
<td>Shanghai</td>
<td>Automotive R&amp;D services, ranging from localization of foreign vehicle design, market research, vehicle styling and design.</td>
<td>N/A</td>
<td></td>
<td>1998; some performance data use 1996 figures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N/A</td>
<td>Total investment by Delphi: over $400 million by 2000.</td>
<td>SAIC: 50%</td>
<td>Varies from 1995 to 1998</td>
<td>Varies from 30 to 50 years</td>
<td>Various locations around China</td>
<td>Automotive components ranging from steering systems to electric harness.</td>
<td>Total sales of Delphi-China were $400 million in 2000.</td>
<td></td>
<td>1998; some performance data use 1996 figures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$147 million</td>
<td>$411 million</td>
<td>GM: 50%</td>
<td>1983</td>
<td>20 years</td>
<td>Beijing</td>
<td>Cherokee SUV Chinese brand SUV</td>
<td>About 80,000 vehicles</td>
<td></td>
<td>1998; some performance data use 1996 figures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1998; some performance data use 1996 figures.</td>
</tr>
</tbody>
</table>

### Table 2. Configurations Of Teaching And Learning Strategies

<table>
<thead>
<tr>
<th>Learning Strategies</th>
<th>Teaching Strategies</th>
<th>Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated</td>
<td>Teachers from the source community provide coordinated on-the-job training to groups of trainees from the recipient community, who work together at the site of the source community and then work together as a team when they return to the recipient community</td>
<td>Lecturing or demonstration by members of the source community in team-oriented training seminars attended by the members of the recipient community (at either the site of the recipient community or that of the source community)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sending expatriates from the source community to manage or train members of the recipient community (usually at the site of the recipient community)</td>
</tr>
<tr>
<td>Discrete</td>
<td>Teachers from the source community provide coordinated on-the-job training to individual members of the recipient community.</td>
<td>Lecturing or demonstration by the members of the source community in individual-oriented training seminars attended by the members of the recipient community</td>
</tr>
<tr>
<td></td>
<td></td>
<td>One-on-one apprenticeship between a member from the source community and a member from the recipient community (at either the site of the recipient community or that of the source community)</td>
</tr>
</tbody>
</table>