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Chapter 5

Knowledge Transfer in Organizations

5.1 Introduction

General Motors Corporation announces that it has decided to build identical plants in Argentina, Poland, China, and Thailand so that knowledge acquired at one plant will be relevant for and transferable to others (Blumenstein, 1997). An interview with John Reed, Chief Executive Officer of Citicorp, attributes a significant component of the firm's success to its ability to transfer local innovations in consumer banking around the world (Tichy & Charan, 1990). Intel uses a "copy exactly" approach to their multiple facilities in which establishments are replicated down to the color of their paint so that knowledge acquired in one establishment is relevant for others (Reinhardt, 1997). US Airways arms its employees with cameras, stopwatches, and pads of paper and sends them on other airlines to identify their competitor's best practices (Carey, 1998). These four examples illustrate the importance firms attach to transferring knowledge in organizations. General Motors, Citicorp, Intel, and US Airways expect to realize tremendous benefits by transferring knowledge acquired at one establishment to another. That is, the firms expect to realize benefits when one of their units "learns" from another unit or organization. This chapter describes research on one organization learning from another—on knowledge transfer across organizations.

The chapter begins with a case example of a firm that expects to reap large rewards from transferring knowledge from one assembly plant to another. Mechanisms for knowledge transfer are then described. A method for assessing the extent of knowledge transfer is presented. Results from a study of knowledge transfer in fast food franchises are described in depth to illustrate how the extent of knowledge transfer can be assessed empirically. Empirical results from studies of knowledge transfer are integrated and the conditions under which knowledge is most likely to transfer are described. Challenges to transferring knowledge across groups or units within

organizations are developed. Strategies for the effective transfer of knowledge are described.

5.2 A Case Example

General Motors Corporation recently announced a "four-plant strategy" in which it is building identical plants in Argentina, Poland, China, and Thailand at the same time (Blumenstein, 1997). According to an article in the *Wall Street Journal*:

The company has designed the plants to look so much alike that engineers may mistake which country they are in. And the assembly lines are being set up so that a glitch in a robot in Thailand, rather than turning into an expensive engineering problem that requires an expert for each machine at each plant, may well be solved by a quick call to Rosario (Argentina) or to Shanghai, China (Blumenstein, 1997, p. A1).

Thus, General Motors is making the plants very similar to increase the relevance of knowledge acquired at one for another. And General Motors expects that the larger experience base at the four plants will provide many problem solutions that the plants can use. That is, General Motors expects that knowledge acquired at one plant will transfer to another so that it benefits as well.

Designing plants differently limits the potential for transferring knowledge across them since knowledge acquired at one plant may not be relevant for another with a different design. For example, a plant using a particular assembly system may discover a way to improve its performance. But, if its sister plant that manufactures the same product does not use the same system, the performance improvements may not be transferable to the second site. General Motors' four-plant strategy aims to increase the relevance of knowledge acquired at one plant for another. General Motors' strategy is similar to Toyota's strategy of designing plants so similarly that productivity improvements developed in one can quickly transfer around the world (Blumenstein, 1997).

Although the General Motors plants are designed to be very similar, local conditions dictate some differences. For example, General Motors anticipates that supplies will have to be delivered to the Shanghai plant by bicycle since the transportation system there is poor (Blumenstein, 1997). Also, the climate in Thailand is so humid that considerable effort will have

to be made to protect the equipment from rust. Thus, the operation of the plants will have to be tailored somewhat to local differences. These differences notwithstanding, enormous potential exists for transferring knowledge across the four plants so that all benefit from knowledge acquired at one.

5.3 Mechanisms of Knowledge Transfer

When knowledge acquired in one organization affects another (either positively or negatively), transfer of knowledge occurs. There has been a long tradition of research in psychology that examines whether individuals are able to transfer knowledge from one situation or task to another (e.g., see Thompson, 1998). This work examines whether experience with one task affects individual performance on a subsequent task. More recently, researchers have begun to examine transfer at the group and organizational levels of analysis. Theorists have argued that not only do organizations learn from their own direct experience, they also learn from the experiences of other organizations (e.g., see Huber, 1991; Levitt & March, 1988). Empirical research is starting to accumulate on whether one organization learns from the experience of other organizations.

How might one organization learn from another organization? Many mechanisms exist for transferring knowledge from one organization to another. The mechanisms include training members of the recipient organization, allowing them to observe the performance of experts at the donor organization, and providing opportunities for communication between members of both organizations. Providing documents, blueprints, and descriptions of the organizational structure to the recipient organization as well as transferring experienced personnel there are additional mechanisms. Since some of the donor's knowledge may be embedded in its hardware, software, and products, providing those to the recipient organization also facilitates knowledge transfer. These various mechanisms map onto the previous discussion in Chapter 3 of where knowledge is embedded in a firm: its people, its technology, or its structure. Thus, in very general terms, knowledge can be transferred by moving people, technology, or structure to the recipient organization or by modifying the people (e.g., through training), technology, and structure of the recipient organization.

Organizations also acquire knowledge from external sources in the environment. Suppliers can be a very important source of productivity improvements. For example, Chrysler Corporation reported that its suppliers developed ideas that saved Chrysler \$1 billion and increased its profits by \$280 million in 1996 (Christian, 1997). Chrysler expects that

ideas submitted by suppliers in 1997 will increase that year's profitability by \$325 million. Examples of cost-saving ideas submitted by suppliers include suggestions for decreasing the weight of a car and for reducing the size of its cooling system.

Products also contain knowledge. By "reverse engineering," or tearing down a competitor's product, a firm can obtain useful information that may improve its product or reduce its costs. Mansfield (1985) argued that knowledge embedded in products transferred more readily than knowledge embedded in processes or organizational practices and routines.

Customers are also an important source of knowledge that can improve a firm's performance (von Hippel, 1988). For example, engineers from Caterpillar go to construction sites around the world to study customers using their earth-moving equipment in order to identify ways to improve it ("Survey of manufacturing," 1998).

In addition, other organizations are important sources of knowledge. The popularity of "benchmarking" and programs to transfer "best practices" or "lessons learned" from one organization to another reflects the usefulness of acquiring knowledge from other firms. Similarly, knowledge available through patent applications (Appleyard, 1996), scientific and trade publications, consultants and conferences can be useful to a firm. At a more macro level, inter-organizational arrangements, such as cooperative relationships (Shan, Walker & Kogut, 1994), strategic alliances (Hamel, 1991; Larsson, Bengtsson, Henriksson & Sparks, 1998; Mowery, Oxley & Silverman, 1996), joint ventures (Barkema, Bell & Pennings, 1996; Kogut, 1988, 1991; Makhija & Ganesh, 1997), transplants (Lewis, 1993), interlocking boards of directorates (Davis, 1991; Haunschild, 1993), consortia (Browning, Beyer & Shetler, 1995), and business groups such as Japanese Keiretsu (Cho, Kim & Rhee, 1998) are also potential mechanisms for knowledge transfer across firms.

A recent study aimed to determine the effectiveness of various knowledge transfer mechanisms. Appleyard (1996) asked respondents in the United States and Japanese semiconductor firms to rate the importance of nine sources of technical information, including colleagues in their company, colleagues at other companies, vendors, suppliers, customers, benchmarking studies, presentations at conferences, scientific publications, and patents. Respondents from both the United States and Japan rated colleagues in their own company as the most important source of technical information. Scientific publications and presentations at conferences were rated second and third in importance by respondents from both countries. Responses of representatives of U.S. and Japanese firms diverged on the source rated as fourth in importance: Japanese respondents rated patents

fourth, whereas U.S. respondents rated colleagues in other companies as the fourth most important source of technical information.

Appleyard (1996) also asked respondents to rate their preferred mode of knowledge sharing with both "horizontal" (another semiconductor company) and "vertical" (vendors) sources. Japanese respondents preferred public mechanisms for knowledge sharing with other semiconductor companies such as conferences, the press, trade journals and patents. In contrast, U.S. respondents preferred a mix of public (trade journals and conferences) and private (telephone and face-to-face meetings) mechanisms. A similar pattern of results emerged for the preferred mode of knowledge sharing with vendors: Japanese respondents preferred public sources, whereas U.S. respondents preferred a mix of public and private sources.

Further work is needed to determine the conditions under which various modes of knowledge sharing will be most effective. In addition to describing patterns of knowledge sharing, it will also be important to determine how patterns of knowledge sharing affect organizational outcomes.

How can one determine if knowledge transfer has occurred? The learning curve model described in Chapter 1 can be expanded to investigate whether knowledge transfers across organizational units. We turn now to our study of fast food franchises to illustrate the approach we use to assessing the extent of knowledge transfer.

5.4 The Franchise Study

Our primary goal in the franchise study was to assess the extent to which knowledge transferred across organizations. That is, we wanted to examine whether one organization learned or benefited from experience at another. A secondary goal for the franchise study was to determine the extent to which knowledge transferred over time—the extent to which knowledge persisted. Thus, we also investigated whether knowledge depreciated (see Chapter 2). To accomplish our first goal, we required a study context in which a large number of organizations produced the same product. This would permit us to assess the extent of knowledge transfer across a reasonable sample of organizations. Fast food franchises seemed an ideal setting for this purpose since many organizations produce the same product.

Another benefit of studying knowledge transfer in fast food franchises is that it provides information about the dynamics of organizational learning and transfer in a service industry. The preponderance of previous work on organizational learning has been conducted in manufacturing settings. Extending this line of work to service

organizations provides information about the extent to which their rates of learning, forgetting, and transfer compare to those found in manufacturing. Since the United States and other developed economies are increasingly service economies ("Survey of manufacturing," 1998), understanding the dynamics of productivity growth in service settings is an important undertaking.

All of the fast food stores in our study produced the same product (pizzas) and were franchised from the same parent corporation. All of the stores had opportunities to learn from the parent corporation. For example, at the time each store started, the parent corporation provided routines, blueprints, and procedures as well as training. The parent corporation also provided ongoing assistance to the stores. Franchise owners were required to attend yearly meetings of the corporation and consultants from the parent corporation visited the various stores.

Our primary focus is on knowledge transfer across the stores themselves. Several of the franchisees owned only one store, whereas others owned multiple stores. We analyzed whether stores learned from their own direct experience, whether they learned from the experience of other stores owned by the same franchisee, and whether they learned from the experience of stores owned by different franchisees. We also analyzed whether knowledge transferred over time by assessing the extent of knowledge depreciation.

5.4.1 Method and Sources of Data

We collected data from the entire set of stores in Southwestern Pennsylvania that are franchised from one of the largest pizza corporations. The sample included 10 different franchisees who owned a total of 36 stores. The largest franchisee owned 11 stores, whereas five of the franchisees owned only one store each. The oldest franchise organization had been in business for 11 years, and the youngest for just 3 months. The average age of the franchise organizations was 3.75 years.

The corporation's regional office provided data concerning pizzas sold and production costs for each store per week for a one and one half year period. Thus, we had approximately 75 observations for 36 stores, which resulted in a data set of over 2,500 observations. Structured interviews with the franchisees provided additional information about the frequency with various mechanisms were used to transfer information and also about the timeliness of service at the stores.

The franchise data have many attractive properties. The inputs to the production function (i.e., the raw materials) are homogeneous.

Therefore, input characteristics are controlled for naturally in the sample. Differences in technology across pizza stores are very small. Thus, factors that may be hard to control for statistically in production environments are controlled for naturally in the sample. The symbols used and the variables they represent are listed in Table 5.1.

Table 5.1
Variables Used in the Franchise Study

Symbol	Variable
t	Calendar time in weeks
J_n	Number of stores in franchise n
q_{nit}	Pizzas produced by franchise n in store i in week t
c_{nit}	Costs (food and labor) for store i in franchise n in week t
$Q_{nit} = \sum_{s=0}^t q_{nis}$	Cumulative number of pizzas produced by store i in franchise n through week t
$FQ_{nit} = \sum_{s=1}^t Q_{nis}$	Cumulative number of pizzas produced by franchise n through week t
$IQ_t = \sum_{n=1}^{10} FQ_{nt}$	Cumulative number of pizzas produced in all stores in all franchises through week t
p_{nit}	Percentage of pan pizzas produced by franchise n in store i in week t
S_{nt}	Dummy variables for each store

As noted previously in the discussion of measuring knowledge (see Chapters 1 and 2), the cumulative number of products produced at a particular organization serves as a proxy variable for knowledge acquired by the organization. In this particular study, the cumulative number of pizzas produced, Q , is a proxy for store-specific knowledge. To investigate knowledge transfer across the stores, we extended the approach to measuring knowledge by aggregating the cumulative number of units produced by all the stores in the relevant set. Thus, franchise-specific knowledge, FQ , is measured by summing the cumulative number of units produced by all stores in the franchise. Just as the cumulative number of units produced at a store is a proxy for store-specific knowledge, the cumulative number of units produced by all stores in the franchise is a proxy for franchise-specific knowledge. Similarly, inter-franchise knowledge, IQ , is measured by summing the cumulative number of units produced by all stores in all franchises.

We estimated several models in which the unit cost of production was analyzed as a function of store-specific experience, franchise experience, inter-franchise experience, and other variables. The most basic model we estimated using least-squares regression (Column 1 in Table 5.2) was:

$$\ln(c_{nit} / q_{nit}) = b_0 + b_1 \ln(Q_{nit-1}) + b_2 \ln(FQ_{nit-1}) + b_3 \ln(IQ_{t-1}) + b_{ni} s_{ni} + u_{nit} \quad (5.1)$$

We allowed for serial correlation of the error term, u_{nit} , in all the models we estimated. We also included dummy variables for each store in all equations. The dummy variables, s_{ni} , control for variance associated with store specifics such as management style, age, and location.

In Equation (5.1), if the coefficient on Q (b_1) is significant, store-specific learning has occurred. That is, a store's unit cost was affected by production experience at the store. If the coefficient on FQ (b_2) is significant, transfer of learning between stores owned by a common franchisee has occurred. That is, the unit cost of production at a store was affected by production experience at other stores in the franchise. If the coefficient on IQ (b_3) is significant, transfer of learning between stores owned by different franchisees has occurred.

In these analyses, the unit of time is a week. The variables Q , FQ , and IQ are the cumulative pizza production through the end of the previous week. The lagged cumulative output is used on the right-hand side of Equation (5.1) because cumulative output serves as a proxy for experience acquired as a result of past output.

We used the same approach to investigate whether knowledge persists through time or whether it depreciates as we used in our previous studies (see Chapter 2). We replaced the conventional cumulative output measure with the following knowledge variable:

$$K_{nit} = \lambda K_{nit-1} + q_{nit} \quad (5.2)$$

Equation 5.2 allows for the possibility that knowledge depreciates over time by including the parameter λ . As in our discussion of the shipyard results, if $\lambda = 1$, the accumulated stock of knowledge is simply equal to lagged cumulative output, the conventional measure of learning, and there is no evidence of depreciation. If $\lambda < 1$, there is evidence of depreciation: recent output is a more important predictor of current productivity than past output.

We also investigated alternative explanations of our findings by estimating models with additional control variables. We controlled for

economies of scale in the analysis. As noted previously, the scale of operation may expand as organizations gain experience and therefore, may be correlated with cumulative output. Some of the productivity gains apparently associated with cumulative output could actually be due to changes in the scale of operation. To avoid this problem, we controlled for economies of scale by including measures of the number of pizzas produced each week and its square.

We also controlled for product mix, measured here by the percentage of "pan" pizzas. As noted previously, some product options may be more costly to produce than others. Hence, it is appropriate to control for the percentage of these options in estimating learning rates. Furthermore, we controlled for technological progress associated with the passage of time by including a calendar time variable. This enables one to separate the extent to which productivity gains are a function of general technological changes in the environment versus changes in the particular organization. Finally, we allowed the rate of learning to change over time by including a quadratic term for the knowledge variable. This enabled us to test whether the leveling off in the rate of learning, or the "plateau" effect observed in several studies occurred here.

The model that included the full set of control variables (Column 4 in Table 5.2) was:

$$\begin{aligned} \ln(c_{nit} / q_{nit}) = & b_0 + b_1 \ln K_{nit-1} + b_2 \ln FK_{nit-1} \\ & + b_3 \ln IK_{t-1} + b_4 t + b_5 q_{nit} \\ & + b_6 q_{nit}^2 + b_7 (\ln K_{nit-1})^2 \\ & + b_8 p_{nit} + b_{ni} s_{ni} + u_{nit} \end{aligned} \quad (5.3)$$

where FK and IK are defined the same as FQ and IQ except that K replaces Q in the summations. Thus, knowledge that transfers is also allowed to depreciate.

An issue that arose in the franchise study that may confront other researchers who study learning in multiple organizations is the absence of data from the start of operation at all of the organizations. In particular, we did not have data from the start of production for half the stores. These stores were in operation several years before the data collection began. We dealt with this limitation by treating pizza production prior to the beginning of the data collection as an unknown coefficient in the model (see Column 5 of Table 5.2) and estimating it along with the other coefficients. As will be seen shortly, the results from estimating this model were virtually the same as from the other models.

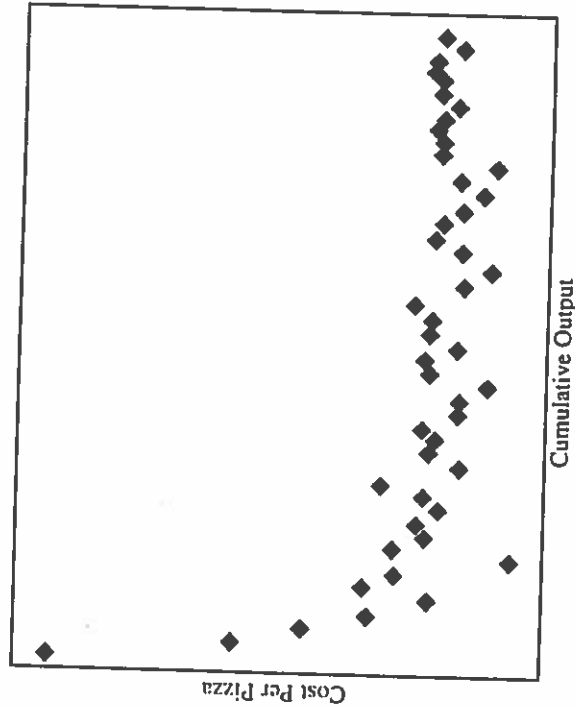
5.4.2 Results

A learning curve plotted from a single store is shown in Figure 5.1. This figure shows the characteristic learning curve pattern: the unit cost of producing pizza decreased at a decreasing rate as the cumulative number of pizzas produced increased.

5.4.2.1 Store-Specific and Franchise-Specific Learning

Results concerning the effects of store-specific learning, transfer between commonly owned stores, and transfer between differently owned stores on the unit cost of pizza production are presented in Table 5.2. This table

Figure 5.1
The Relationship Between Total Costs Per Pizza and Cumulative Output



Note. Reprinted by permission from E. Darr, L. Argote and D. Epple. The acquisition, transfer and depreciation of knowledge in service organizations: Productivity in franchises, *Management Science*, Volume 41, Number 11, (November, 1995). Copyright 1995, The Institute of Operations Research and the Management Sciences (INFORMS), 2 Charles Street, Suite 300, Providence, RI 02904 USA. These data are from a single store for a period of 1.5 years. Units were omitted to protect confidentiality of the data.

shows the results of estimating five different models of unit cost. The dependent variable in each model is the cost per unit of producing each pizza. The independent variables in each model are shown in the five columns. As can be seen from the table, we estimated increasingly complex models that included more predictor variables.

Results of estimating Equation (5.1) using a maximum-likelihood estimation algorithm allowing for first-order autocorrelation of the residuals are shown in Column 1 of Table 5.2. Analysis of the residuals from Equation (5.1) revealed first-order autocorrelation. There was no evidence of higher order autocorrelation. All of the models shown in Table 5.2 correct for first-order autocorrelation by jointly estimating the correlation coefficient with other coefficients in the models.

The coefficients of the store-specific dummy variables are not of particular interest so are not reported here. A joint test of the null hypothesis that there were no store-specific effects was rejected at a high significance level ($p < .001$), so important store-specific effects were present in the sample. Store-specific dummy variables were included in all analyses. The estimate of the constant term is not of particular interest for the research questions. The constant terms are omitted in order to preserve confidentiality of the data.

Column 1 shows the effect of the conventional measure of store-specific learning (lagged cumulative output for each store) on cost per unit. As can be seen from the table, the variable representing store-specific learning has a significant negative coefficient, supporting our expectation that the unit cost of production would decrease as the cumulative number of pizzas produced at each store increased.

Learning curves are often characterized in terms of a progress ratio, p . As noted previously, the progress ratio, p , is related to the coefficient for store-specific learning, b_1 , as follows:

$$p = 2^{-b_1} \quad (5.4)$$

Based on the results shown in column 1 of Table 5.2, a progress ratio for the entire sample was calculated to be $p = 0.93$. For each doubling of cumulative output, the unit cost of producing a pizza decreased to 93% of its previous value. Thus, pizza stores in the sample demonstrated a slower learning rate than the modal "80% learning curve" found in manufacturing firms. Although it was slower in this service sector than typically observed in manufacturing, the rate of learning was significant.

The effects of transfer between commonly owned stores and transfer between differently owned stores on cost per unit are also presented in

Table 5.2
Results Concerning the Transfer of Knowledge From the Franchise Study

	(1)	(2)	(3)	(4)	(5)
Store-Specific Learning (b_1)	-.1170 (.019)	-.0980 (.020)	-.0970 (.020)	-.1040 (.019)	-.1060 (.022)
Transfer between commonly owned stores (b_2)	-.1040 (.016)	-.0660 (.019)	-.0644 (.020)	-.0594 (.022)	-.094* (.047)
Transfer between differently owned stores (b_3)	-.015* (.007)	-.008 (.010)	-.009 (.010)	-.004 (.010)	-.001 (.011)
Calendar Time (b_4)		.0034 (.001)	.0034 (.001)	.0044 (.002)	.0024 (.0008)
Current Pizza Count (b_5)		-.00030 (.1E-04)	-.00030 (.1E-04)	-.00030 (.1E-04)	-.00040 (.9E-05)
Square of Current Pizza Count (b_6)		.6E-070 (.4E-08)	.5E-070 (.4E-08)	.5E-070 (.4E-08)	.9E-070 (.4E-08)
Square of Store-Specific Learning (b_7)			.009 (.007)	.009 (.008)	.003 (.009)
Percentage Pan Pizza (b_8)			.021 (.017)	.022 (.021)	.052 (.048)
Depreciation of Knowledge (λ)				.800 (.046)	.830 (.042)
Autocorrelation Coefficient (u)	.5690 (.017)	.5810 (.014)	.5890 (.015)	.5120 (.022)	.4920 (.024)
R ²	.237	.557	.565	.593	.653

Note. Standard errors are shown in parentheses.

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* $p < .05$, † $p < .01$, and ‡ $p < .001$

Column 1 of Table 5.2. The negative coefficients b_2 and b_3 suggest that both transfer between commonly owned stores and transfer between differently owned stores accounted for significant decreases in the unit cost of production. The latter effect, however, was not robust to alternative specifications of the model. This is discussed in the following paragraphs.

Models with more control variables were estimated to explore alternative explanations for the results. We divided the control variables into two separate sets (Columns 2 and 3) in order to understand better their incremental impact. In Column 2 of Table 5.2, calendar time was introduced to capture the possibility that technical change associated with the passage of time rather than learning associated with organizational experience was responsible for decreases in unit production costs. The positive coefficient for the time variable in Column 2 of Table 5.2 indicates that time is not a viable alternative explanation for the decrease observed in unit production cost. The coefficient on the time variable actually indicates that the cost of pizza production increased with the passage of time, perhaps reflecting increases in food and labor costs over the one and a half year period of the study.

Current pizza count and the square of current pizza count were also included in Column 2 to capture the possible effects of economies of scale on cost per unit. The negative coefficient for current pizza count and the positive coefficient for the square of current pizza count in Column 2 of Table 5.2 indicate that significant scale effects were present. Cost per unit first decreased and then increased with increases in the current volume of production.

The decrease in cost per unit as volume rises from relatively low output levels is natural since some labor and operating costs must be borne merely to keep a store open, and those costs are spread over more units as volume increases. Increasing cost per unit at higher volumes seemed to result from increased coordination costs. Coordination became difficult for high-volume production, especially since less experienced part-time employees were used to supplement regular employees during peak loads.

Comparing Column 1 and Column 2 of Table 5.2 reveals that the impact of transfer between differently owned stores was no longer significant, whereas the effects of store-specific learning and transfer between commonly owned stores on the unit cost of production were unchanged with the addition of calendar time, current pizza count, and the square of current count. This illustrates the importance of controlling for scale economies since other variables may pick up their effects if scale variables are excluded.

We conducted a specification test (Hausman, 1978) to assess whether there might be simultaneity in the determination of cost per pizza

and current pizza count. Our model allows for current pizza count to affect costs through economies of scale. It is conceivable that there is also an effect in the reverse direction: stores with lower cost per pizza may charge lower prices and thereby generate a larger sales volume. Such simultaneity or endogeneity would lead to biased coefficient estimates. To test for the possibility of endogeneity of current count, the model was estimated with a two-stage least squares procedure that Fair (1970) developed. This instrumental variables procedure provides consistent estimates of models with endogenous variables and serially correlated errors. The coefficient estimates using instrumental variables were compared to the original coefficient estimates. The two sets of coefficient estimates were very similar. A test statistic of 8.16 was calculated for Hausman's specification test. The test statistic was distributed as χ^2 , $df=44$, with a critical value of 60.48 at the .05 level. Thus, there was no evidence of endogeneity of current pizza count in the model.

In Column 3 of Table 5.2 the square of the knowledge variable was introduced into the model to allow for possible changes in the learning rate. The coefficient for this variable was insignificant, indicating that there was no change in the rate of learning over the length of the study. Thus, we did not observe the "plateau" effect in this study.

The proportion of total pizza production accounted for by pan pizza was also introduced into the model at this stage to control for product mix. The estimate of pan pizza effects in Column 3 was insignificant, indicating that product mix did not affect the unit cost of production. A comparison between Column 2 and Column 3 reveals that the learning, time, and scale effects were unchanged by the inclusion of these additional variables.

The possibility that the results were driven by a few newly opened stores in the sample was investigated by removing the four new stores from the sample. The results from the reduced sample were almost identical to the results in shown in Table 5.2.

5.4.2.2 Depreciation

Results on the depreciation of learning are presented in Columns 4 and 5 of Table 5.2. Column 4 is a linear model that does not include entire production histories, whereas Column 5 is a nonlinear model including entire production histories. The maximum likelihood estimate of λ for the model shown in Column 4 was 0.80. The hypothesis of no depreciation ($\lambda = 1.0$) was very strongly rejected. The depreciation rate is very rapid for these organizations.

Learning curve analysis has traditionally proceeded from the beginning of production in an organization. The majority of stores in this sample were in operation several years prior to the beginning of data collection. Through further data collection, we obtained complete production histories for 18 of the 36 stores in our sample. The impact of including entire production histories for each store on estimated learning effects was investigated using a nonlinear model in which pizza production prior to the beginning of our sample was added to the store, intra-franchise, and inter-franchise aggregates. For each of the 18 stores for which we were unable to obtain complete data, production history was treated as an unknown coefficient.

The results of these analyses are shown in Column 5 of Table 5.2. Including complete production histories did not change our results concerning store-specific learning, time, scale effects, and product mix. The effect of transfer between commonly owned stores remained significant but became somewhat less significant than in the previous analysis. The maximum likelihood estimate of the depreciation parameter, 0.83, remained significantly less than one in this model.

These results indicate a very rapid rate of depreciation. A value of $\lambda = 0.83$ implies that roughly one half (0.83⁴) of the stock of knowledge at the beginning of a month would remain at the end of the month. From a stock of knowledge available at the beginning of a year, a negligible amount (0.83¹²) would remain one year later. In fact, without continuing production to replenish the stock of knowledge, virtually all production knowledge would be lost by mid-year.

We hypothesized that knowledge transfer between commonly owned stores should be greater than transfer between differently owned stores because of greater use of transfer mechanisms between commonly owned stores. There are many mechanisms for transferring knowledge across franchises. For example, all franchises are required to attend a yearly meeting. And a consultant from the parent corporation routinely visits each store to provide advice. These transfer mechanisms were more or less constant for all the stores in the sample. Other mechanisms, however, varied across stores. For example, there seemed to be more communication and interaction between some stores than others. We measured the frequencies of phone calls, personal acquaintances, and meetings between the various stores. We found that the frequencies of these communication mechanisms for transferring knowledge were significantly greater between commonly owned stores than between differently owned stores. Further research is needed to determine if these (and other mechanisms) contributed to the knowledge transfer observed.

5.4.2.3 *Timeliness*

We also investigated whether a different but also important outcome, service timeliness, evidenced learning (Argote & Darr, in press). Service timeliness was measured as the percentage of "late" pizzas. We adopted the corporation's metric for coding a pizza as late: if a prespecified amount of time elapsed from when an order arrived to when the pizza was completely prepared, it was listed as late.

The dependent measure in our analysis of service timeliness was the number of late pizzas per unit of pizzas produced each week. The predictor variables paralleled those previously described for our analysis of cost per unit. Thus, we examined whether service timeliness improved as a function of a store's direct experience, of the experience of other stores owned by the same franchisee, and of the experience of stores owned by different franchisees. As in the analysis just described of cost per unit, dummy variables for each store and key control variables were also included in the models. In the service timeliness model, we also controlled for labor costs at each store. Finally, we allowed for the possibility that service knowledge depreciated by replacing the conventional cumulative output measure with the specification of knowledge shown in Equation (5.2).

Results indicated that stores benefited from their own direct experience and from the experience of other stores owned by the same franchisee. Service timeliness was not affected by the experience of stores owned by different franchisees. These results paralleled those reported earlier for cost per unit. Knowledge transferred across stores owned by the same franchisee but not across stores owned by different franchisees. Results also indicated that service knowledge depreciated. Recent output was found to be a more important predictor of service timeliness than cumulative output.

5.4.3 Discussion

The fast food stores in our study evidenced firm-specific learning: as they gained experience, the unit cost of production decreased at a decreasing rate. The results on firm-specific learning are robust: firm-specific learning effects contributed to reductions in production cost independent of calendar time, scale effects, and product mix. Additionally, store-specific learning was evident when we added complete production histories and allowed for knowledge depreciation.

This is one of the first studies to focus on learning in service organizations. Although the modal progress ratio in the fast food franchises

we studied was less than the modal figure found in manufacturing, learning effects were significant contributors to the productivity of the stores. Further research is needed to determine whether the slower rate of learning is characteristic of most service organizations and if so, why the rate is slower than that typically observed in manufacturing. To accomplish this, we believe that it will be more fruitful to move beyond the diffuse characterization of "service" versus "manufacturing" organizations and focus on the specific variables that differentiate the two environments.

Indeed the line between manufacturing and service is blurring. An automotive company recently looked to a fast food firm for ideas about improving performance. Alex Trotman, Ford's Chairman, sent a task force to McDonald's to learn how McDonald's produces the same hamburgers all around the world ("Survey of manufacturing," 1998). Just as McDonald's delivers the same hamburger around the world, Ford wanted to be able to produce the same car on a global basis. This example of a manufacturing firm seeking to imitate a service firm suggests that the underlying business processes at each firm have much in common.

There are also points on which manufacturing and service firms generally differ. For example, there was much less opportunity to match tasks to the expertise and interests of individual workers in the pizza stores we studied than in the manufacturing plants. Thus, an important source of productivity gains was not available to the fast food stores. Similarly, many manufacturing organizations are able to sequence their products in a way that maximizes productivity. This option may not be available to service organizations who produce on demand. For example, the truck plants we studied sequenced their products such that trucks with options that required significantly more steps to include such as air conditioning were never sequenced back-to-back in the production line. By contrast, the pizza franchises produced on demand to satisfy customers and had less opportunity to sequence their pizzas so as to maximize their productivity. Future research is needed to determine if these factors are the underlying variables that explain differences between rates of learning in service and manufacturing sectors.

The results on transfer of learning extend our current understanding of the conditions under which transfer occurs. The results suggest that knowledge transfer between affiliated organizations is greater than transfer between independent organizations. Future research is needed to determine why knowledge transfer is greater between stores in the same franchise than between stores in different franchises. For example, is the pattern of differential transfer largely a function of differences in motivation, differences in opportunities to communicate, or otherwise? Competition was minimized in the franchise organizations by corporate policies that, for

example, limited how close the stores could locate to each other. Also, the stores cooperated on marketing and promotions. Although there was little competition between the stores and some cooperation, there were more incentives to share information with stores owned by the same franchisee than with stores owned by different franchisees. Thus, differences in motivation could have contributed to differences in the degree of knowledge transfer.

There were also more personal relationships and opportunities to communicate among stores owned by the same franchisee than among stores owned by different franchisees. These results are consistent with past work demonstrating that social networks are denser within related than between independent organizations (e.g., see Tichy, Tushman & Fromburn, 1979; Tushman, 1977). In the current study, opportunities to share information were greater within than between franchisees. Differences in opportunities to communicate and share information could also have contributed to differences observed in the degree of knowledge transfer. Further research is needed to determine why knowledge transfer is greater between affiliated than independent organizations.

The finding that being embedded in a superordinate relationship such as a franchise increased the degree of knowledge transfer has important practical implications. It suggests that embedding organizations in a network that gives them a larger experience base to draw on is a powerful way for improving the performance of a focal firm. This suggestion is consistent with the trend noted on the part of many franchise organizations to move away from single store owners to owners who own very large numbers of stores. A recent *Wall Street Journal* article argued that most franchise systems are moving away from "mom-and-pop" franchises to franchises where the same individual owns many stores:

Franchising specialists say such high-flying franchisees are becoming more numerous—and vastly more important.

Most franchise systems have a growing number of "big boys" with 20 or more stores. For example, Grand Metropolitan PLC's Burger King Corporation unit in Miami says five U.S. franchisees top the 50 store mark, compared with only two in 1985 (Tannenbaum, 1996, p. A1).

Our results suggest that the ability to learn from a larger experience base and to transfer knowledge from one store to another contributes to the greater productivity of multi-store franchisees.

Recent results of a study by McEvily and Zaheer (1998) are consistent with the recommendation that being embedded in a network

improves organizational performance. The researchers examined whether participating in regional institutions, Manufacturing Extension Partnership (MEP) centers, improved the capabilities of small manufacturers. The MEP centers provide training courses, workshops, equipment demonstrations, supplier certification and the like to small manufacturers. Based on an analysis of data from 227 small manufacturers in the metal-working sector located in the Midwestern area of the United States, McEvily and Zaheer (1998) concluded that participation in a regional network was generally associated with enhanced competitive capabilities.

The transfer results from the franchise study are generally consistent with our previous results on the extent to which transfer of learning occurs (Argote, Beckman & Epple, 1990; Epple, Argote & Murphy, 1996). The previous studies found that intra-plant transfer across shifts within a production facility was greater than transfer across geographically separated production facilities, such as the shipyards. Groups within a single plant such as two shifts are more related than geographically separated groups. Previous results concerning transfer of learning are, therefore, consistent with the results presented here.

Events that occurred in the food franchises after we completed data collection provided additional validation for our finding about the importance of being embedded in a multi-store network. Three of the stores in the sample closed or changed owners due to productivity problems. All three stores that closed or changed owners were single-store franchisees. These stores were not able to benefit from production experience at other stores. Consistent with our results, these stores were less productive than their counterparts in multi-store franchisees.

5.5 Levels of Knowledge Transfer

Knowledge transfer in organizations has been studied at different levels of analysis. This section provides an overview of whether knowledge has been found to transfer at these different levels. Subsequent sections identify the conditions under which knowledge transfer is most likely to occur. Some researchers have examined whether knowledge transfer occurs across products or models of the same product within an organizational context (e.g., Udayajiri & Balakrishnan, 1993). Others have studied whether knowledge transfers between units of the same organization, such as shifts within a manufacturing plant (Epple, Argote & Murphy, 1996) or Product Development and Marketing departments (Adler, 1990). Others have examined whether knowledge transfers across organizations embedded in a superordinate relationship, such as a franchise or chain (e.g., Baum &

Ingram, 1998; Darr, Argote & Epple, 1995). Still others have examined whether knowledge transfers or "spills over" across competitors (e.g., Henderson & Cockburn, 1996; Irwin & Klenow, 1994). The extent of knowledge transfer found to occur at each of these levels will now be reviewed: across products, across units of the same organization, across organizations embedded in a superordinate relationship, and across independent organizations.

Knowledge transfer from one model to another or from one product to another can contribute significantly to a firm's performance. Ghemawat (1985) described a dramatic example of knowledge transfer across products in the motorcycle industry. British motorcycle manufacturers apparently did not understand that achieving a viable cost position on one product depended on their manufacture of other products, since different products shared parts and manufacturing processes. British manufacturers stopped producing small motor bikes when they were threatened with competition from the Japanese on that end of the market. Although getting out of the small bike market improved their performance initially, it destroyed their performance in the long run. The small bikes shared many parts and processes with their larger counterparts. When the British stopped production of the small bikes, they dramatically reduced their experience base for learning about the parts and processes shared with the large bikes. According to Ghemawat (1985), the British share of their own home market fell from 34% in 1968 to only 3% in 1974.

The Lockheed case previously described in Chapter 2 also suggests the importance of the ability to transfer knowledge across products for firm performance and survival. A competitor of Lockheed, McDonnell Douglas, produced a military KC-10 tanker that was very similar to its commercial DC-10 counterpart. The ability to transfer knowledge across the KC-10 and the DC-10 may have contributed to the more favorable cost position McDonnell Douglas enjoyed relative to Lockheed.

Several studies have empirically examined the extent of knowledge transfer across models or products. These studies have generally found that knowledge transfer occurs—but to an incomplete degree. In his detailed analysis of the Lockheed L-1011 production program, Benkard (1997) found that transfer of knowledge occurred from one model of the L-1011 to another. The transfer, however, was incomplete: not all of the knowledge acquired on the production of the first model transferred to the second. Lockheed began producing one model and produced it with minor variations throughout the entire production program. Several years into the production program, Lockheed began producing a different model with a shorter fuselage and different cargo and galley configurations. Benkard (1997) found considerable—but incomplete—transfer from the first to the second

model. Benkard estimated that the first unit of the second model required approximately 25% more labor than another unit of the original model would have required.

Henderson and Cockburn (1996) also found considerable knowledge transfer across products. In their analysis of the determinants of research productivity in drug discovery, Henderson and Cockburn (1996) found evidence of internal spillovers of knowledge between related research programs within the same firm.

Irwin and Klenow (1994) found weak evidence for learning spillovers across different generations of products in the semiconductor industry. Irwin and Klenow (1994) did not have access to firm-level data on production cost but rather used price as a proxy for unit cost data. Using firm-level price data, Irwin and Klenow (1994) concluded that knowledge transferred or spilled over only in two of the seven product generations. By contrast, using industry-level price data, Udayagiri and Balakrishnan (1993) presented evidence that knowledge transferred over generations for the five semiconductor products they analyzed. Further, the researchers found that experience producing Dynamic Random Access Memory (DRAM) chips benefited the production of other memory products. The difference in findings across these two studies of knowledge transfer in the semiconductor industry may be due to their differing focus on firm- versus industry-level data.

Both studies used price as a proxy variable for unit costs. It is hard to disentangle the price effects that arise as a consequence of market dynamics from the effects that derive from knowledge transfer. Clearly more work is needed on knowledge transfer effects in the semiconductor industry.

More generally, further research is needed to understand the conditions under which knowledge transfers across products or generations of products. The similarity of products and the extent to which they build on a common knowledge base are key factors conditioning the ease of transferring knowledge across them. The role of similarity will be addressed in a subsequent section of this chapter.

Researchers have also studied knowledge transfer across the components of an organization. For example, as described in Chapter 3, my colleagues and I studied the amount of knowledge transfer that occurred from the first shift to the second shift when the new shift was introduced at a truck assembly plant (Epple, Argote & Murphy, 1996). We found that the transfer from the period of one-shift operation to the period of two-shift operation was rapid and almost complete. Within two weeks, the second shift achieved a level of productivity that it had taken the first shift almost two years to achieve. We suggested that the rapid and complete transfer

was due to much of the organization's knowledge being embedded in its technology (cf. Mishina, 1992).

A significant amount of knowledge has also been found to transfer across organizations that are embedded in a superordinate relationship. My colleagues and I examined transfer of knowledge across 13 World War II shipyards that went into production at different points in time (Argote, Beckman & Epple, 1990). Mechanisms for transferring knowledge across the shipyards existed (Lane, 1951). The organizations produced the same product with a standardized design. A central agency was responsible for purchasing, designing each yard's layout, approving the technology it used, and supervising its construction. The central agency also stationed engineers, inspectors, and auditors at each site to share information about "best practices." Shipyards that began production later were found to be more productive initially than those with earlier start dates. Once shipyards began production, however, they did not benefit further from production experience at other yards. Thus, transfer of knowledge occurred across the shipyards at the start of production but not thereafter.

The results of our franchise study described earlier in this chapter indicated that fast food stores benefited from the experience of other stores in the same franchise (Darr, Argote & Epple, 1995). Similarly, Baum and Ingram (1998) found that Manhattan hotels benefited from the experience of other hotels in the same chain. Ingram and Simons (1997) found that kibbutzim benefited from the experience of other kibbutzim in the same federation but not from the experience of kibbutzim in different federations.

Several studies have examined whether knowledge transfers or spills over across firms in an industry. Although there is evidence of knowledge transfer from other firms in the industry, firms typically learn more from their own direct experience than from the experience of their competitors. For example, Zimmerman (1982) studied transfer of knowledge in nuclear reactors built between 1953 and 1963. The unit cost of constructing power plants and the cumulative experience in the industry constructing power plants. Both types of experience were found to be significant predictors of the unit cost of construction. The effect of firm-specific experience, however, was more significant than the effect of industry experience.

Joskow and Rose (1985) took a more refined approach to measuring experience in their study of 411 coal-burning steam-electric generating units built between 1960 and 1980. Joskow and Rose (1985) analyzed the unit cost of construction as a function of firm-specific experience, architect-engineer experience, and industry experience. An architect-engineer team typically designed plants for more than one firm. Joskow and Rose (1985)

found that firm-specific and architect-engineer experience were significant predictors of the unit cost of construction, whereas industry experience was not significant. Thus, firms learned from their own direct experience and the experience of architect-engineer teams. Transfer of knowledge occurred across firms that employed the same architect-engineer team but not across other firms in the industry.

Irwin and Klenow (1994) also studied knowledge transfer across competitors. Although knowledge transfer was found to occur, firms learned three times as much from an additional unit of their own direct experience as from an additional unit of experience at another firm. Further, knowledge appeared to spill over as much between firms in different countries as between firms within a country. In contrast to popular notions about learning in Japanese firms, Japanese semiconductor firms were not found to differ from firms in other countries in their rate of learning.

Henderson and Cockburn (1996) also analyzed knowledge transfer across competitors. In their study of factors affecting research productivity in drug discovery, Henderson and Cockburn (1996) found that firms benefited from their own direct experience and from the experience of their competitors. Although the effect of the experience of competitors was considerably smaller than the effect of a firm's own experience, the benefits of the experience of others accounted for a significant amount of the total variance in productivity. Thus, the Henderson and Cockburn results are similar to those of Irwin and Klenow as well as Zimmerman. Firms generally learn from their own direct experience and from the experience of their competitors. Although they do not learn as much from their competitors as from their own experience, the transfer of knowledge from other firms contributes significantly to a focal firm's productivity.

Thus, knowledge transfer has been found (to varying degrees) at all levels of analysis. Related research will now be discussed and the conditions under which knowledge is most likely to transfer across organizations will be developed. The focus is primarily on knowledge transfer across organizations or units of organizations. Related work that helps illuminate these processes will be included.

5.6 Related Research

Although interest in how one organization transfers knowledge to another is relatively new, considerable work has been done in the past on related topics. For example, work has been done on "transfer of training." This work examines how to design training programs to increase the likelihood that participants transfer skills acquired in the training program to on-the-job

performance (e.g., see Baldwin & Ford, 1988, for a review). Work has also been done in psychology on how individuals transfer knowledge learned on one task to another (e.g., see Singley & Anderson, 1989, for a review). This research might examine, for example, how experience with one programming task affects performance on another. In a somewhat different vein, work has been done on the transfer or diffusion of innovation (e.g., see Rogers, 1995). This work might examine, for example, how a new farming practice diffused across farmers. These different lines of work focus primarily on individual (rather than organizational) outcomes and hence are beyond the scope of this monograph. These lines of work will be drawn upon when they have implications for the transfer of knowledge across organizations.

Some work has been done at the organizational level on the diffusion of practices across organizations (e.g., DiMaggio & Powell, 1983; Tolbert & Zucker, 1983). For example, Tolbert and Zucker (1983) examined the diffusion of civil service reforms across cities in the United States. Much of this work has emphasized that organizations often adopt practices to achieve legitimacy rather than to improve their efficiency (see Scott, 1987, for a review of this perspective). Research has also been done on factors affecting the adoption or transfer of practices or technology within organizations (e.g., see Allen, 1977; Attewell, 1992; Cool, Dierickx & Szulanski, 1997; Keller & Chintia, 1990; Leonard-Barton, 1988; Ouinjian & Carne, 1987). For example, Cool, Dierickx and Szulanski (1997) examined factors explaining the diffusion of electronic switching technology within the operating companies of the Bell System.

Our focus is somewhat different than past work on the adoption of organizational practices or technology. We do not examine whether or not an organization adopts a practice. Instead we examine whether an organization learns from the experience of other organizations. Because their experience may be embedded in practices or technology, research on the adoption of practices may be relevant for understanding how one organization learns from the experience of another. Past work on the adoption of practices will be drawn upon when it illuminates how the adoption of practices affects the performance of the recipient unit.

Our work on knowledge transfer at the organizational level of analysis is most analogous to research on knowledge transfer at the individual level of analysis. Just as researchers of individual knowledge transfer examine how experience on one task affects performance on another, we examine how experience at one organization affects performance at another. Factors such as similarity that are important predictors of the extent of knowledge transfer at the individual level turn out to be important at the organizational level as well. Additional factors,

however, come into play in understanding knowledge transfer at the organizational level of analysis. These factors will now be discussed.

5.7 Conditions Under Which Knowledge Transfers

This section identifies the conditions under which knowledge transfers across organizational units. That is, the section identifies the conditions under which experience in one organization affects the performance of another. The section is organized into examining how knowledge transfer is affected by characteristics of the relationship among the organizations, characteristics of the organizations involved in the transfer, features of the knowledge being transferred, and dimensions of the transfer process.

5.7.1 Characteristics of the Relationship Among Organizations

As noted previously, one very important factor affecting transfer of knowledge across organizations is whether the organizations are embedded in a superordinate relationship. My colleagues and I found that being embedded in a superordinate relationship, such as a franchise, increased the likelihood of knowledge transfer (Darr, Argote & Epple, 1995). Similarly, Baum and Ingram (1998) found that Manhattan hotels benefited from their own direct experience and the experience of hotels that were related to them through belonging to the same chain. Along similar lines, Ingram and Simons (1997) found that kibbutzim benefited from the experience of other kibbutzim that belonged to the same federation, whereas they did not benefit from the experience of those in different federations.

Powell, Koput and Smith-Doerr (1996) found that biotechnology firms that were linked together in a Research and Development alliance were more likely to have access to critical information and resource flows that facilitated their growth than firms not engaged in such collaborative relationships. McEvily and Zaheer (1998) found that participation in regional institutions, Manufacturing Extension Partnership centers, improved the competitive capabilities of small manufacturers. Uzzi (1996) found that clothing apparel firms that were embedded in networks had a greater chance of survival than firms connected to other firms only through "arms-length" ties. Uzzi suggested that learning from one another contributed to the superior performance of firms in the network. Burns and Wholey (1993) found that regional and local hospital networks influenced the diffusion of an administrative innovation, matrix management. Thus,

being embedded in a franchise, chain, or network relationship facilitates the transfer of knowledge.

Being embedded in a superordinate relationship may affect both the motivation and communication of participants in ways that facilitate knowledge transfer. Incentives of firms involved in superordinate relationships are typically more favorable to knowledge transfer than incentives at independent firms. For example, competition is usually minimized among organizations that belong to franchises, chains, or networks. These organizations cooperate in certain arenas. The organizations generally trust each other to a greater degree than those not embedded in a network or superordinate relationship (Granovetter, 1985; Uzzi, 1996).

Being embedded in a franchise, chain, or network also provides more opportunities to communicate than are afforded independent organizations (who may even be proscribed from direct communication with each other). Meetings, informal interactions, and opportunities to observe each other's organizations are all more likely to occur among organizations embedded in such a relationship than among independent organizations. Personnel movement may also be encouraged among the organizations and they may have access to each others' documents and databases. These communication opportunities provide mechanisms for transferring both explicit and tacit knowledge across organizations. For example, Uzzi (1996) noted that more tacit knowledge flowed across the firms embedded in a network than across independent organizations. Thus, organizations embedded in superordinate relationships have more opportunities to share information and learn from one another.

Being close geographically has also been found to facilitate knowledge transfer. Galbraith (1990) analyzed 32 different attempts to transfer manufacturing technology from one facility of an organization to another. He examined the amount of time it took to increase productivity at the recipient facility to the level achieved at the donor site prior to transfer. Galbraith found that the time it took for productivity to recover was slower when the organizations were geographically far apart.

The results of our research on intershift transfer of knowledge also suggest that geographic proximity facilitates knowledge transfer. Results from our study of transfer of knowledge across shifts in a manufacturing facility indicated that knowledge acquired during the period of one-shift operation carried forward quite rapidly to the period of two-shift operation (Epple, Argote & Murphy, 1996). The carry-forward of knowledge was almost complete within two weeks of the second shift's start-up. We found a more rapid and more complete degree of knowledge transfer in this study of inter-shift transfer than in studies of knowledge transfer across

geographically dispersed organizations. It seems likely that the greater proximity of the two shifts facilitated knowledge transfer between them.

Research on transfer of knowledge in nuclear power plant operation also underscores the importance of proximity for knowledge transfer. Lester and McCabe (1993) examined how the performance of nuclear reactors in the United States and France varied as a function of industry structure. The researchers found that transfer of knowledge across reactors was greatest when the reactors were located at the same site. This finding explained much of the performance advantage of France, which typically builds four reactors at the same site, relative to the United States, where the preponderance of units are built at sites where there is at most one other reactor.

By contrast, Darr (1994) found that geographical proximity was not a predictor of knowledge transfer in pizza stores in Great Britain, once similarity of store strategy was taken into account (cf. Burt, 1987). Darr (1994) found that stores were more likely to learn from other stores following a similar than a dissimilar strategy. Geographic similarity and customer similarity were insignificant predictors of knowledge transfer when strategic similarity was taken into account.

Other studies have found similarity to be an important predictor of the extent to which firms monitor and imitate each other. For example, Porac and Thomas (1994) found that similar retail organizations were more likely to monitor each other than dissimilar organizations. In a longitudinal simulation of student groups, Baum and Berta (1998) found that groups were more likely to imitate other student groups that occupied a similar market position.

Further research is needed on the role of geographic proximity and similarity in knowledge transfer. This research would benefit from specifying (and testing) the underlying processes through which the factors affect knowledge transfer. For example, does proximity facilitate communication and, thereby, improve knowledge transfer? Alternatively, are proximate organizations more likely to be similar and thus, have more relevant knowledge to share? A greater understanding of the processes that mediate the relationship between proximity and knowledge transfer is needed.

The quality of the relationship among organizations also affects knowledge transfer. Szulanski (1996) examined barriers to the transfer of best practices within organizations. One of the factors found to contribute to the degree of knowledge transfer was the quality of the relationship between the donor and the recipient. A poor relationship made it more difficult to transfer best practices. The relationship between organizational subunits or work groups will be discussed more fully later in this chapter.

5.7.2 Characteristics of the Organizations

Characteristics of an organization, such as its size or success, also affect the likelihood that it will be imitated by other organizations. In a study of imitation among firms in their choice of investment banker, Haunschild and Miner (1997) found that organizations were more likely to imitate firms with exceptional performance than to imitate firms with average performance. Somewhat surprisingly, firms imitated both the best and the worst performers. The latter effect was particularly pronounced for deals completed during the most recent year, when publicity might have the greatest impact (cf. Haunschild & Miner, 1997). Thus, imitation of firms with the high premiums (i.e., the worst deals) may reflect the salience of these investment bankers rather than the quality of their deals. Haunschild and Miner (1997) also found that firms were more likely to imitate large firms and to follow a particular strategy when it was used by many other firms in the industry (see also Burns & Wholey, 1993). Baum and Berta (1998) found that student groups were more likely to copy successful than unsuccessful groups.

Further research is needed to determine the conditions under which imitating other firms with particular characteristics affects the performance of the imitator. Several of the characteristics found to increase imitation in the Haunschild and Miner study may be proxy variables for the use of practices that enhance firm performance. For example, large firms or firms with exceptionally high performance may primarily use practices that enhance performance (cf. Haunschild & Miner, 1997). Thus, imitating firms with these characteristics may enhance the performance of the imitator. Imitating firms with other characteristics, such as the use of popular strategies, may confer legitimacy on the imitator and thereby enhance performance. Imitating firms with still other characteristics such as exceptionally low performance seems unlikely to improve the performance of the imitator. Research is needed on the conditions which imitation improves the performance of the imitating firm. It seems likely, for example, that imitating practices at another firm will improve the performance of a focal firm when the contribution of the practice to performance is well understood.

Characteristics of the recipient organization can also affect the extent of knowledge transfer. Cohen and Levinthal (1990) introduced the important concept of "absorptive capacity," which they defined as the ability of a firm to recognize the value of external information, assimilate it, and apply it. Cohen and Levinthal argued that absorptive capacity, which is largely a function of the firm's level of prior related knowledge, is critical to innovation. In an empirical study of the transfer of best practices within a

firm, Szulanski (1996) found that high absorptive capacity on the part of recipients facilitated the transfer of best practices.

In a related vein, Rothwell (1978) described the many problems that develop when the technology to be transferred is beyond the understanding of the recipient organization. Similarly, Galbraith (1990) found that previous experience with technology transfers minimized the initial productivity loss associated with transfer of manufacturing technology to new establishments. Furthermore, Hamel (1991) reported that a wide gap in skills between partners in a strategic alliance impaired transfer of knowledge between them. In order to replicate a partner's skills, a firm must understand the steps between its current capability and that of its partner.

Allen's (1977) work on technology transfer also underscores the importance of absorptive capacity on the part of recipients and suggests a structure for facilitating it. Allen found that for applied research problems whose solution could not be completely codified in scientific principles, having a "gatekeeper" at the boundary of a group who could communicate with internal and external constituencies facilitated performance. The gatekeeper absorbed knowledge from outside and interpreted it for internal constituencies.

Ancona and Caldwell (1992) also examined the activities groups use to manage relationships with other groups. Based on interviews and questionnaires from managers of new product teams, the researchers identified strategies groups took vis-à-vis external constituencies. Ambassadorial activities, which involved protecting the team and garnering resources and support for it, initially had a positive effect on meeting deadlines and budgets but the effect dissipated over time. Although activities aimed at coordinating technical and design issues did not affect team performance initially, these activities had a positive effect on innovation over the long run. Prolonged scouting activities that involved gathering information and scanning the environment were negatively associated with team performance—both initially and over the long run. These results suggest that task-coordinator activities, which are intimately connected to the organization's workflow, may be more important over the long run than ambassadorial or scouting activities.

Motivation also matters in knowledge transfer across groups. Szulanski (1996) found that the higher the motivation of the recipient organization, the greater the knowledge transfer. Similarly, Zander and Kogut (1995) found that the more competitors were perceived as engaging in developing a similar product, the faster the speed of internal technology transfer. Thus, the fear of being surpassed by competitors enhanced the transfer of capabilities within the firm.

Interestingly enough, Szulanski (1996) concluded that although motivation mattered, it mattered less than cognitive or knowledge-related factors in explaining the transfer of best practices within an organization. According to Szulanski (1996), characteristics of the practice and opportunities to acquire a deep understanding of it were more important than motivational issues in determining whether transfer occurred.

5.7.3 Characteristics of the Knowledge Transferred

Characteristics of the information being transferred also affect the ease and success of knowledge transfer. Tacit knowledge or knowledge that is not well understood is more difficult to transfer than explicit knowledge. In their study of factors affecting the speed of transfer of manufacturing capabilities, Zander and Kogut (1995) found that knowledge that was codified in documents and software and that could be readily taught to new workers transferred more easily than capabilities not codified or easily taught. Similarly, Szulanski (1996) found that knowledge that was high in "causal ambiguity" was harder to transfer than well-understood knowledge. Our work on intershift transfer of knowledge suggests that embedding knowledge in technology is a very powerful and effective way to transfer knowledge (Epple, Argote & Murphy, 1996). Much of the knowledge embedded in technology was explicit and well-understood.

The complexity of the information being transferred is also likely to influence the success of the transfer. Galbraith (1990) found that attempts to transfer complex manufacturing technology were associated with higher initial losses in productivity at the recipient organization than attempts to transfer simpler technology. Similarly, Ounjian and Carne (1987) and Rothwell (1978) found that increased complexity reduced the rate of diffusion of innovation. By contrast, Meyer and Goes (1988) found that an innovation was more likely to be assimilated into hospitals when it was complex.

The observability of knowledge also affects its ease of transfer. Meyer and Goes (1988) found that the ease of observing an innovation and seeing its effect influenced its rate of assimilation. Observable innovations were assembled more easily than ones that were more difficult to observe.

The information features of the innovation from our study of fast food franchises that transferred most widely are consistent with these features found to facilitate knowledge transfer. As described in Chapter 3, an innovative method for placing pepperoni was developed at one of the stores in Southwestern Pennsylvania. The method of distributing pepperoni evenly on a pizza before it was cooked that had worked well for regular

pizza did not work well for deep dish pizza. When the method was used on deep dish pizza, distributing pepperoni evenly before cooking resulted in a cooked pie with a clump of pepperoni at the center. A store in Southwestern Pennsylvania discovered an effective method for achieving an even distribution of pepperoni on deep dish pizza after it was cooked. The pepperoni was placed on the pie in a pattern that resembled spokes on a wheel. As the pizza cooked and the cheese flowed, the pepperoni would distribute themselves (more or less) evenly on the pizza. This method for distributing pepperoni was not complex. It was observable and codified in a routine that could be easily taught to new employees. Thus, the method scored high on features of information found to facilitate knowledge transfer. The pepperoni placement method transferred initially to other stores in the same franchise. A consultant from the parent corporation recognized the effectiveness of the method and promoted it in visits to other franchises and at national meetings. The method is now used by almost every store in the corporation. This example illustrates that knowledge that is observable, explicit, and not overly complex transfers readily to other organizations.

Interestingly enough, in their study of assimilation of innovations in hospitals, Meyer and Goes (1988) found that characteristics of the innovation itself, such as its observability, were more important predictors of the innovation's assimilation than characteristics of the organization, its leadership or the environment in which the organization was embedded (see also Szulanski, 1996). Organizational leaders, structures, and environments mattered less than attributes of the innovation in determining assimilation. Thus, characteristics of the knowledge being transferred may be particularly important in determining the degree of transfer.

Although some features of knowledge may be immutable, others may be amenable to change. In our study of pizza franchises, some tacit knowledge seemed inherently tacit. Knowledge about how to hand toss pizza, for example, was a kind of tacit knowledge not easily made explicit. By contrast, other knowledge that was tacit could have been codified in more explicit terms that would enable the knowledge to transfer more readily. For example, one order taker at a store developed heuristics for sequencing pizza preparation in a way that took advantage of differences in cooking times for different types and sizes of pizza. The heuristic enabled the ovens to be used more efficiently and the pizzas to be prepared more quickly. Although the heuristic remained in the mind of one employee, it could have been codified in a procedure that others could use.

5.7.4 Characteristics of the Transfer Process

Characteristics of the transfer process itself, such as its timing, also affect the extent of knowledge transfer. Organizations seem particularly open to learning from the experience of others early in their life cycle. Thus, there may be "windows of opportunity" (Tyre & Orlikowski, 1994) for transferring knowledge from others.

The results of our shipyard study are consistent with the prediction that organizations are more likely to learn from others at the start of their operation (Argote, Beckman & Epple, 1990). We examined transfer of knowledge across 13 World War II shipyards that went into production at different points in time. Shipyards that began production later were found to be more productive initially than those with earlier start dates. Once shipyards began production, however, they did not benefit further from production experience at other yards. Thus, transfer of knowledge occurred at the start of production but not thereafter.

The results of Baum and Ingram's work on hotel chains are also consistent with the prediction that organizations are more open to learning at the start of operation. Baum and Ingram (1998) found that Manhattan hotels benefited from the experience of hotels in different chains in the industry up to the time of the focal hotel's founding but not thereafter. Similarly, in their study of the adoption of farming practices, Foster and Rosenzweig (1995) found that framers learned from the experience of other farmers and that their learning from others diminished over time. In a study of success rates at angioplasty surgery, Kelsey et al. (1984) found that organizations were most likely to learn from the experience of others when they first began to perform the new surgical procedure.

By contrast, in a study of imitation of which investment banker to use on an acquisition, Haunschild and Miner (1997) found that firms learned from each other on a continuing basis. Along similar lines, we found that pizza stores learned from other stores in the same franchise on an ongoing basis (Dart, Argote & Epple, 1995). The different results regarding whether learning is confined to the start of operation or occurs on a continuing basis may be due to differences in prevailing knowledge repositories across the settings. For both the shipyards and the hotels, a significant component of the knowledge was embedded in the physical equipment, layout and technology of the establishments. By contrast, less knowledge regarding the investment banker decision or pizza production was embedded in "hard" form. Changing physical equipment, layout and technology may be more costly and disruptive than changing softer forms of knowledge. Future research is needed to examine factors affecting when firms are most open to

learn from other firms. The extent to which knowledge is embedded in technology versus softer forms is likely to be a key factor.

The learning mechanism also affects the extent of knowledge transfer. Rulke, Zaheer and Anderson (1998) contrasted the extent to which three learning channels affected an organization's knowledge of its own capabilities as well as the capabilities of other firms. Three types of learning channels were identified empirically and supported by factor analysis: purposive (learning through deliberate attempts to transfer knowledge through company newsletters, formal training programs and the like), relational (learning from personal contacts both inside and outside the firm), and external arm's length (learning from trade association publications and newsletters). Rulke, Zaheer and Anderson (1998) found that purposive and relational (but not external) channels contributed to greater self-knowledge of an organization's own capabilities. Somewhat surprisingly, an organization's knowledge of the capabilities of other organizations was not affected by any of these learning channels.

Additional aspects of the transfer process affect its success. In his study of attempts to transfer manufacturing technology from one facility to another within a firm, Galbraith (1990) found that the time it took for productivity to recover was faster when co-production continued at the donor site and when the engineering team from the donor organization was relocated for at least one month to the recipient organization. Continuing production at the donor site may facilitate the transfer of tacit knowledge that is not written down or embedded in documents and plans. Since production continues at the donor site, the recipient site would be able to access the donor's store of tacit knowledge through observation. Once production is discontinued at the donor site much of the tacit knowledge would be lost.

Moving engineering personnel to the recipient organization is a powerful way to transfer tacit as well as explicit knowledge. Many other studies have found that moving personnel is a very powerful way to facilitate knowledge transfer. Allen (1977) argued that individuals are the most effective carriers of information because they are able to restructure information so that it applies to new contexts. Similarly, based on results from a study of technology transfer in the textile machinery sector, Rothwell (1978) concluded that the most effective way to transfer technology was to move people.

Research on tacit knowledge provides insights into why moving personnel is a powerful way to transfer knowledge. Berry and Broadbent (1987) found that although experienced individuals were not able to articulate their knowledge, they were able to transfer their knowledge to a similar task. That is, experience on one task improved performance on

another task even though individuals were not able to articulate why their performance had improved on the first task. Individuals were thus able to transfer tacit knowledge from one task to another. This ability to transfer tacit knowledge across different contexts makes personnel movement a powerful transfer mechanism.

This richness of information transferred may explain the effectiveness of personal meetings and conferences relative to correspondence, papers, and publications in transferring technology (cf. Daft & Lengel, 1984). In a study of the diffusion of computer simulation technology, Dutton and Starbuck (1979) found that face-to-face meetings and conferences were more effective in diffusing the technology than written media such as papers, proceedings, and correspondence. Face-to-face meetings and conferences provide opportunities to transfer a richer set of information, including some tacit knowledge, than written media. The richness afforded by face-to-face communication conferences was especially important early in the diffusion of technology, when common understandings were being developed.

Future research is needed to understand more fully the conditions under which knowledge transfers and to determine the effectiveness of various transfer mechanisms. Are certain mechanisms more effective knowledge conduits than others? Does the effectiveness of a particular mechanism vary as a function of the type of knowledge being transferred or the stage of the transfer process? More generally, a greater understanding of the micro processes underlying the transfer of knowledge is needed.

5.8 Challenges to Knowledge Transfer Across Units Within Organizations

Although there are many benefits to knowledge transfer across organizations, it can be difficult to achieve. This section focuses on barriers to transferring knowledge across units of the same organization. While firms usually want to minimize or at least circumscribe knowledge transfer to other firms, they typically desire to foster knowledge transfer across their own departments or units. Even when knowledge transfer is desired, however, it can be difficult to achieve.

There are many reasons why it is difficult to transfer knowledge across units in the same organization. For example, the knowledge organizations acquire may be tacit and not easily articulated. As discussed previously, if knowledge cannot be articulated, it poses particular challenges for transfer since it is not easily communicated through verbal or written media. Transferring knowledge across organizational subunits or

departments (rather than across individuals) poses particular challenges. Two factors make it particularly hard to transfer knowledge across subunits or work groups: competition between units and differences in context. These two factors are the focus of this section.

The first factor that impedes knowledge transfer across organizational subunits or work groups is competition between them (see Messick and Mackie, 1989, for a review). Competition between groups or units is a barrier to transferring knowledge since members of one group may not be motivated to share information with another (cf. Szulanski, 1994). Drawing on social identity theory (e.g., see Tajfel, 1981; Turner, Hogg, Oakes, Reicher & Wetherell, 1987), Ashforth and Mael (1989) argued that much of the conflict that occurs between groups in organizations derives from the very existence of different groups. According to social identity theory, individuals' desires for positive self-evaluation lead them to differentiate between social groups by perceiving one's own group more favorably than other groups (Abrams & Hogg, 1990). Thus, the desire to enhance one's social identity leads to more positive perceptions of the "in group" and more negative perceptions of the "out group." While there is disagreement as to the precise mechanism through which in-group biases occur, the in-group bias is very robust (see Brewer, 1979, for a review).

Building on social identity theory, Kramer (1991) argued that categorizing individuals into distinctive groups produces intergroup competition in organizations. Thus, attempts to promote group identity in organizations may also produce intergroup competition. Giving groups distinct names, providing opportunities for members to interact, publicizing the performance of different groups, providing rewards based on the performance of different groups, and other techniques designed to increase group identity are also likely to increase intergroup competition. Intergroup competition, in turn, impairs sharing of information and transfer of knowledge across groups.

There is debate about the minimal conditions necessary to produce in-group favoritism and intergroup competition (e.g., see Insko & Schopler, 1987). Is merely being categorized into groups sufficient to produce in-group biases or do other factors such as differences in interaction and rewards have to be present? Since other factors, such as more interaction within than between groups, typically exist in organizations, it seems likely that in-group favoritism would develop there.

Kramer (1991) noted that organizational settings may be particularly conducive to the development of competition between groups. In organizational settings, it is often difficult or impossible to assess performance in absolute terms. Instead, organizations rely on relative comparisons. Is Department A more or less productive than Department B?

Being perceived as a high-performing department thus means being perceived as performing better than some other department. This emphasis on relative performance exacerbates competition between units, because often the only way a unit can be perceived as high-performing and thereby enhance members' social identity is to be seen as being better than other units. The increased competition between groups thereby limits knowledge sharing across them.

The second factor that affects transfer of knowledge across groups in organizations is the degree of similarity of group contexts. Transfer of knowledge from one situation to another requires some degree of similarity between the two situations for transfer to occur. Much research has been done on transfer at the individual level of analysis. A recurring theme in this research is how difficult it is for an individual to transfer knowledge acquired in one situation to another (Singley & Anderson, 1989). Singley and Anderson (1989) proposed a model of transfer built on Thorndike's earlier identical elements theory of transfer. According to these models, transfer is based upon the elements shared between tasks. The more elements that are shared, the greater the transfer will be.

When one moves from the individual to the group or subunit level of analysis, the likelihood of finding identical elements diminishes. Groups typically develop their own idiosyncratic ways of doing work (Levine & Moreland, 1991). Groups may divide tasks in different ways, use technologies somewhat differently, develop different ways of coordinating and communicating, and develop their own unique cultures. Differences across groups are likely to be accentuated by providing groups autonomy in deciding how to accomplish their work and by encouraging them to develop their own culture and task-performance strategies. Differences in how groups accomplish their tasks make it hard to transfer knowledge from one group to another since knowledge acquired in one group may not be applicable to another.

We saw examples of differences developing in how work was done in our study of truck assembly plants (Argote & Epple, 1990). Two of the plants started out with the identical technology. Over time, one of the plants drastically changed how it used the technology to override key features. After these changes were made, managers at the other plant argued that much of the knowledge acquired at the first plant was not relevant for their operation because the technologies of the two plants were so different.

Research on situated cognition also implies that knowledge may be difficult to transfer across work groups. In this tradition, knowledge is seen as situated—highly dependent upon the particular constellation of people, machines, and conditions that exist at the work site (e.g., see Hutchins, 1991; Lave, 1991; Suchman, 1987). Individuals learn through intensive

apprenticeships that expose them to the idiosyncratic conditions that exist in their work settings. Brown and Duquid (1991) provided compelling examples of situated cognition in their study of service technicians. Training manuals were not very helpful for these technicians. Instead they learned their jobs through interacting with other service technicians, customers, and the machines. Stories that other technicians told were often more helpful in diagnosing what was wrong with a machine than the machine's error code because the stories captured idiosyncratic local conditions while the error codes did not. Idiosyncratic local conditions make it very difficult to transfer knowledge across groups.

We have seen instances where local conditions limited the potential of knowledge transfer in our research. For example, one of the organizations we studied was fortunate to have a particularly gifted manager. Over time, the manager assumed more and more responsibilities. Micro changes in the distribution of responsibilities at the organization accumulated to the point where its macro structure started to differ from its sister organizations. These differences in expertise and in the division of labor at the two organizations decreased the relevance of some of the knowledge acquired in one organization for another.

5.9 Promoting Knowledge Transfer Across Organizational Units

It is difficult to transfer knowledge across organizational units. Several reasons why it is difficult for one unit to benefit from the experience of others have to do with the nature of experience. A unit's own experience is likely to be more relevant than the experience of other units. As noted previously, differences in member capabilities, culture, structure, or technology may make knowledge acquired at a different organizational unit less relevant than a unit's own knowledge. Further, a unit's own direct experience may be easier to interpret than the experience of another unit. Causal connections may be clearer and the link between actions and outcomes easier to understand. Thus, there may be inherent differences in the structure of experience that make it easier for an organization to learn from its own experience than from the experience of others.

These inherent differences in experience notwithstanding, organizations seemingly do not fully exploit their opportunities to learn from other organizations or even other parts of their own organization. There are obvious reasons why it is difficult to learn from a competitor, yet even when organizational units are part of the same firm or involved in a cooperative relationship with other firms, knowledge transfer is difficult to achieve (Szulanski, 1996).

The differences documented in the performance of plants that are part of the same firm and produce the same product with similar technology illustrate the difficulty of transferring knowledge across organizational units (Argote & Epple, 1990; Hayes & Clark, 1986). Although it could be argued that some of the knowledge acquired at one plant is not relevant for another, it is hard to explain the dramatic productivity differences between plants on the order of 2:1 by such an argument (Chew, Bresnahan & Clark, 1990). It could also be argued that these plants do learn from one another—and that the learning results in one plant being superior at one point in time and another plant superior at a different point in time. This argument, however, is inconsistent with the data, which generally show that the same relative ranking in productivity may persist across plants for years (e.g., see Argote & Epple, 1990). Thus, the pattern of results suggests that organizations do not take full advantage of the opportunity to transfer knowledge from one part of their operations to another.

How can organizations promote knowledge transfer across their units? Adler and Cole (1993) described how Nummi, the General Motors-Toyota joint venture in Fremont, California, transferred knowledge through minute standardization and documentation of activities. The standardization increased the relevance of knowledge acquired in one part of the establishment for another and the documentation served as a conduit for knowledge to flow from one part of the organization to another. This approach was highly successful in the Nummi environment where a high volume of a homogeneous product was manufactured.

Benefits of knowledge transfer can be achieved, however, even in more decentralized organizations which face more heterogeneous environments. For these units, a balance between standardization and local adaptation is key. Rather than regiment what the units should do, providing them opportunities to interact with each other, to learn "best" practices, and to adapt them to local conditions will be more effective.

Strategies for improving relationships between groups will be helpful in facilitating knowledge sharing among them (see Kramer, 1991). For example, providing incentives for group members to interact by introducing "superordinate goals" (Sherif, 1958) that require the cooperation of different units will increase knowledge sharing. Increasing the salience of higher-level organizational boundaries and emphasizing the need to compete effectively against other firms can also contribute to knowledge sharing within the organization. These approaches are likely to reduce strong in-group favoritism and induce a higher level categorization of belonging to the same organization.

Providing opportunities to interact through conferences and meetings will also foster knowledge sharing. Interaction with members of

other groups is likely to reduce in-group favoritism and provide opportunities for group members to see that knowledge acquired by another group may have some relevance to their operation as well. These face-to-face interactions provide opportunities to acquire deep understandings of how and why "best practices" work. Thus, members of organizational units can acquire a deep understanding of the practices of their counterparts that enables them to tailor the practices to local conditions by keeping key features and eliminating superficial ones. These opportunities to interact also contribute to the development of transactive memory systems or meta knowledge of who knows what in the organization that enhance organizational performance (see Chapter 3). Providing opportunities to interact and learn about best practices rather than legislating the adoption of them has the further advantage of providing employees control over their work. In addition to allowing employees to adapt practices to their contexts, the control also has psychological benefits for employees (Tannenbaum, 1968).

Face-to-face methods of communication such as meetings and conferences can be fruitfully supplemented by electronic means once a relationship is established. Electronic means of communication are generally more effective at augmenting existing relationships than establishing new means (Kraut, Egido & Galegher, 1990). Electronic means can be effective at transferring knowledge across organizational units, especially when participants already have some familiarity with each other.

Personnel movement, where feasible, is also an effective means of transferring knowledge across organizational units. As noted previously, people are capable of transferring tacit as well as explicit knowledge. Thus, moving personnel is a particularly potent mechanism for transferring knowledge.

In short, a multiplex approach to knowledge transfer is likely to be most effective. Personal contacts and face-to-face communication are rich communication media (cf. Daft & Lengel, 1984) that are particularly well-suited for identifying information to be transferred and acquiring a deep understanding of it. Personal interactions are likely to be most effective early in the transfer process (cf. Dutton & Starbuck, 1979). Once information has been identified and adapted to the new context, less personal means of communication such as documents, routines, and technology can be very effective. Indeed, if information is to be transferred on a large and consistent scale, it is important that it eventually be embedded in less personal means such as routines and technology. If there is little need to adapt the information to local conditions, an organization can rely less heavily on personal means of communication from the start and

rely more heavily on impersonal means such as documents, blueprints, routines, and technology.

At a more macro level, embedding an organizational unit in a superordinate relationship such as a community of practice or a consortia is likely to facilitate knowledge transfer. These relationships lower motivational barriers to knowledge transfer. They also foster communication among members and thereby facilitate the flow of information across groups or departments.

5.10 Conclusion

Transferring knowledge from other groups or organizations is an important source of productivity gains. Although organizations learn more from their own direct experience than from the experience of others, learning from others contributes significantly to a firm's productivity and survival prospects. The ability to transfer knowledge from other groups or organizations and learn from their experience has been found to affect important organizational outcomes, including productivity, timeliness, and survival.

Several factors have been found to increase the likelihood of knowledge transfer across organizational boundaries. Organizations seem particularly open to benefiting from knowledge acquired by other organizations at certain points in their development, such as when they begin operation. Embedding organizations in a superordinate relationship such as a franchise, chain, or network increases the likelihood that knowledge will transfer across the organizations. Proximity and similarity also facilitate knowledge transfer. Codifying knowledge in observable artifacts such as routines also facilitates knowledge transfer. Rich communication mechanisms such as face-to-face interactions and personnel movement are particularly powerful mechanisms for knowledge transfer. These media permit the transfer of tacit as well as explicit knowledge and allow for the acquisition of a deep understanding of the information being transferred. Thus, these mechanisms are particularly well-suited for identifying knowledge to be transferred and adapting it to local conditions. Once the information has been adapted to local conditions, less personal transfer mechanisms such as routines and technology will be particularly useful since they permit the consistent transfer of knowledge on a large scale.

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