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TECHNOLOGY TRANSFERS

Factors affecting the Successful Transfer of Technology

by

Michael E. White

A research paper submitted in fulfillment of the requirements for _3_ credits, GRADUATED INDEPENDENT RESEARCH PROJECT Winter Term 1997, Professor Joanne Oxley , Faculty Supervisor.

Faculty Comments

Mike has done an interesting piece of work. In the paper he reviews the literature on technology transfer, derives a series of hypotheses from that literature, and explores them through an interview-based case study of a high tech firm. While some of the technology transfer practices of the firm studied are clearly idiosyncratic to its own set of circumstances, many practices are in line with predictions drawn from the literature. The study therefore provides an interesting illustration of how the general principles of effective technology transfer are applied in practice.

J. Oxley
Signature of Faculty Supervisor

Asst. Professor.
Title

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GLOSSARY

SUCCESSFUL TRANSFER	A technology transfer in which the transferee becomes capable of performing one or several functions attached to the technology in a satisfactory manner.
TRANSFEROR	The entity that has developed the technology and is now releasing control of it.
TRANSFEREE	The entity that will be gaining control of the technology from the entity that developed it.
TACIT KNOWLEDGE	Knowledge that *cannot* be shared through specifications, drawings, etc. For example, how to ride a bike.
CODIFIED KNOWLEDGE	Knowledge that *can* be shared through specifications, drawings, etc. For example, the dimensions of a brake pad and the materials required to build that pad.
TECHNOLOGY	The power to do work.
EXTERNAL TRANSFER	A transfer in which neither the transferee not is a wholly owned subsidiary or internal department of the transferor
INTERNAL TRANSFER	A transfer in which the transferee is a wholly owned subsidiary or internal department of the transferor

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INTRODUCTION

INTRODUCTION

Any study about technology transfers should endeavor to first define what exactly a *technology transfer* is. Seurat (1979, pp. 1) defines it as "the capacity to store and transmit to people the accumulated experience of others." Robinson(1988, pg. 3-5) proposes that a technology transfer consist of an "embodied element" and a "disembodied element". The embodied element incorporates certain aspects of a technology that can be described by scientific measurements, such as physical dimensions and chemical compounds. The disembodied element consist of human skills and knowledge.

This paper uses the term "codified knowledge" to describe the part of the technology that can be described by scientific measures. I use the term "tacit knowledge" to describe the part of the technology that consist of the human skills, knowledge, and accumulated experience. Consequently, I define technology transfer as the sharing of codified knowledge effused with the tacit knowledge required to understand the codified knowledge. Through this definition, I have tried to describe the integration of both types of knowledge into any technology.

How does an organization successfully transfer technology? What impacts the successful transfer of a technology? In an attempt to answer these questions, this paper first reviews some of the current research on technology transfers. Second, I present some hypotheses concerning technology transfers. Finally, I attempt to link the research and my hypotheses with a survey of a company's real world experiences. This survey, which starts on page 41, is based on interviews with the company and their technology transfer partners.

TECHNOLOGY TRANSFERS

This section reviews the current thinking on the characteristics of a technology transfer. An explanation of what is a successful transfer is suggested. A classification of different types of technology transfers is offered. Finally a discussion comparing internal and external technology transfers is presented.

CHARACTERISTICS OF TECHNOLOGY TRANSFERS

Cusumano and Elenkov (1993) suggest that technology transfers are complex processes that are not completed in one transaction. Instead, technology transfers evolve over the life of the technology. Transfers of technology tend to follow three major stages: acquisition, adaptation, and improvement.

Per Cusumano and Elenkov, researchers tend to see technology transfers as a relatively predictable process whereby recipient organizations acquire, assimilates, and then improve technology. Much work has been done to understand how organizations as well as individuals or groups within an organization can best use, cultivate, or acquire technical capabilities.

These facts indicate that technology transfers are not just the selling of a product to an entity and leaving them to learn how to use it. The acquisition of capabilities to use the technology Is Integral to the transfer of technology. These capabilities are strongly intertwined with the tacit knowledge element of the technology. Consequently the acquisition of tacit knowledge Is fundamental to a technology transfer.

SUCCESSFUL TECHNOLOGY TRANSFER

Seurat(1979, pp. 16-17) claims: a technology transfer takes places when the transferee becomes capable of performing one or several functions attached to a specific technique in satisfactory conditions. Integral to this claim is the transfer of the tacit knowledge that will allow successful application of the technology.

Other researchers have gone further to suggest that a technology transfer is not successful until the transferee has the capabilities to improve the transferred technology. The ability to improve a technology can signal the successful assimilation of the tacit knowledge associated with the technology.

However, I would suggest that a technology transfer can be successful without improving the transferred technology. Even if the technology is not improved, the acquisition of the tacit knowledge associated with that technology begins to build the skills of the transferee. With these new skills the transferee will eventually be able to improve any technology, not just the technology currently being transferred. Therefore, this study adopts Seurat's definition.

CLASSIFICATION OF TECHNOLOGY TRANSFERS

Cusumano and Elenkov (1993) examine the following classifications of technology transfers; "material" transfers; "design" transfers; and "capacity" transfers. These classifications are based on the desired output from the transfer.

Material transfers

Transfers characterized by the simple transfer of new materials and techniques associated with those materials. In a material transfer, the transferor is not concerned with an orderly or systematic local adaptation of the technology.

Design transfers

Transfers primarily carried out through the transfer of certain blueprints, formulas, books, etc. These types of transfers are made to obtain new material types or to copy equipment designs.

Capacity transfers

Transfers made through the transfer of scientific knowledge that enables the production of locally adaptable technology, following the prototype technology. An important element in the process of capacity transfer is the migration of scientists as the diffusion of idea depends heavily on extended personal contact and association.

As described in the preceding paragraphs, technology and the transfer of that technology both contain an element of codified knowledge and an element of tacit knowledge. From the classifications presented, it can be seen that the amount of tacit knowledge embedded in the transfer increases as the desired output of the transfer increases. Figure 1 is a graphical representation of this phenomenon.

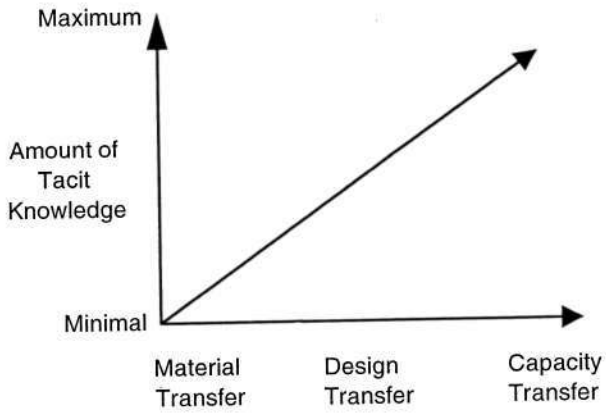


Figure 1 -- Amount of tacit knowledge versus transfer type

TRANSFER OPTIONS

Robinson (1988 pp. 17-18) references the primacy and completeness of a technology when talking about transfer options. He defines primacy of a technology transfer as a continuum running from *user technology* to *design technology.* Completeness is defined as a continuum running from *partial* to *complete* technology transfer.

Robinson explains primacy as the difference in knowing how to use a tractor and having the ability to invent the tractor in the first place. Completeness is the difference between transferring instructions on how to drive the tractor, and transferring all the technology relating to tractor-drawn implements, including data on the various soils, climates, topography, and appropriate crops for each.

The closer the technology is to a design technology, the more tacit knowledge is required by the transferee to successfully implement the technology. Likewise, a complete technology has a higher degree of tacit knowledge. Ergo, Robinson classifies the options for technology

transfers by the amount of tacit knowledge integrated into the technology.

INTERNAL TRANSFER VERSUS EXTERNAL TRANSFER

Another dimension that affects the transfer of technology is the internal versus external transfer decision. This dimension is affected heavily by the tacit knowledge embedded in the transferor and the transferee.

Internal transfers can take several forms, such as transfers to a wholly own subsidiary, a joint venture or other partnership, etc. External transfers involve the selling or leasing of the technology to a separate organization.

Usually the first criterion used to decide between an internal and external transfer is the need to protect the technology. Protection of technology is more complete with an internal transfer. There are contractual and monetary supportive bonds that mitigate the risks of the technology being "shared" with competitors. Internal transfers also allow the transferor easier access to improvements made to the technology by the transferee.

The second criterion is usually the cost of the transfer. Internal transfers are thought to be less costly for a variety of reasons. Robinson (1988 pp. 38-48) cites the following examples:

1. Persons at both ends of a transfer speak the same language in an organizational and technological sense.
2. Prolonged negotiation as to terms and conditions may be eliminated, likewise most of the associated costs, including legal.

3. The firm runs little risk of non-payment for commercial reasons.
4. Performance bonds or guarantees are rarely involved.
5. Claims based on failure of the technology to operate as expected are extremely unlikely.

Research has shown that certain factors positively affect the likelihood of an internal transfer. These factors include:

1. The greater degree to which the technology is an *Incremental technology* (i.e., the technology is an improvement on the present technology and not a new *basic technology).*
2. The technology to be transferred is "close" to the firm's core competency.
3. The transferor has little experience transferring technologies.

Other research (e.g. Davidson & McFetridge, 1984) has shown a positive correlation between the following factors and the willingness of the transferor to complete an external transfer:

1. A relatively high investment in research and development as a percentage of sales.
2. The larger the size of the transferor.
3. High level of diversification by the transferor.
4. A greater amount of *process* innovation versus *product* innovation by the transferor.
5. The more mature the technology is.

DEFINING TECHNOLOGY

This section offers a review of the characteristics of Technology.

TECHNOLOGY CHARACTERISTICS

Robinson(1988 pp. 11-16) discusses twelve dimensions of technology. These dimensions are:

Maturity	Dynamic Quality	Relative Importance
Continuity of Production	Factor Substitutability	Scale Specificity
Availability	Complexity	Centrality

The following paragraphs describe the dimensions that pertain to this study. However, by not including an explanation, the author does not intend to diminish the importance of any dimension of technology discussed by Robinson.

Maturity

The longer a technology is on the market, the more likely its embedded tacit and codified knowledge will be shared through scientific symposiums, technical publications, seminars, etc. This infusion of the technology into the "common" knowledge reduces the costs of training and labor.

An example of a mature technology is television. Most people can operate a TV, some even before they can walk. It has become common knowledge and does not require special training or labor. However, the programmable TV remote Is an Immature technology that requires that the user be trained or comprehends the basic tacit knowledge required to use the remote.

Dynamic Quality

This dimension describes the speed at which the technology is expected to change. Currently it is common for microprocessor technology to change every 6-12 months. This type of technology has a high degree of dynamic quality.

Relative Importance

A technology that is used to start a new industry or product has a higher degree of relative importance. This technology is *basic* to the industry or product.

Complexity

A technology has a high degree of complexity if it is extremely difficult to understand the technology's use and design. For example, while understand how to use a cellular telephone is quite easy, understand the design of the technology and how it functions is very complex.

Centrality

An indication of what the technology's relationship is to the transferor's or transferee's core competency. A "central" technology is one that is essential to the core competency of the firm. A "peripheral" technology is inessential to the core competency of the firm.

Susceptibility to Reverse Engineering

An indication of how easy it would be to analyze and commercialize the technology without assistance from the developers of the technology. A technology with a high degree of susceptibility to reverse engineering is a technology with a high degree of codified knowledge.

HYPOTHESES

HYPOTHESES

From the review of the research, it is obvious that technology transfers are not simple executions of simply handing a technology to a transferee and walking away. This section attempts to present a number of hypotheses based on the research. These hypotheses are based on the following assumptions:

1. The technology exists and can be immediately transferred. However, the technology may have to have minor adjustments to be used in the transferee's application.
2. Governmental barriers do not exist.

Figure 2, on page 40, is a model of how the characteristics of the technology, the characteristics of the transferee, and the characteristics of the transferor influence the mode of transfer selected and the transfer process. The following sections present hypotheses that summarize these influences.

TECHNOLOGY CHARACTERISTICS.

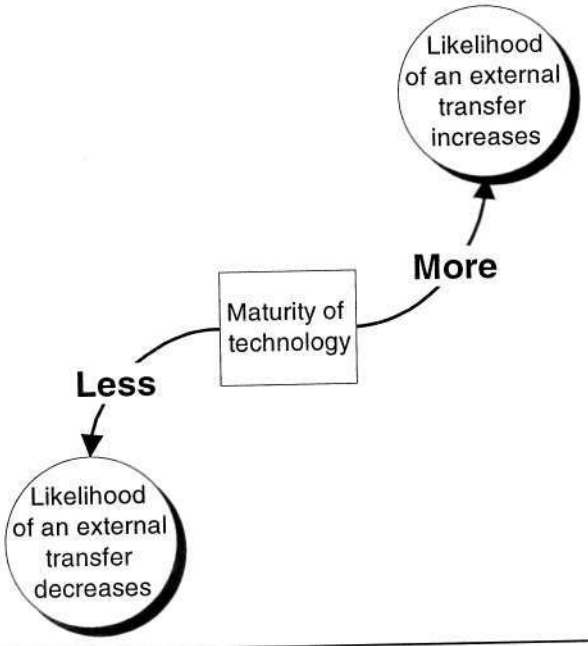
The following hypotheses attempt to explain the effect of the following relationships between the characteristics of the technology and the technology transfer process and transfer mode decision:

1. Degree of technology maturity versus mode of transfer selected.
2. Degree of dynamic quality versus mode of transfer selected.
3. Degree of core competency protection versus mode of transfer selected.
4. Degree of tacit knowledge transferred versus mode of transfer selected.

Technology Maturity versus Transfer Mode

As outlined earlier, maturity of a technology indicates how long the technology has been in existence. The longer a technology is in existence, the more likely it is that the skills, required to successfully implement the technology, have been disseminated. This dissemination can take the form of scientific symposiums, articles in technical publications, university courses, etc. This would indicate a reduction in the amount of tacit knowledge needed to be transferred to guarantee successful use of the technology. With the reduction in the tacit knowledge requirement, an external transfer becomes feasible.

Therefore, as the maturity of a technology increases, the likelihood of an external transfer increases.



Hypothesis 1 -- As the maturity of a technology increases, the likelihood of an external transfer increases.

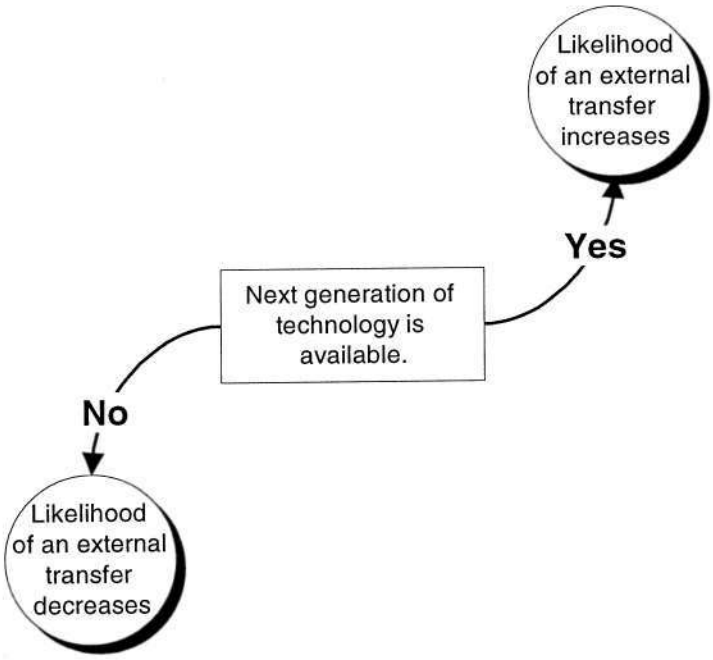
Dynamic Quality of Technology versus Transfer Mode

Technology that changes frequently is said to have a high degree of dynamic quality. These changes can be a simple as a curved handle on a hammer or as complex as developing an electric car. It is the rate at which the change occurs that gives the technology its dynamic quality.

When technology is changing at a very fast rate, such as in the area of microprocessors, the ability to develop the next version of the technology may allow the transferor to undertake the risk of an external transfer. This is because by the time the older version of the technology has been transferred, the transferor can have the next version ready for deployment into production. If the transferee does share the technology with others, the transferor can obsolete the older version by introducing the next version.

If the transferor has already developed the next version of the technology and the older version is still producing revenue, the transferor may be more likely to externally transfer the older version if the transferor desires to update its version of the technology or if the transferor can not produce both versions profitably. This would allow the transferor to continue to reap the financial rewards of the older version, through licensing agreements, etc., while simultaneously introducing the new version.

Therefore, as the next generation of a technology becomes available, the likelihood of an external transfer increases.



Hypothesis 2 – A as the next generation of a technology becomes available, the likelihood of an external transfer increases.

Core Competencies versus Transfer Mode

The technology developed by the transferor can be integral to the transferor's core competencies. Transferring this type of technology externally where the transferor could not control its distribution would be very risky.

Therefore, as the degree to which the developed technology is part of the transferor's core competency increases, the likelihood of an external transfer decreases.

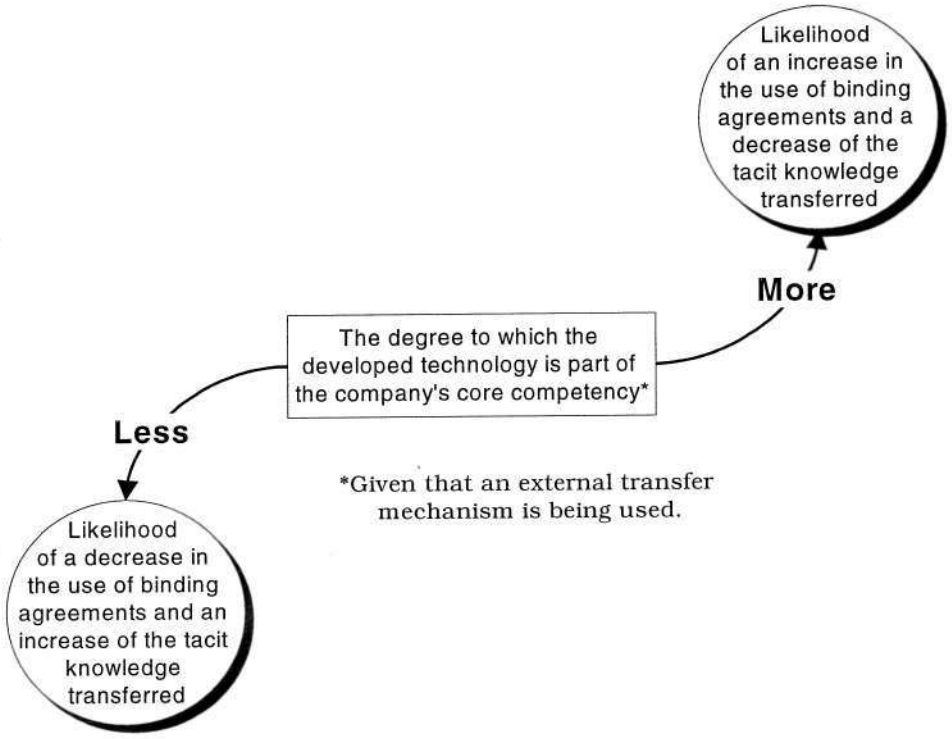
Error! No topic specified.

Hypothesis 3 – As the degree to which the developed technology is part of the transferor's core competency increases, the likelihood of an external transfer decreases.

When an external transfer mechanism is used to transfer a technology integral to the transferor's core competency, the transferor will want to

mitigate the risk involved by having a binding agreement with the transferee. Also, the transferor will not transfer the tacit knowledge required to develop the next generation of the technology (i.e., *incremental technology).* The transferor will want to keep control of the *basic technology* and will require some sort of inspection rights of the transferee.

Therefore, given that an external transfer mechanism is to be implemented, as the degree to which the developed technology is part of the transferor's core competency increases, the likelihood of binding agreements increases and the amount of tacit knowledge transferred decreases.



Hypothesis 4 -- As the degree to which the developed technology is part of the transferor's core competency increases, the likelihood of binding agreements increases and the amount of tacit knowledge transferred decreases.

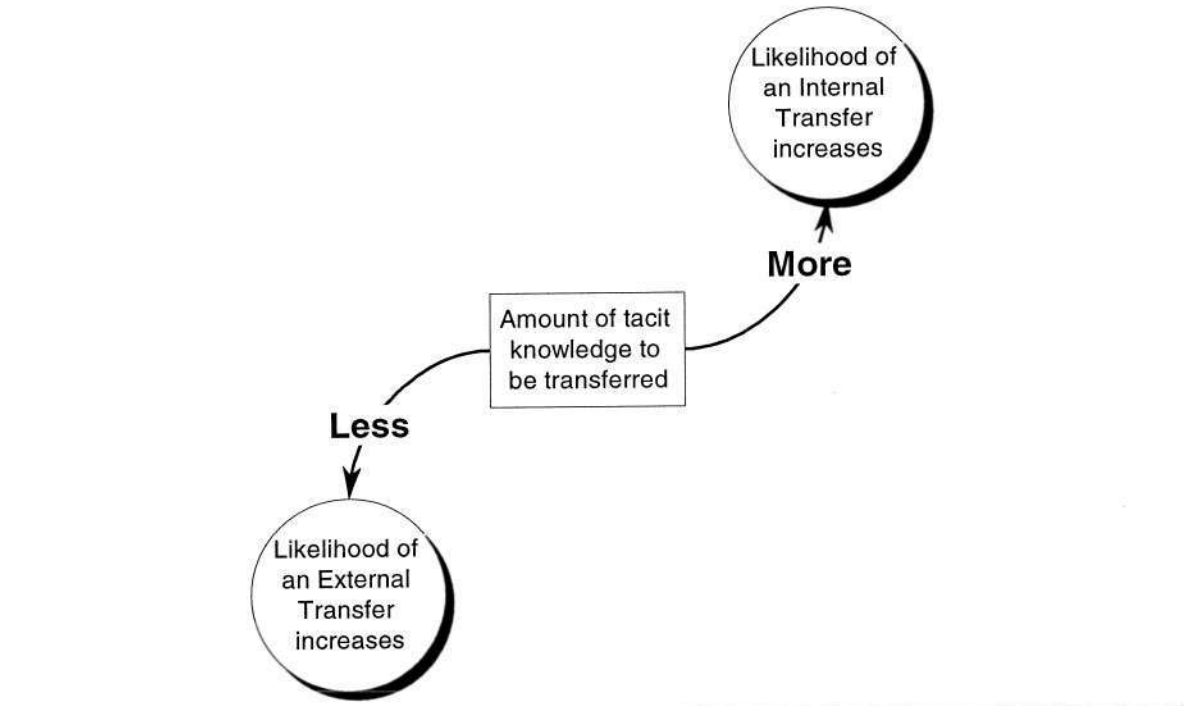
Tacit Knowledge's Impact on the Transfer Mode Decision

The transfer of tacit knowledge is more costly than codified knowledge owing to the additional time and personnel required to transfer this type of knowledge. The transfer of tacit knowledge is usually accomplished by temporary or permanent transfer of personnel to the transferee's organization. These costs can be decreased if the transferor and transferee have the "same language" in an organizational and technological sense. Also this language can decrease the risk of non-payment and legal risks can be relieved.

Wholly owned subsidiaries, joint ventures, etc., tend to have the same organizational language and systems. Thus, an internal transfer would decrease the costs involved with different organization languages. Also, wholly owned subsidiaries can have contractual accounting agreements that have provisions for the payment of the parent company. These agreements decrease the risks of non-payment especially in the event that the subsidiary is located in a country that does not allow expatriation of profits. These agreements reduce the time needed to negotiate new agreements and provide a form of retribution if the technology transfer agreement is not fulfilled.

Transfers to external companies provide none of these cost advantages. The organizational language will probably be different. The technology transfer may be the first legal agreement between the organizations and take a long time to negotiate.

Therefore, as the degree of tacit knowledge to be transferred increases, the likelihood of an internal transfer increases.



Hypothesis 5 -- As the degree of tacit knowledge to be transferred increases, the likelihood of an internal transfer increases.

TRANSFEROR CHARACTERISTICS

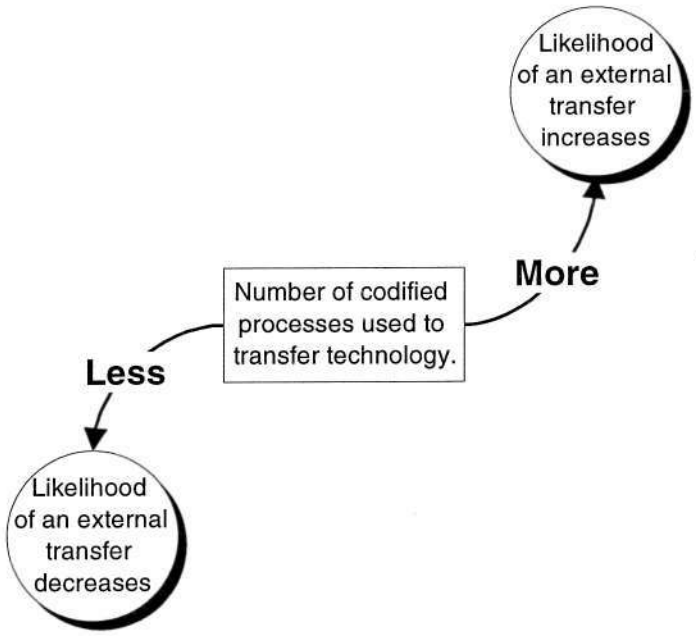
The following hypotheses attempt to explain the effect of the following relationships between the characteristics of the transferor and the technology transfer process and transfer mode decision:

1. Size of the transferor versus the mode of transfer selected (i.e., internal or external).
2. Degree of cross-functional teams used to develop the technology versus the amount of tacit knowledge integrated into the technology.
3. Degree of experience with technology transfer versus suitability as a transfer partner.
4. Degree of transferee's success or failure In technology transfers versus suitability as a transfer partner.

Processes for Codification of Know-How

External transfers require codified knowledge. To transform tacit knowledge to codified knowledge in a systematic manner, organization will utilize processes and procedures. These processes tend to become more codified as an organization grows. This codification of these processes positively impact the transfer of tacit knowledge involved with them.

Therefore, as the number of codified processes used to transfer technology increases, the likelihood of an external transfer increases.



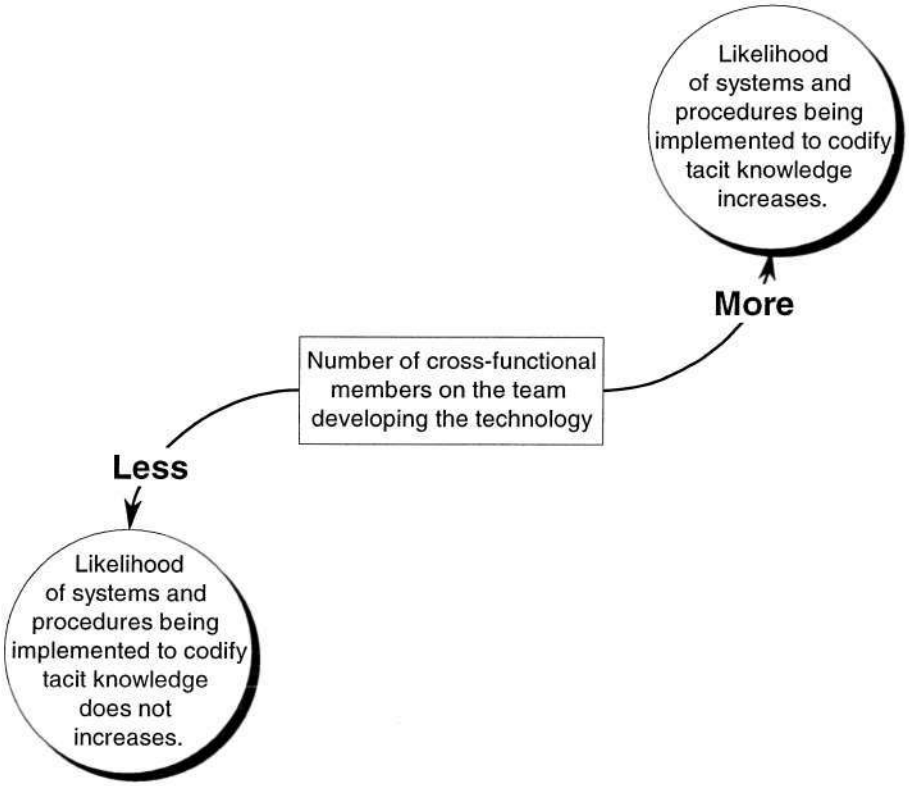
Hypothesis 6 -- As the number of codified processes used to transfer technology increases, the likelihood of an external transfer increases.

Cross-functional Teams Affect on Tacit Knowledge

A recent phenomenon in restructuring of corporations is the use of cross-functional "teams." As teams grow in size and are populated with members from different functional groups within an organization, (i.e.,

marketing, engineering, manufacturing, etc.,) it becomes harder for the team to comprehend the "whole" tacit knowledge embedded in the technology. For example, it is easier for a 4 person project team who come from two functional disciplines to understand the tacit and codified knowledge of a technology, then for a 25 person team. This inability to share the "whole" tacit knowledge, increases the incentives to implement systems and procedures that try to codify the tacit knowledge of the teams. An example of these systems and procedures is the use of a decision matrix, market research, Consumer Satisfaction Modeling, System Engineering techniques, etc. These systems in turn facilitate external transfers of the technology.

Therefore, as the number of cross-functional members on a team increases, the likelihood that systems and procedures will be implemented to codify tacit knowledge will increase and the likelihood of an external transfer will increase.

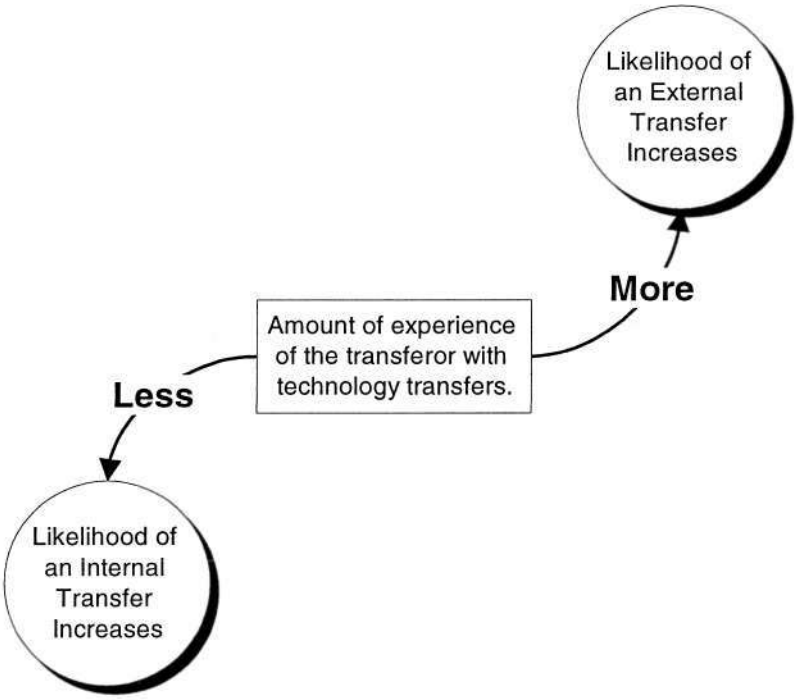


Hypothesis 7 -- As the number of cross-functional members on a team increases, the likelihood that systems and procedures will be implemented to codify tacit knowledge will increase and the likelihood of an external transfer will increase.

Experience with technology transfers

There is another aspect of knowledge that will affect technology transfers. This is the knowledge gained through experience with technology transfers. The more experience that a transferor has in transferring technologies, the better systems and procedures the transferor should have in place for technology transfers. The same holds true for the transferee. These systems and processes should lessen the risk involved with transferring technologies and reduce the costs associated with the transfers.

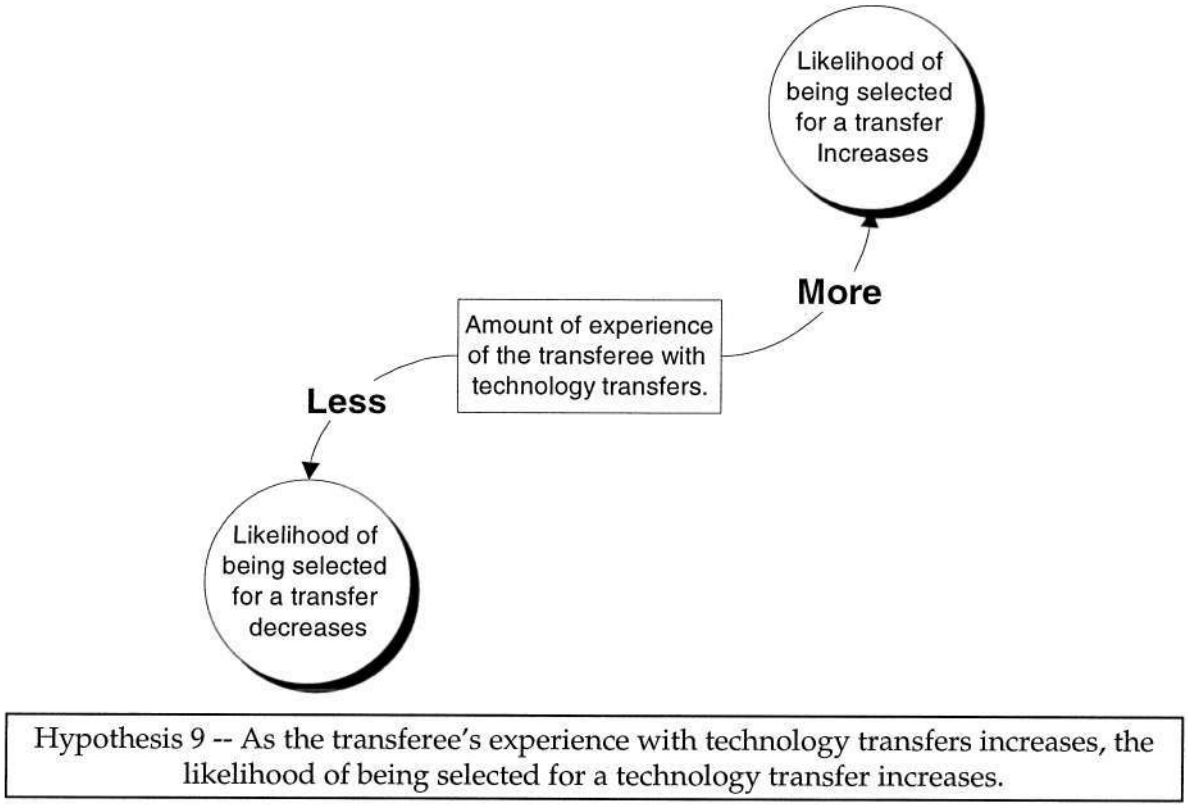
Therefore, as the transferor's experience in technology transfers increases, the likelihood of an external transfer increases.



Hypothesis 8 -- As the transferor's experience in technology transfers increases, the likelihood of an external transfer increases.

The same logic holds true for the transferee. In fact, transferors with no or little technology transfer experience will still consider technology transfers to transferees with experience.

Therefore, as the transferee's experience with technology transfers increases, the likelihood of being selected for a technology transfer increases.



Hypothesis 9 -- As the transferee's experience with technology transfers increases, the likelihood of being selected for a technology transfer increases.

TRANSFEREE CHARACTERISTICS

The following hypotheses attempt to explain the effect of the following relationships between the characteristics of the transferee and the technology transfer process and transfer mode decision:

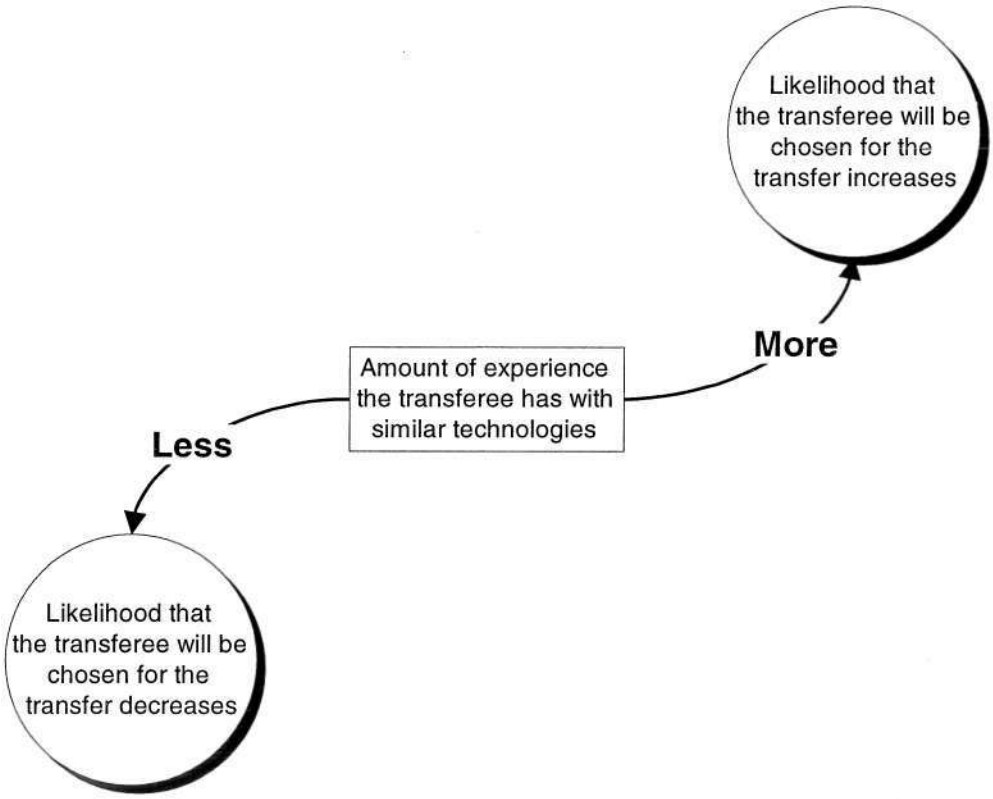
1. Degree of transferee's experience with similar technologies versus suitably as a transfer partner.
2. Degree of tacit knowledge transferred versus the desire for an improvement in the transferred technology.
3. Degree of a transferee's ability to learn versus suitability as a transfer partner.

Experience with similar technologies

Transferees that develop or work with technologies similar in nature to the technology to be transferred, have tacit knowledge that makes them

more suitable for selection as the transferee. For a transferor with a new machine drilling technology, for example, a manufacturer who has no prior experience with technology transfers but is experienced in working with machine tools, may be a better transferee than a manufacturer who has many prior experiences with technology transfers but makes clay pots.

Therefore, as the transferee's experience with similar technologies increases, the likelihood that the transferee will be selected for a technology transfer increases.

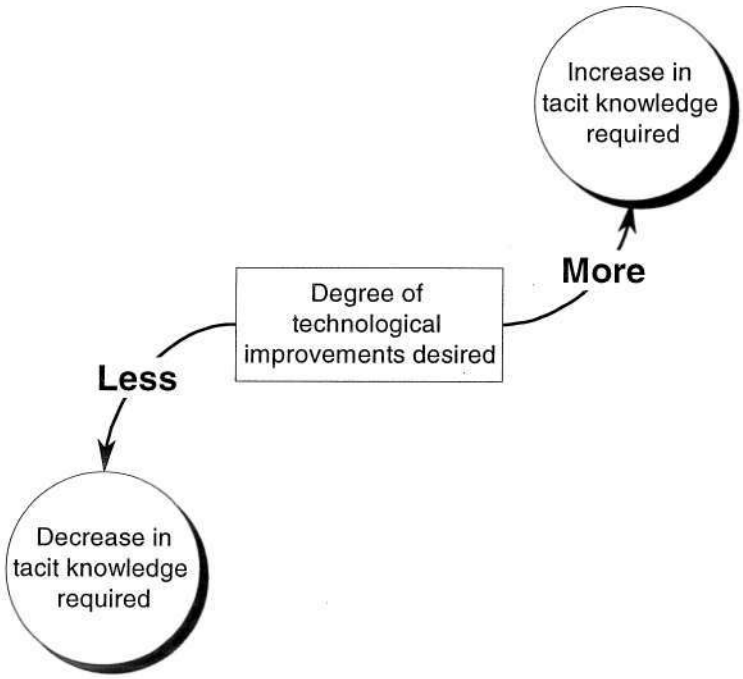


Hypothesis 10 -- As the transferee's experience with similar technologies increases, the likelihood that the transferee will be selected for a technology transfer increases.

Technological Improvements

The classifications of technology transfers listed in Figure 1, on page 5, are dependent on the amount of tacit knowledge that the transferor transfers to the transferee. If the transferee wants to gain the capability to improve the transferred technology into an *incremental* or *branching* or *major new* technology, the transferee will try and negotiate for a transfer of all the tacit knowledge associated with the technology (i.e., a capacity transfer). However, if the transferor desires to limit the capabilities of the transferee, the transferor will negotiate for either a material or design transfer that restricts the amount of tacit knowledge transferred.

Therefore, as the desire for technological improvements from the technology transfer increase, the amount of tacit knowledge involved in the transfer will increase.



Hypothesis 11 -- As the desire for technological improvements from the technology transfer increase, the amount of tacit knowledge involved in the transfer will increase.

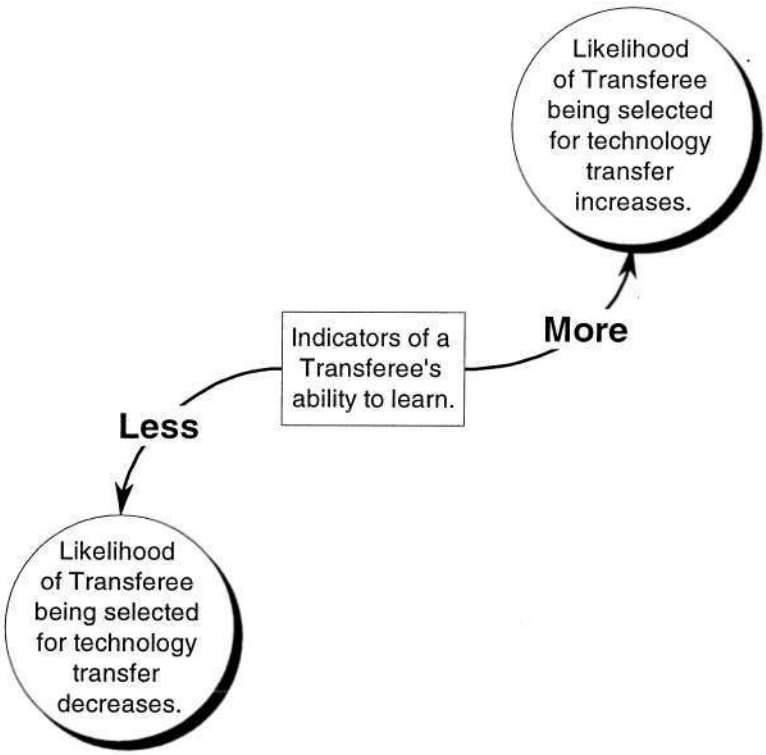
Ability to Learn

The transfer of tacit knowledge mandates that the transferee be able to "learn" new processes, technologies, structures, etc. Assessing this "learning capability" can be very difficult. However, there are certain indicators that can be assessed by the transferor. These include, but are not limited to:

1. Number of advanced degrees held by transferee's employees.
2. Number of patents held by the transferee.
3. In-house training program provided by the transferee.
4. Use of continuos improvement process systems.

Owing to the tacit nature of technology transfers, a high degree of learning on the part of the transferee is highly desirable. This ability to learn should allow for a smoother, less costly transfer process.

Therefore, as the indicators of a transferee's ability to learn increase, the likelihood that the transferee will be chosen increases.



Hypothesis 12 -- As the indicators of a transferee's ability to learn increase, the likelihood that the transferee will be chosen increases.

COMPANY CASE STUDY

When studying technology transfers, there is an astonishing amount of academic literature available on the subject. It was interesting to discover that there were disagreements on how and why technology transfers occurred. I endeavored to find out how a company, faced with the decision to transfer its technology's codified and tacit knowledge, logically determined the best type of transfer to pursue.

To accomplish this I interviewed the Vice President of Sales and Director of Product Marketing of the company in this case study. The *Technology Transfers Survey* section lists the questions asked during my interviews.

This case study begins with a background analysis of the competitive market factors the company faced when deciding the transfer mode, the characteristics of the technology to be transferred are presented, the characteristics of the transferor, and the characteristics of the possible transferees. Next the case study attempts to correlate the hypotheses offered in the Hypotheses section, with the real world situation of the company. Finally, the study attempts to explain any differences between the hypotheses and the actions taken by the company.

Owing to competitive concerns raised by the company involved in the study I have eliminated names. This allows the case study to be presented in general terms that can be applied to other companies facing a technology transfer decision.

BACKGROUND

This section provides an analysis of the market forces facing the company, characteristics of the technology to be transferred, characteristics of the company, and possible types of transferees.

MARKET FORCES

The company faces many well-established large competitors in its market. The competitors have many subsidiaries and are well known in the market.

The company produces a product that is new to its market. The market needs to be educated in the new technology's cost benefits and capabilities. However, through various trade shows and trade journals the company has introduced its product to the market.

The large competitors understand the opportunities that the new technology provides and have begun to make buy-out overtures to the company's owners. Also these competitors have started development projects to form similar technologies for use in their products.

The customers in the market expect new technology to be introduced periodically. Their main justifications for investing in the new technology are cost savings or efficiency improvements. Customers are demanding products that are user friendly and easy to learn. At the same time, the learning capabilities of the customer have been rising to meet the rising complexity of the new technologies introduced.

Customers in this market generally are not *innovators.* They are fast followers however. Once the technology has been proven in a real-world application, customers are willing to implement the technology.

CHARACTERISTICS OF THE TECHNOLOGY

The characteristics of the technology produced by the company are listed in Table 1. For a full description of the characteristics listed in the table see Robinson (1988 pp. 11-16).

Characteristic	Degree of Characteristic In the Technology		
	Low	Medium	High
Maturity	X		
Dynamic Quality			X
Relative Importance			X
Continuity of Production	X		
Factor Substitutability		X	
Scale Specificity	X		
Availability			X
Complexity			X
Centrality			X
Environmental Specificity		X	
Susceptibility to Reverse Engineering		X	
Firm Specificity			X

Table 1 -- Characteristics of Company's Technology

The technology Is new to the market and Is sold as a product. It Is currently available on the market and does not require large production runs to be produced profitably. It is a core technology for the company and Is very complex. It has tacit knowledge that Is specific to the company. It is mildly susceptible to reverse engineering and being substituted for by another product.

CHARACTERISTICS OF THE COMPANY

The company in this study is a start-up venture. It is a small company (less than 100 employees). It sales are less than $50 million.

The company's core team (i.e., President, Vice Presidents, Directors) have many years experience in developing and selling products for the market. The team has experience in technology transfers in their prior positions with other companies.

The company has very limited funds, with most of those being applied to product development. Thus the company's abilities to market its product are limited.

POSSIBLE TRANSFEREES

To combat these limitations, the company has decided to transfer their technology to the global market through three channels. The three channels are, 1) Brand Labelers, 2) Distributors, and 3) Direct Sales. This study attempts to understand which factors were included in deciding how to transfer technology between the transferor and individual channels.

The company's main concerns with the transfer of technology are;

1. How do they provide enough tacit knowledge so that the channels can successfully implement the technology?
2. How do they protect their core technology, since their technology is desired by many competitors?
3. How do they transfer enough tacit knowledge to the end user so that their technology is seen as a viable alternative to currently used technology?

The company has dictated that no full tacit knowledge transfers (i.e., *capacity transfers)* will be allowed. This is to protect their core competency.

Brand Labelers

The company contracts with a Brand Labeler to have its technology embedded in the Brand Labeler's products. The company commits to performing the first six months of customer support after which the Brand Labeler can contract for further customer support. The company also trains the Brand Labeler's sales force and marketing department.

The company considers Brand Labeler's an extension of the product engineering and marketing departments. The company sees Brand Labelers as partners. The company has modified their technology to make it easier for the Brand Labeler's to incorporate into their products.

The company will consider *design transfers* for Brand Labeler's. Brand Labeler's contract with the company to have modifications incorporated into the core technology so that the technology is better suited for the Brand Labeler's needs.

Distributors

The company considers distributors an extension of their sales force and technical support. Distributors are expected to complete the whole selling process from the initial contact through post-sales support.

Distributors usually do not alter the product. Therefore, transfers to distributors are limited to *material transfers.* The company does not contract with distributors to add further enhancements to its technology. However, a distributor may suggest that such enhancements be made.

Distributors allow the company to reach more markets (international) while not having to develop the infrastructure required to reach these markets. Also because distributors are local to these markets, they understand their customers' needs, can react quicker to changes in them, and speak the same language.

Direct Sales

The company uses direct sales to support its local and important customers. These customers tend to be the innovators to try the company's new technology. Also the company provides all customer service for direct sales. Currently these customers tend to be rather large and are important to establish the company's product.

Technology transfers to the customer are limited to *material transfers.* If the customer requires a special redesign of the product, that customer must contract for a *design transfer.*

TRANSFER MODE DECISIONS

This section reviews the decisions made by the company for the type of transfer mode and transfer selected. Each hypothesis is applied to the company's decision and analyzed for compliance or non-compliance.

No Internal Transfers

Upon first look, the first obvious non-compliance is that internal transfers are not an option for this company. However, the company considers Brand Labelers extensions of their company. Therefore, the company considers transfers to the Brand Labelers to be internal transfers and is willing to transfer more knowledge to them.

As described earlier in hypothesis 4, if a company does decide to use an external transfer mechanism, then we should observe many contractual agreements to mitigate the risk. As mentioned before, the company has contractual agreements with both the Brand Labeler's and its Distributors. Its direct sales to end customers are protected by trademark and copyright protections. These agreements verify that the company does take steps to protect its technology.

Core Technology

As stated earlier (hypothesis 3) if the technology to be transferred is integral to the company's core competency, the company is unlikely to transfer this technology externally. Remembering that the company only engages in external transfers, the company does not transfer any of its core technology. The reason given by the Director of Product marketing was that the company needs to protect its ability to be a viable business concern. Also the Director stated that there is not a way for the company to protect its claim to the technology once it had transferred it externally. Furthermore, the Director continued on to say that he would never allow the core technology to be transferred unless the company was bought by the transferee.

Transfers to Brand Labelers

Currently the company has two Brand Labeler agreements in the US. The company is pursuing another Brand Level agreement in a foreign company.

The Brand Labelers were the first type of technology transfer pursued by the company. According to the Vice President of Sales, the number one reason for the Brand Labeler agreements was to establish sales for the company's products. However, the new Brand Labeler is being sought to provide access to a foreign market that the company does not embody the proper knowledge to enter.

This may indicate that the company is looking for a mutual transfer of tacit knowledge. While the company is transferring the tacit knowledge needed to support their technology, they are seeking the tacit knowledge that improves their product planning and marketing skills.

When questioned about the characteristics of the selected Brand Labelers, the Vice President stated that the company looked for Brand Labelers that; sold to the same type of customer that the company would sell to; had previous experience with similar types of technology; had successfully completed a Brand Labeler agreement in the past; and that the Brand Labeler has the ability to "learn".

These concerns fit nicely into hypotheses 9, 10, and 12. These hypotheses state that a company should be more likely to pick a transferee who had more experience with technology transfers, more experience with similar technologies, and a higher ability to learn.

Brand Labeler versus Other Channels

Remembering that the company considers transfers to Brand Labelers to be internal transfers, the company is willing to transfer tacit knowledge that allows the Brand Labeler to adapt or improve the technology for their application (i.e., *design transfers).* These include contract agreements for modifications to the technology or temporary transfer of personnel to the Brand Labeler for technology modification.

The company is not willing to perform *design transfers* for distributors or Direct Sales customers. Instead the company transfers only the tacit knowledge required to successfully use the technology (i.e., *material transfers)* to these channels. These actions are in agreement with hypothesis 5, which states, as the degree of tacit knowledge to be transferred increases from the *material transfer* to the *design transfer,* the company is more likely to only to consider an internal transfer.

Technology Modifications

The company expects it Brand Labelers to modify its technology to meet their needs. Thus the desire for technological improvements increases for the Brand Labeler transfers. Also the company expects its distributors to perform customer support functions. However, the company does not expect its direct sales customers to improve the technology or need to support others using the technology.

As part of the Brand Labeler agreement, the company is responsible for the training of the Brand Labeler's sales force, support engineers, and marketing department. As part of the Distributor agreement, the company provides training for the distributors support and design engineers.

This training is an indication that the amount of tacit knowledge needed to perform technology modifications and technology support is greater than that needed just to successfully use the technology. This supports hypothesis 1 l's reasoning that as the desire for improvements increases, so does the amount of tacit knowledge needed.

Experience Increases

As stated before, the first technology transfers the company engaged in were Brand Labeler transfers. Recently the company has signed a number of distributor agreements.

When asked about the emphasis on the distributor agreements, the Director of Product Marketing stressed the following reasons,

1. **the need to have the company's name on more installed product**
2. **the company had learned how to transfer the technology more efficiently**

When asked about the efficiency concern, the Director said that more written processes were being put in place to simplify the transfer of technology. With more codified processes in place the company is more willing to transfer the technology externally. These actions conform to hypothesis 6's reasoning; as codified technology transfer processes increase, the more likely a company will be to transfer the technology externally.

When asked why a certain distributor was chosen, the Vice President of **Sales stated that, the company looked for the same qualities** as a

Brand Labeler. He added that most of the distributors chosen, were distributors with whom he or someone on the management team had prior experience.

The Vice President claimed that this level of experience, be it acquired with the current technology or through prior dealings, makes the transfer of technology between the distributor and the company easier while lessening the risk associated with the transfer. This is in agreement with hypothesis 8; as the company gains experience with technology transfers, the likelihood of an external transfer should increase.

Next Generation Availability

When asked if the availability of the next generation of technology had made the company more willing to consider external transfers, both the Vice President and Director said that it was not a big motivator.

However, they did mention that part of the company's core technology was dependent on an exclusive license that was expiring within the next year. This motivated them to expand their distribution as quickly as possible. They hoped to have their name in the market quickly with the current technology and follow it up with the next generation of technology. The next generation of technology is not subject to an exclusive license.

Technology Development

When asked if the uses of cross-functional teams had caused any concerns, the Director stated that a large amount of information that

was contained in the decision making process was lost. He also said it seemed to get worse with the more functions involved.

This had a direct impact on the company's ability to codify the technology for transfer. This meant having to involve more people in the training of the transferee's personnel. Also, much time was spent re-engineering the technology to understand why it had been developed a certain way.

When asked if steps were being taken to keep this from happening in the future, the Director stated that they were going to more of a project management and systems engineering process. As stated in hypothesis 7, as the company increases the number of cross-functional members on its teams, it should be more willing to implement systems and procedures that codify the tacit knowledge.

WHAT IS SUCCESS

When I asked the Director of Product Marketing what a successful technology transfer was, two factors became clear. The first was that the transferee could use the technology the way the company intended and that there were no misunderstandings about the technology's capabilities. The second factor was, that a minimal amount of personnel were required to make the first factor a reality.

When asked of the Vice President of sales, three factors were stressed. First, the transferee could train a customer or someone else in the technology's capabilities. Second, that the transferee could provide support of the technology. Third, that the transferee understood how the technology fit into the market.

Long Term Commitment

When asked if they thought a technology transfer was a long or short term proposition, both the company's representatives and the distributors unanimously said that it was a long term proposition. All parties pointed out that the investment of time and personnel to learn the new technology made it a long term proposition. Even in the case of a *material* or *user technology* transfer, the parties agreed that the transferor would have to be responsible for some limited teaching of the user.

The give and take nature of this exercise was accentuated. The transferor may have to "give" their tacit knowledge, but they get to "take" the tacit knowledge of the transferee's application.

CONCLUSION

During this research effort it was interesting to find over and over again, that people on the front lines of technology transfers were less concerned with the codified knowledge of the technology than with the tacit knowledge of the technology. Every distributor I talked with always mentioned the importance of the training they would receive from the company or the ability of the company to provide personnel on-site for support.

The efforts of the company itself were centered around minimizing the tacit element of the technology. They believe this will give them the ability to transfer the technology more successfully and more efficiently.

A very interesting concern on the part of the company's Director and Vice President emerged during our conversations. They were both concerned that the transferee has tacit knowledge about the market and industry, similar technologies, and the customers to which they sold. From Robinson's definitions, they were concerned about the need to perform a *capacity transfer.* They both believed that a *capacity transfer* was beyond the scope of their organization.

At present, I have not been able to verify hypotheses 1 and 2. Hypothesis 1 requires that the technology be on the market for a longer time before its viability can be proven. Hypothesis 2 was not verifiable because of the special circumstances. However, I do believe that the company was trying to gain rents that it was fearful of losing if it did not increase its external transfers. I look forward to revisiting this company in a few years to analyze the data for Hypotheses 1 and 2.

It was gratifying to realize that the company perceived that a technology transfer was a long term proposition. This perception will serve them well. Also the company's definition of success was in agreement with Seurat's definition.

This study has served to reinforce a lesson that I learned during a technology transfer exercise. An idea is only as good as the originator's ability to teach me what it means.

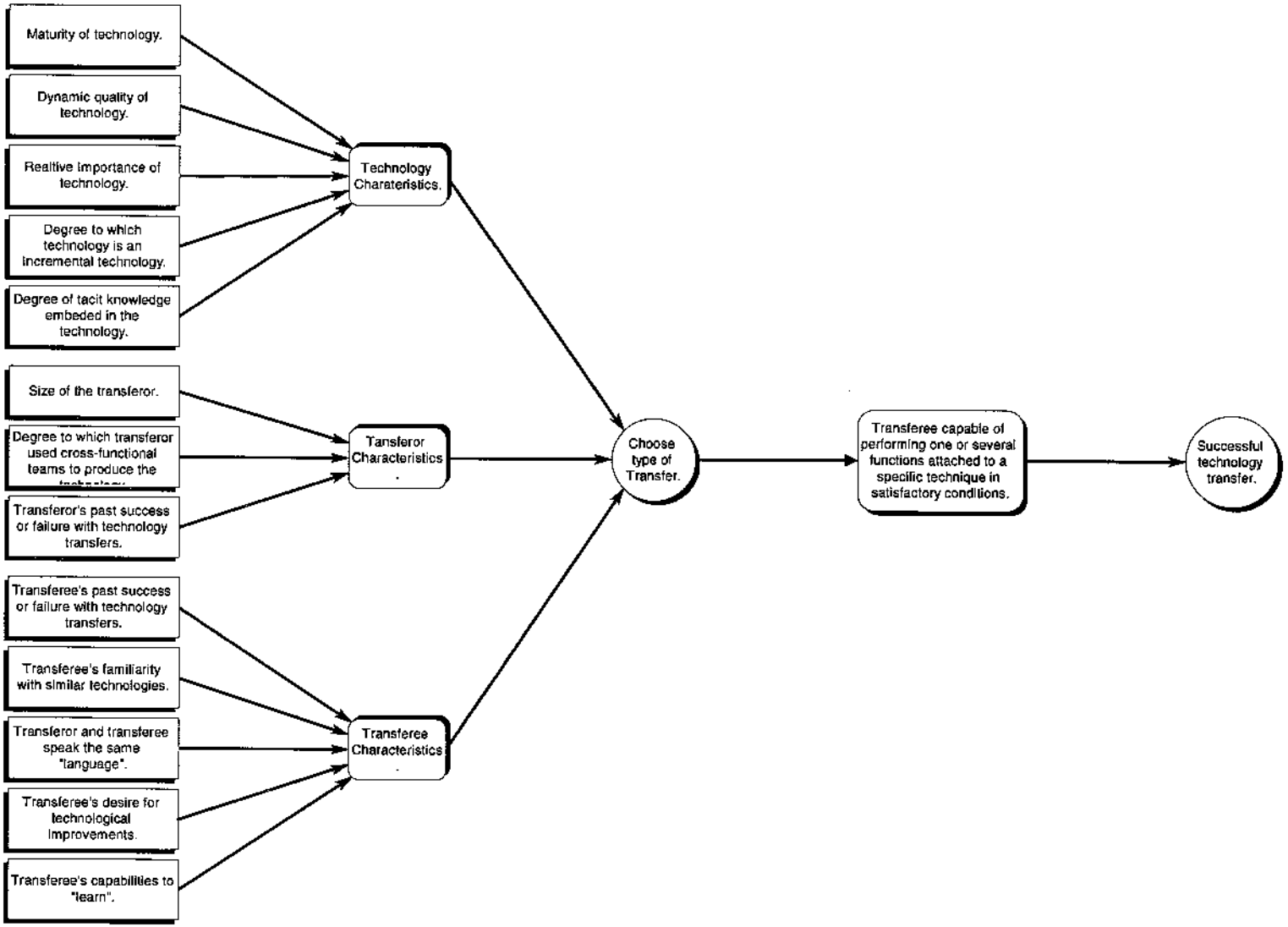


Figure 2 -- Factors effecting a successful technology transfer

TECHNOLOGY TRANSFERS SURVEY

1. If a technology has a large degree of knowledge that can not be codified in specifications or procedures, is your company more likely to transfer this technology or less likely?

2. What measures does your company implement to transfer technologies that are more tacit in nature?

3. What is the most common form of technology transfer that your company employs (for example, Joint Venture, Licensing, etc.) and why?

4. When investigating a partner for a technology transfer, what traits of that partner are important to your company?

5. When investigating a partner, for a technology transfer, how important is the partner's degree of experience in technology transfers? Does this importance change when the partner is a subsidiary vs. another company?

6. What are the characteristics of a "successful" technology transfer for your company?

7. With the expanded use of teams to develop technologies, has your company realized an increase in the tacit knowledge inherent to the technologies being developed?

8. Has your company implemented organizational changes to codify the technologies developed by teams?

9. Does your company have a guide or set of procedures for the transfer of technology from your company to a subsidiary or another company? If yes, can you please provide a copy of that procedure.

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