

CHALMERS



Technology As A Product (TAAP)

- The development of a framework for selling technologies as products

Master of Science Thesis

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Göteborg, Sweden, 2012

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Abstract:

The ever increasing technological complexity and multidisciplinary nature of products has altered the product development strategies of companies around the world. The diversity of the technologies involved in these complex products means that it is no longer feasible for most companies to possess and foster expertise in all the technologies required for their product development. Companies today are more than ever focusing on acquiring technologies from external sources, and technology trade is fast becoming big business. All this presents an opportunity for mature and technology oriented companies that have accumulated a wealth of technologies initially developed for their own products. These technologies can now be leveraged and marketed to potential buyers to form an additional revenue source for these companies. This trade opens up an opportunity also for small technology development companies that otherwise lack the resources to compete in the finished goods market.

The benefit from this opportunity can be greatly improved if a repeatable 'technology as a product' approach is followed rather than the traditional approach for a one off transfer of technology. This approach suggests that a company efficiently builds and packages the technology, enabling it to sell or license it to multiple buyers, and thus maximizing profit from the sale of the technology. This paper formulates a framework for this approach based on literature on knowledge and technology transfer as well as practice from industry in the trade of technology. In the initial stage a hypothetical model is formed from issues identified from the literature that are likely to affect technology trade. These issues are then investigated, and in some cases validated, with the experience of five European companies from different industries, ranging from startups to large multinational technology developers. The final framework, a culmination of these issues, attempts to carve out a hypothetical guideline for aspiring technology sellers. The proposed framework is the first step towards a comprehensive validation research study, which will in turn lead to a concrete/robust guideline for technology oriented companies to efficiently trade their technologies as products.

Key words: *Technology development, Technology transfer, Knowledge transfer, Technology as a product*

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1 INTRODUCTION

'There is nothing more powerful than an idea whose time has come'

--Victor Hugo

1.1 TECHNOLOGY TRADE

All the available evidences suggest that trade in technologies has become more common than in the past (Arora, Fosfuri, & Gambardella, 2001; Kline, 2003; Fosfuri, 2006; Lichtenthaler, Lichtenthaler, & Frishammar, 2009). A surge in patenting activities has been noticed in the U.S. in the recent past, mostly due to shift innovation management to more applied inventions (Kortum & Lerner, 1999). Technology firms of today have an incentive to undertake technology trade partnerships, which are sustained a through long lasting trade relationships (Eaton & Eswara, 1997). There is empirical evidence to suggest that even competitors can collaborate in precompetitive research, such as 'window opening' activities in new technologies and in some non competitive but essential technologies such as health, safety and environment (Tidd & Trewhella, 1997). Mansfield (1988) noted in his study of American and Japanese firms that the Japanese firms have taken great advantage of external technologies in their innovations.

Arora, Fosfuri, and Gambardella (2001) highlight that trade in technology offers a host of opportunities for almost all types of companies and can have a significant impact on the corporate strategies of such companies. With such trade, companies can now choose to license out downstream activities instead of investing in them. They suggest that entrepreneurial startup companies which would otherwise find it hard to survive in the finished product market can now play to their organizational strength of versatility by focusing on research and development of technology rather than focusing on the application of the technology. They also point out that technology trade opens up the market to new entrants who would otherwise find it very hard to break into end-consumer product markets because these markets are dominated by large companies that have matured in those markets.

1.2 MARKET DRIVERS IN TECHNOLOGY TRADE

There has been quite a lot of research conducted on the issues or drivers that make this trade attractive both for the seller and the buyer. Some of these issues are shown in Figure 1.



Figure 1: Market drivers for technology trade

Complex and Diverse Products

Products are becoming increasingly complex. In order to maintain a competitive edge most products require the use of a variety of emerging and new technologies. This interdisciplinary nature and complexity of modern products means that it is not practical for a firm to maintain a high level of competence in all the technologies required for the development of the finished product through in-house research (Tidd & Trewhella, 1997). Technology acquisition from external sources can thus provide an insight, and a quicker and cheaper head start in to new and emerging technologies (Olleros & Macdonald, 1988). These acquired technologies can also be used to augment existing R&D in a company.

Competition

Most of the existing finished product market are quite saturated and are dominated by proven large firms that have developed a strong foothold in the market through a consistent output of competitive products over the years. This makes it increasingly difficult for new entrants in the market to compete with such companies that have invested heavily in the technologies involved in making the finished product, and have an infrastructure in place to foster such technologies (Arora, Fosfuri, & Gambardella, 2001).

The market for the trade in technologies however is not that saturated. Coupled with the fact that most large companies are finding it increasingly difficult to keep up with all the technologies required for a product opens up an opportunity for startup companies that have a technology but don't have the resources to break into the end product market. Also keeping in view the different resource and organization structure requirements, most

companies find it more profitable to only develop technologies and outsource the product development and production.

Furthermore, competition and the resultant focus in primary product market may prevent large companies to invest in the transformation of new ideas and technologies in to end-consumer products. They may however license the technology to prospective buyers from other markets to get return on their investment in the development of the technology. All of this adds to the attractiveness of technology trade from the perspective of small startups to multinational giants.

In-house R&D Constraints

Tidd and Trehwella (1997) point out that most companies simply do not have the resources focus on all the technologies with in-house R&D. Whenever there is a lack of suitable in-house R&D in a specific area, external technology acquisition is much quicker than building the capability in-house from scratch. They further highlight that some companies that do have some level of in-house research, use external technologies to fill the gaps in their research. Also, in order to keep the focus on their core technologies, many companies acquire the 'peripheral technologies' from companies that possess an expertise in the technology as it is much cheaper and faster than developing it themselves. (Tidd & Trehwella, 1997).

Discontinuous Technological Change

One of the main drivers for the trade of technology is 'Discontinuous Technological Change' (DTC), when companies suddenly find themselves in the midst of a new radical technology that has the potential to change the existing way of business (Lambe & Spekman, 1997). The fickle nature of modern technology, with new and radical ways of solving traditional problems makes it virtually impossible for companies to build technologies from scratch. This issue forces the companies to hunt technologies from external sources of technology to quickly and cost effectively build up a capability to compete in the market with a product employing leading edge technologies.

Organizational Benefits

For strategic reasons most firm's try to insulate their in-house research from the external espionage. Unlike scientists who openly publish their findings and engage in a dialogue with their peers in other research institutes and universities, technologists therefore are rarely allowed to communicate with their peers outside their organization (Allen, 1977). External technology acquisition can thus provide some organizational benefits by, providing an opportunity for peer reviews of internal R&D, and mitigating other unwanted closed culture characteristics, such as the 'Not-invented-here' syndrome, which inhibits the ability of firms to learn from external technologies (Sen & Rubenstein, 1990). Furthermore, in some cases external acquisition of technologies provide an opportunity for companies to create goodwill in a new market, or with a customer; acquisitions may

also be used as a means to influence future governmental legislation on their market (Tidd & Trewhella, 1997).

1.3 PROBLEM STATEMENT

Keeping in view the market drivers and benefits explained above, it may be more useful for technology oriented companies to formally include selling technologies in their business portfolios. The selling of technology in the form of 'Transfer of Technology (TOT)' is a mature business option and is well documented in research literature. In this study TOT is regarded as a unique or one off event where the technology is sold to a single customer without accounting for any issues related to repeatability of the process, Figure 2.

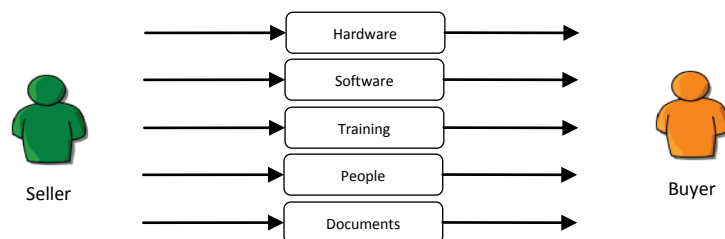


Figure 2: General case of Transfer of Technology

However if a company wants consider selling technologies as a viable primary source of revenue over a long period of time, the same technologies may need to be marketed to various customers. The idea proposed in this study centers on the idea that profit from technology can be maximized if technology is also treated as a product, and thus can be sold to multiple buyers with more efficiency, see Figure 3.

The concept of technology as product should account for issues related to repeatability in the process, and transfer of the technology to numerous customers. Despite the business

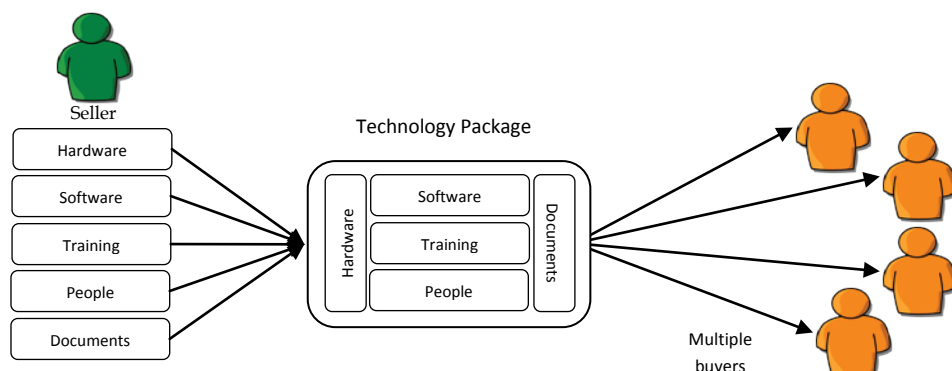


Figure 3: Proposed technology as a product

potential in the trading of technologies, research in the area of maximizing profit by selling technology as a product is scarce. Most of the literature on technology trade

mainly deals with TOT which does not account for the repeatability associated with TAAP. Furthermore there is no formal framework to guide a company on how to prepare and execute the trading of technologies as products.

Research Questions

In view of the limited understanding of technology as a product, the following two research questions have been formulated to guide the study.

Question 1:

What are the issues or challenges associated with TAAP?

Question 2:

What process should be followed for selling technologies as products more efficiently, and which tools and organization structure will enable the implementation of that process?

1.4 PURPOSE OF STUDY

The purpose of this study is thus to identify the issues associated with technology trade from the available literature on related subjects (such as knowledge and technology transfer) and the practice of five case companies; and attempt to formulate a framework for selling technology as a product. Furthermore this study will point out new avenues for future research on the subject, in order to tackle the problems in practice that are not appropriately addressed in current literature.

1.5 SCOPE OF STUDY

This study intends to provide a general overview of the issues associated with the trading of technologies as products. There shall be no attempt to get an in-depth perspective on any single issue. The variation w.r.t. size, market, and age of the case companies included in the study should help in providing a broader perspective on most of the issues and their significance to those companies. Amesse & Cohendet (2001) outline four types of technology transfer contexts as shown in Figure 4. This thesis focuses on the fourth type of transfers, i.e. reproduction, selling and diffusion of proven technologies between two organizations.

	Within organization	Between organizations
Creating Technology	I MANAGING INNOVATION	II CONTRACTING OUT R&D AND OUTSOURCING
Reproducing and Diffusing Technology	III TRANSFERRING TO DIVISIONS OR SUBSIDIARIES	IV BUYING OR SELLING PROVEN TECHNOLOGIES (licensing, turnkey, BOT etc.)

Figure 4: Four types of technology transfer contexts (Amesse & Cohendet, 2001)

The focus in the thesis shall be to shed some light on the sellers' perspective; however it might be needed to provide some insight in to the buyers perspective for the formulation of the framework.

1.6 DELIMITATIONS

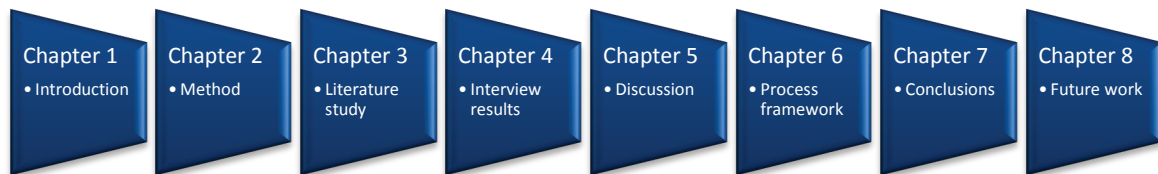
Due to time constraints, the case companies were included on the basis of their availability and willingness to be part of the study. There was no criteria set in the beginning for the selection of the case companies. However, an attempt was made to get as much variation in the companies w.r.t. size, target market, and type of technology. Because of this diversity in the companies interviewed and the exploratory nature of the study it was not always possible to follow one set pattern of questions for all interviewees. The data gathered therefore has less quantitative significance. Hence no trend or pattern can be derived from the data for an in-depth analysis of any single issue associated with technology as a product.

The resulting framework for technology is a proposal that needs to be investigated further with more quantitative studies for validation. The framework is generalized to address most of the issues of the case companies and does not address the specific needs of any single case company involved in the study. Despite all efforts to frame questions appropriately there may be some level of interviewee bias on some issues; to the effect that the interviewee may have become too defensive and exaggerative of practices in the company.

The term technology is loosely defined in the study to capture as much information on related issues as possible as some of the case companies are not specifically selling know-how. They are however engaged in the selling and acquiring of technology hardware, which also involves the indirect transfer of know-how.

1.7 READING GUIDE

The following chapter 2 describes the process according to which the study has been conducted. It outlines the interviews conducted and provides a brief introduction on each of the interviewees. It also introduces the study model used in the literature research and planning the interviews. The next chapter 3 of the report highlights the results of the literature survey conducted as per the study model, on the issues that may have some relevance to TAAP. The issues highlighted from the literature were further investigated in the interviews with the case companies. Chapter 4 then lists the results of the interviews. Each narration is followed with a summary of the conclusions drawn from the answers. It is to be noted that not all the issues highlighted in the interviews could be investigated in detail because of the limited interviews and nature of business of the companies. However after an analysis of the results, an effort was made to highlight the important themes which were noted in the interview process. These themes are discussed in detail in chapter 5. In the next chapter 6, these themes are used to build a process framework for TAAP. In the same chapter the proposed framework is then compared to another process published recently in literature. In the end Chapters 7 and 8 list the conclusions from the study and highlights the possible avenues for future work to further research on TAAP respectively.



2 METHOD

'Everything has been thought of before, but the difficulty is to think of it again'

--Johann Wolfgang von Goethe

In a deductive research approach theory is constructed or deduced from observation (Bryman & Bell, 2003). Theory can be built through a *'recursive cycling among the case data, emerging theory, and later, extant literature'* (Eisenhardt & Graebner, 2007, s. 25). Using a similar approach this thesis attempts to formulate a theoretical framework for 'technology as a product' from existing literature and the practical experience of five technology oriented companies. The process of the conducted study is outlined in Figure 5.

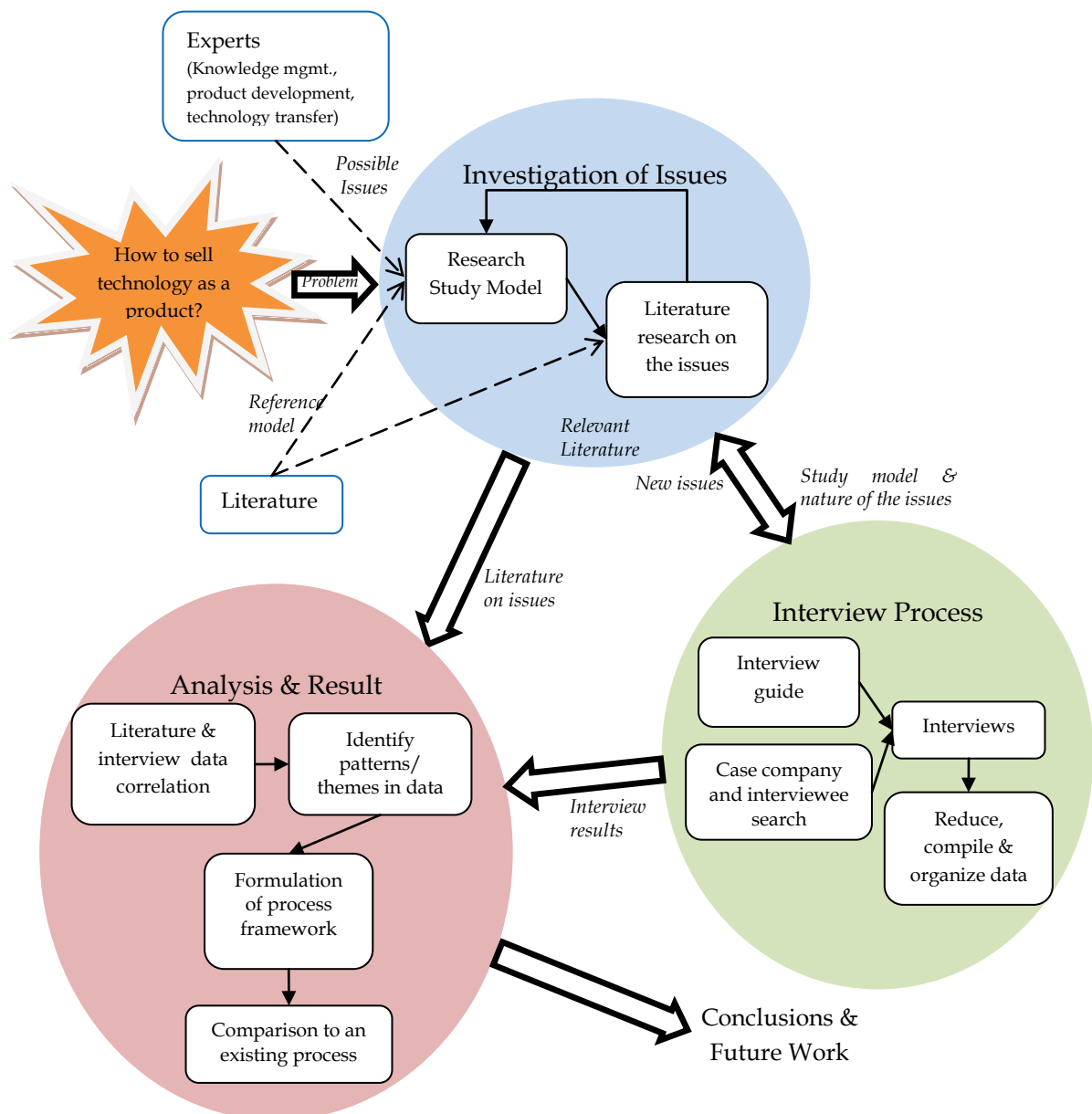


Figure 5: Process of conducted study

2.1 INVESTIGATION OF RELEVANT ISSUES

The first step in conducting the study was to investigate the issues that can affect the trade of technology as a product. This exercise basically addressed the first research question given in section 1.3. These issues were further investigated and validated in the interview process (described later in this chapter). Since issues related to TAAP are not directly identified in existing literature, therefore literature on related fields such as technology and knowledge transfer was studied. As literature on related fields is quite vast, a study model had to be formulated to guide the search for issues affecting TAAP.

Study Model

The research model was developed after detailed discussions with experts/ researchers studying the areas of knowledge management, product development and technology transfers. The study model was based on the model used by Cummings and Teng (2003). The model has been adapted to provide an overview on the problem at hand. The issues were first loosely arranged in the contexts in order to guide the investigation process.

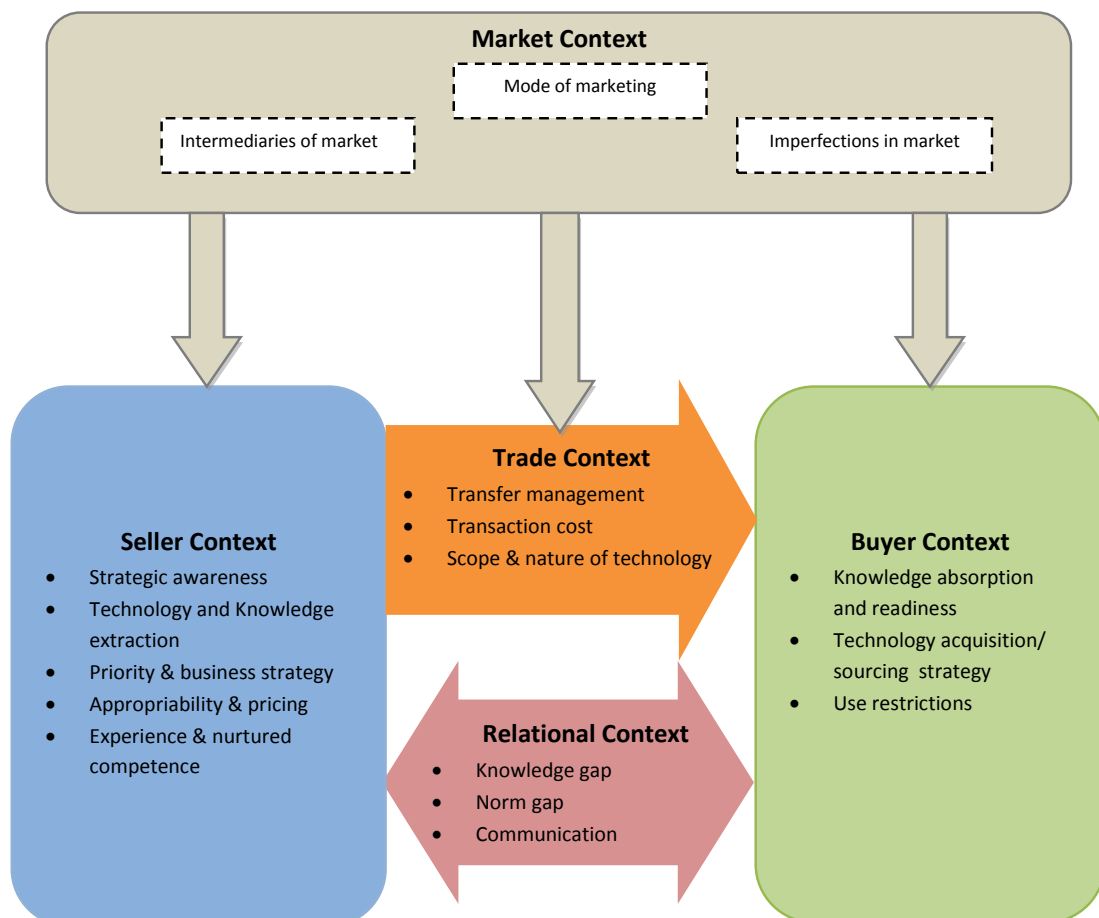


Figure 6; Study Model

The study model was continuously updated as the literature study progressed with inputs from the supervisor of this thesis and the experts/ researchers on the relevant fields. The final model, i.e. Figure 6, and the relevant literature on the issues was used to construct the interview guide.

2.2 INTERVIEW PROCESS

Firstly in this step an issue-wise Master questions list was prepared (Appendix I) from the relevant literature to highlight the issues to be validated during the interviews. Due to variation in the job nature and experience of the interviewees in the study it was not possible to keep a consistent and fixed or structured interview guide for all the interviewees. Semi-structured interviews on the other hand allow loose structuring with open ended questions to initially explore the topic under investigation, and allow the interviewer the opportunity to choose which issue merits further investigation with detailed questioning (Britten, 1995). Since this study is more of an exploratory nature rather a confirmatory nature, that is why the interviews were semi structured and most questions in the interviews were kept to be more open-ended so as to incite the imagination of the interviewee on the issue and get his unbiased opinion. The topics/issues to be investigated along with some general opening questions on the topic were fixed beforehand for each interview. Additional questions, from Master questions list, were asked if the issue was found to lead to a discussion with interesting results. The questions from this list were also used to clarify any misinterpretations.

An effort was made to guide and not lead the interviewee, with discussions so that the significance of the issues highlighted in the study model was investigated. Due to the limitation of time and relevant experience of the interviewees not all issues were investigated in each interview; the unimportant issues that were not relevant to the specific interviewee were screened out before the interview.

All the interviews were first audio recorded. The recordings were then later transcribed. Some details on the case companies, interviews and interviewees is provided in the following sections

2.2.1 CASE COMPANIES

Five case companies, varying in maturity, size, and type of technology, were chosen for the study.

Case Company 1

Case Company 1 (CC1) deals with development of diesel engines, mostly for marine and power generation applications and is based in Switzerland. The company has around 550 employees. It is part of global conglomerate (around 15000 employees worldwide) that deals with the development, manufacture, of various technologies. CC1 main area of

expertise is two stroke engines. There are two aspects of CC1's business; 1) the development of engines and, 2) the provision of service for the engines to the vessel operators, shipyards and engine producers (the licensees). Earlier, the company was involved in the development and production of diesel engines. However, at present it only supplies the know how to build diesel engines, and the licensees manufacture and build the engines. This know how includes detailed plans for production and support in production and the commissioning of facilities required for production. CC1 has three different types of customers:-

- i. The licensee, who manufactures the engines with CC1's data-pack and support.
- ii. The shipyard, which buys the engine from the licensee and then integrate it in the ship that it builds. CC1 also supports the shipyard with warranty, handling and technical/ quality issues. CC1 has a dedicated department that provides this support.
- iii. The owner or operator of the vessel. CC1 also provides support in the handling, maintenance, spare parts and warranty issues.

Case Company 2

Case Company 2 (CC2) is a Swedish company that primarily deals with the development of components for jet engines. The service and maintenance of jets engines is also a part of their business. It is also a part of a global conglomerate that deals with a variety of different types of technologies and industries. The company has a history of development of military aircraft engines but at present it has become more of a component or subsystems supplier as the engines have become more advanced. The company is usually a part of a consortium of companies that develops the modern day jet engine. The company has a global supplier network that support its development activities.

Case Company 3

Case Company 3 is a young Swedish company that is currently developing a unique technology and product for generating electric power from tidal currents. The idea behind the design, which is patented by the company, was initiated in a large Swedish company with a history in aircraft and automobile systems development, when they were exploring alternate methods to generate power from wind. The company was searching for a solution that would cause less interference in aviation radars as compared to windmills. Though the idea used by CC3 was not feasible for wind application, it was workable for use in tidal currents. This technology had high prospects, however since this technology was not in line with the core business it was not developed in-house at the Parent company. The idea was further investigated at a Swedish university in terms of its business prospects and technical feasibility. The studies verified the potential of the technology and in 2007 the development of this idea has been significant. CC3 is therefore a spin off from the Parent company which still owns shares in the company and is one of their major investors. The tidal power generation device is presently their core product

and the focus of all their development activities. They have various technology suppliers all around Europe.

Case Company 4

Case Company 4 (CC4) is a Swedish company that develops swept path simulation software for aviation and road applications. The company started in the early 1990's, and is currently one of the leading players on the niche market worldwide. It is a relatively small company (staff-wise) and employs a permanent staff of around 10 people. The company also has an office in the U.S. and has a supplier network spread all around the world. Their licensees are the major airport authorities, and construction companies/consultancies. They also engage external subsystem suppliers for noncore applications in their development.

Case Company 5

Case Company 5 (CC5) is the youngest and smallest company among all the companies. It is a startup company that is developing medical equipment for the leakage detection of highly toxic drugs in skin cancer surgeries. The company is currently housed in the business incubation center at a Swedish university. CC5 provides a software based alternate solution to the products currently on the market. Their product is currently in the development and testing stage. Apart from their core technology, i.e. the software that calculates the leakage, they also use a variety of other base electronics and communication technologies in their development.

2.2.2 INTERVIEWS

A total of seven interviews were conducted as part of this thesis. A company-wise breakup of the interviews is given in the following Table 1.

S#	Case Company	Interviewee	Duration	Interview Location
1	Case Company 1 (CC1)	IP1	2 hours	Company
2	Case Company 2 (CC2)	IP2	2 hours	Chalmers University of Technology
3	Case Company 3 (CC3)	IP3A	1 hour	Company
4	Case Company 3 (CC3)	IP3B	2 hours	Company
5	Case Company 4 (CC4)	IP4	1 hour	Company
6	Case Company 5 (CC5)	IP5A	1 hour	Chalmers University of Technology
7	Case Company 5 (CC5)	IP5B	1 hour	Chalmers University of Technology

Table 1: Interviews conducted

2.2.3 INTERVIEWEES

A brief introduction to the interviewees is presented in Table 2.

Interviewee	Introduction
Interview Person 1 (IP1):	IP1 is the General Manager for a specific product segment at CC1. IP1 has responsibilities on both the commercial side of the business and the technical side of the development of this segment of engines. On the commercial side IP1 deals with the requirements from the market research and the license management where he gets input from customers. On the other hand IP1 is also responsible for deciding upon the next step of development
Interview Person 2 (IP2):	IP2 works in the Advanced Engineering department which is responsible for setting up and coordinating all the technology development projects at CC2. He has been employed at CC2 since 1995 has a Ph.D. in the field of product development.
Interview Person 3A (IP3A):	IP3A is the part of the senior management of CC3 and overlooks all the commercial and technical aspects of the under development marine energy technology product at CC3.
Interview Person 3B (IP3B):	IP3B is a member of the team that is responsible for the mechanics and hydrodynamics part of the technology that is being developed at CC3. IP3B covered the technical aspects of the subject for CC3.
Interview Person 4 (IP4):	IP4 is the head of the software development at CC4, and is also responsible for purchasing tools and components. He has been working in the company from 1990 and was one of its founding members of the company.
Interview Person 5A (IP5A):	IP5A is the developer the technology at CC5 and is the founding member and current owner of the company.
Interview Person 5B (IP5B):	IP5B is a Master's student at Chalmers School of Entrepreneurship and is assigned with the task of managing the initial development of the company, i.e. CC5, at the business Incubation Center of Chalmers University of Technology, Sweden.

Table 2: Interviewee introductions

2.3 ANALYSIS AND FINAL RESULT

The data in the transcripts was then reduced and important details were then extracted and arranged on a single format to highlight the answers of all the interviewees on each issue. The answers on each issue were then combined to determine any similar patterns or conflicts. After the interview process a second round of literature search was done to clarify any ambiguities and support any new issues highlighted in the interviews. The results of the interviews were then analyzed issue wise in light of the literature study to unearth the important themes that resonated among the case companies. These themes are discussed in detail in chapter 4 of this report. Afterwards these themes are used to formulate a process framework that captures and addresses all the important issues highlighted in the literature and interviews. In the final stages of the development of the framework it was discovered that Bianchi, Chiesa, and Frattini (2011) had also proposed a

process for the management of selling technologies. Hence in order to analyze the strengths and weaknesses, the proposed process framework for TAAP is then compared to the process proposed by that Bianchi, Chiesa, and Frattini (2011). The study is then completed with a conclusion on the results and identification of future work avenues to further investigate the issue of selling technologies as products.

3 LITERATURE STUDY

'All experience is an arch, to build upon'

--Henry H. Adams

This chapter describes the literature survey conducted for the topic. It begins with a discussion on the concept of 'technology' and the fuzziness of its definition. The main focus of the chapter however, is to highlight the issues that may affect technology as a product. It is to be noted that the literature study was deliberately conducted in a slightly unfocussed manner in an attempt to scan a broad spectrum of issues that may help in understanding the process of selling technologies repeatedly to various buyers. These issues are discussed in the contexts defined in the study model shown in Figure 6.

3.1 WHAT IS TECHNOLOGY?

The term 'technology' has proved to be quite obscure and difficult to define; scholars have thus failed to reach a consensus on one common definition (Molas-Gallart, 1997, Tatikonda & Stock, 2003).

Capon and Glazer (1987) broadly define technology as *'know-how, more specifically (with respect to a firm), as the information required to produce and/or sell product or service'* (Capon & Glazer, 1987, p. 2). They identify three components, or sources, of know-how i.e. product technology, process technology, and management technology. They further distinguish between finished products and technology by regarding products as *'the embodiment or manifestations of know-how'*. They consider technology to be applied knowledge rather than knowledge in general.

Howells (1996) describes the technology *base* of a firm as a combination of both tangible and intangible assets, see Figure 7. The tangible part includes the physical product, plant

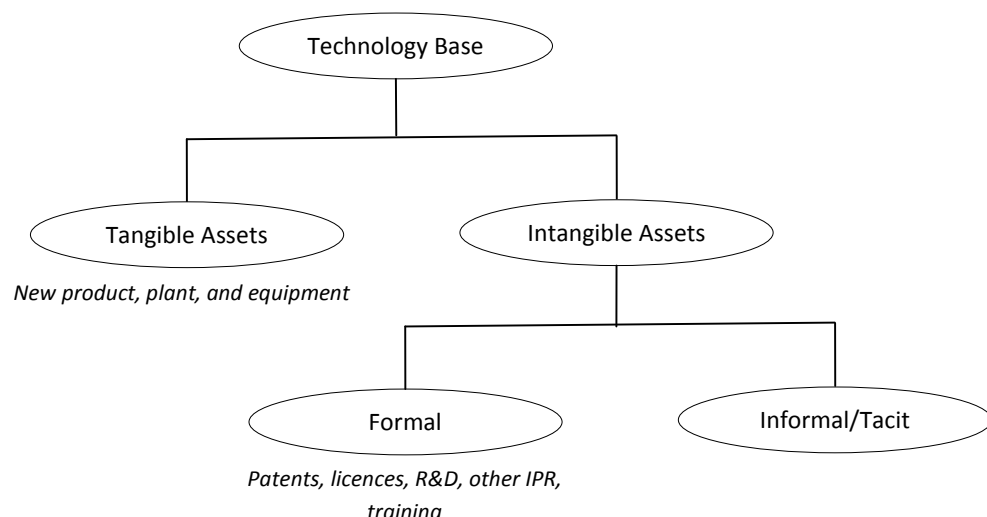


Figure 7: The technology profile of a firm (Howells, 1996)

and equipment that are the embodiment of technology. The intangible part is further subdivided into *formal* technical knowledge such as patents, licenses, contracts, and specific training programs, and *informal* tacit knowledge and skills.

In general, literature defines technology by identifying '*many elements, characteristics, dimensions, facets, and factors*' (Tatikonda & Stock, 2003). Hence, for this thesis the comprehensive view of 'technology' as described by Molas-Gallart (1997) is used, whereby capital equipment, software, scientific and technical knowledge, skills, research and production processes, designs, blueprints, management techniques and principles, and the resulting products developed to solve technical problems, are all forms of technology.

3.2 SELLER CONTEXT

This context deals with the direct issues that confront the seller when trading in know how or technology. It is important know the significance of awareness of opportunity and priority in the success of a business idea.

Once decided that a technology is to be sold, issues related to extraction come into focus. The identification of the elements of technology and extraction have to managed taking into account the level of tacitness and embeddedness of the technology. In this regard it is important to investigate: What is the significance of the tacit knowledge and how does it affect the extraction of technology? Whether codified knowledge is easier to transfer? What are the limitations of codification?

Another issue may be pricing. For a technology to be sold profitably it has to be priced right. In this regard it is important to investigate: What are the factors that can affect the pricing of the technology? What challenges can be associated with pricing of technology?

Furthermore, the seller's profit usually depends on the efficiency with which a product is sold. So, does the transfer process become easier to manage with time as more experience is gained is an important question to answer.

3.2.1 AWARENESS & PRIORITY

An awareness of the presence of opportunity is imperative for the realization of any benefit from the trade of technologies. '*Strategic awareness can be defined as: the ability to make an assessment of the total impact of any new change on the business and its long-term repercussions; the ability to project into the future the consequences of present actions; and, importantly, the ability to perceive the benefits that a strategic orientation will bring to the organization*' (Berry, 1996, p. 489). Most companies have developed technologies for their own use and are primarily product oriented companies. Therefore total impact of the inclusion of the trade of technologies in the business plan needs to be assessed formally in order to gauge the potential benefit from the trade.

When the technology developed is one of the main products of the company the decision to market the technology as a product or develop it itself may rest on the fact whether the company has access to the downstream resources required to transform the technology into a final product, and the nature of competition in both the technology and finished product markets (Arora, Fosfuri, & Gambardella, 2001).

3.2.2 TECHNOLOGY AND KNOWLEDGE EXTRACTION

Any technology or knowledge that is to be transferred needs to be extracted first before it can be transferred. From the study of literature the extraction of the technology is observed to depend on three factors which are intertwined, i.e. tacitness, level of codification, and embeddedness of the technology or knowledge.

Tacit Vs Codified Knowledge

Tacit knowledge is the *'non codified, disembodied knowhow that is acquired via the informal take-up of learned behavior and procedures'* (Howells, 1996, p. 92). In a strategic sense, in the absence of adequate patent protection it is often preferable to develop *'difficult to codify'* technologies through in-house research. The resulting tacit technologies provide a stronger competitive advantage in the market as it is hard to copy or reverse engineer (Tidd & Trewhella, 1997). Winter (1987) also supports this notion by arguing that in certain cases firms may be encouraged to keep the knowledge explicit so as to reduce the risk of leakage. On the other hand knowledge that is tacit and more non-codified is slower and more difficult to transfer (Howells, 1996; Teece, 1981) and requires *'a greater intensity of face-to-face interaction, thus implying higher and more closely complementary technological competencies on the part of co-operating teams'*, in order for the associated technology to be internalized effectively by the recipient (Cantwell & Santangelo, 1998, p. 104). The more knowledge that can be codified the easier it is to transfer the technology or knowledge (Tidd & Trewhella, 1997). The transmission of codified knowledge means the level the communication can be somewhat impersonal such as through documents. This decreases the cost of the transaction.

Teece (1981) however highlights that some level of tacitness is inevitable and in most cases only the broad level of technical knowledge can be codified. This means that in general, some level of transfer of skilled personnel is required in transfer of implicit knowledge of a technology. Winter (1987) however moved away from the traditional notion that codification is an inherent property of knowledge. He insinuates that all knowledge can be articulated despite the difficulty level given the right amount of resources. In some cases tacit knowledge may be very difficult to state explicitly and hence the cost of the codification of such knowledge may be so high that it makes it impractical to articulate. Hence the extent to which knowledge is codified for a technology is an economic decision rather than it being an inherent property (Arora, Fosfuri, & Gambardella, 2001).

However there is another school of thought that is somewhat skeptical about codification at the source and argue that codification can hamper the transfer process. The finding of a study conducted by Cummings and Teng (2003) suggests that codification may make it difficult for the recipient to internalize and use the knowledge, because the codification by the source may be incompatible with the culture beliefs or norms at the recipient. That is, the context in which the codification takes place is also very important. Cummings and Teng (2003) argue that codification that occurs at the source may be 'too context bound' for it to be readily internalized by the recipient. Hence appropriate 'de-contextualization' processes need to be put in place for the successful transfer of codified knowledge

Embeddedness

Knowledge can be embedded with individual members, tools, technologies, tasks and their interrelationships and networks in an organization (Argote & Ingram, 2000). Knowledge that is embedded in an organization is more difficult to transfer (Cummings & Teng, 2003), while explicit and codified knowledge that is embedded in technologies can be easier to transfer (Argote & Ingram, 2000; Zander & Kogut, 1995). Embeddedness of technology and knowledge may thus require that the technology or knowledge be meticulously extracted from the organization's networks. *'The issue is how many knowledge elements and related sub-networks will need to be transferred, absorbed, adapted and adopted by the recipient, and/or how many other recipients will be required to do so to allow the knowledge to be applied by the recipient'* (Cummings & Teng, 2003, p. 43). Hence it is imperative that the embeddedness of the technology or knowledge be gauged before a transfer through an analysis to determine and develop an understanding on the elements that need to be transferred (Cummings & Teng, 2003). Embedded knowledge both implicit and explicit can be efficiently transferred if there is a transfer of personnel involved (Cummings & Teng, 2003; Galbraith, 1990).

3.2.3 APPROPRIABILITY AND PRICING

Apart from the transaction cost the other important factor that determines the rate at which technology diffuses worldwide is the economic rents to be gained by the seller (Teece, 1981). In other words this is the incentive that drives a firm that generates the technology to market it. The dimensions that affect the appropriability of the returns of intellectual assets are as follows (Teece, 1986)

- Nature of technology
- The strength of property rights regime
- Complimentary assets
- The ease of replication
- The ease of imitation

Due to the low volume of technology trade, there is a high degree of indeterminacy with respect to the price of the technology (Teece, 1981). The profit of royalty from such

endeavors in some cases depend on the negotiation skills of both the parties especially in cases where the technology is unique to a seller or on the other hand the demand of the technology is unique to one buyer (Killing, 1980), implying that there is no general demand for the technology. Arora, Fosfuri, and Gambardella (2001) point out this difficulty in appropriation to be one of the limitations to rise of the markets for technology.

An important problem highlighted by Teece (1981) is disclosure of information upfront. Not disclosing enough will limit the buyer in assessing the value of the technology which may affect its attractiveness. However most problems with appropriability can be somewhat addressed with robust contracts between the two parties so as to ensure an efficient transfer of know-how (Arora, Fosfuri, & Gambardella, 2001).

3.2.4 EXPERIENCE & NURTURED COMPETENCE

Teece (1997) suggests that the extent to which technology and its transfer mechanism has been understood also depends on the maturity of the technology and the number of times it has been successfully transferred. As more experience is gained the transfer process becomes more and more efficient and the consequently the transaction cost decreases. Teece (1977) in an empirical investigation of 26 international transfers noted that the transfer costs declined with the level of relevant experience of the transferee. Hence the technology transfer competence needs to be nurtured especially when the cycle is to be repeated often as is to be the case with 'Technology as a product'. For an efficient and effective transfer process a firm should develop an *organization competence* specific in the transfer of technology such as managing the uncertainty associated with technology, executing complex inter organizational interaction and capturing the learning to optimize the process (Tatikonda & Stock, 2003).

3.3 TRADE CONTEXT

This context deals with the issues related to the traded good, i.e. the inherent properties of the specific technology, and the transaction. An important issue with the sale of technology as a product may be the transaction cost. It is important to investigate what is the significance of, and the issues of associated with, the transaction cost of a technology? Another important issue is the transferability of the technology. Keeping in view that a technology may have multiple elements, it may be useful to know; 1) the significance of knowing the scope of transfer and nature of the technology, and 2) how to manage the transfer process to make it easier.

3.3.1 TRANSACTION COST

The transaction cost in most technology transfers is nontrivial (Teece, 1981). The transaction cost is the total cost that includes the resource cost of both transmittal (at the

seller's end) and absorption (at the buyer's end). This cost depends on the '*characteristics of the transmitter, receiver, the technology being transferred, and the institutional mode chosen for transfer*' (Teece, 1981, p. 82). An established market for technology can make it easy for a company to assign a value to the technology (Arora, Fosfuri, & Gambardella, 2001). However the fact remains that the market for technology has not matured enough and has certain imperfections (discussed in detail in the Market Context) which can lead to difficulties in valuation (Lichtenthaler & Ernst, 2008), which significantly increases the transaction cost for technologies (Arora, Fosfuri, & Gambardella, 2001). Furthermore the transaction cost can also increase if the technology is too complex and the buyer does not possess the capability to absorb it (Teece, 1977).

3.3.2 SCOPE AND NATURE OF TECHNOLOGY

Technologies may have different forms, from intellectual property such as patents, to software codes, hardware, technical services etc. (Arora, Fosfuri, & Gambardella, 2001). In this regard, the scope of the technology should include all the internal elements of the technology (Tatikonda & Stock, 2003).

As highlighted in Section 3.1, technology has no single definition and may have different forms, from intellectual property such as patents, software codes, hardware products, technical services, etc (Arora, Fosfuri, & Gambardella, 2001). In this regard, the scope of the technology should include all the internal elements of the technology (Tatikonda & Stock, 2003). It is therefore imperative to identify all these elements before a transfer can take place. This aspect is investigated as the '*package*' of technology in this study.

Complexity & Modularity: Complexity is a measure of both the number of distinct parts in the system and of the nature of the interconnections or interdependencies among those parts (Langlois, 1999). As outlined before technology can often comprise of various numbers of interrelated elements, and thus can be termed as complex in most cases. It has been found that technologies that are not complex and easy to understand can be transferred much more easily than complex technologies (Galbraith, 1990).

In product and process development, modularity can provide a solution to manage growing complexity (Baldwin & Clark, 1997). This concept can be extended to both technological and organizational design to manage complexity (Sanchez & Mahoney, 1996). It basically breaks up a complex system in to small manageable discrete pieces which then communicate among each other only through a defined set of interfaces in a standard architecture (Langlois, 2000). The mix and match characteristics of a modular system can be very useful as it allows for the overall system to be tailored to variety of different demands (Langlois & Robertson, 1992).

3.3.3 TRANSFER AND MANAGEMENT

As discussed earlier the tacit knowledge due to the embeddedness of the technology can play a critical role in the determining success in the technology transfer. In order to obviate any difficulties that may occur in the transfer of tacit knowledge, the management of the involved parties may undertake a mutual pre-transfer knowledge preparation process where the tacit knowledge is converted in to a more articulated form and, adapted to be more readily absorbed by the recipient through dialogues, presentations, discussions, etc. (Cummings & Teng, 2003).

Standardization: Various scholars have implied that along with codification, standardization also makes technology easier to transfer (Arora & Fosfuri, 2000). Mature and standardized technologies are more easily understood and readily absorbed by the recipient, which reduces the cost associated with the transfer of the technology (Teece, 1977).

3.4 RELATIONAL CONTEXT

This context covers the relational issues in the partnership between the seller and the buyer. In this regard it is important to investigate the communication requirements in transferring knowledge or technologies. Furthermore it is important to ascertain the significance and dynamics of knowledge and norm gaps on the selling of technologies.

3.4.1 COMMUNICATION OF INFORMATION

A firms ability to absorb new knowledge and technology, i.e. *absorptive capacity*, is in part dependent on its structure of communication beyond the boundaries of the organization (Cohen & Levinthal, 1990). With regard to transfer of technology there are three main elements of communication (Tatikonda & Stock, 2003):-

- a) Communication methods, i.e. the media used to communicate information e.g. face to face meetings, facsimile, email, written documents etc.
- b) Communication magnitude and frequency, i.e. how much information and how often.
- c) The nature of information exchanged, i.e. the level of codification, tacitness, complexity etc.

Allen (1977) describes documentation as an important byproduct of information processing in technology and forms an important means of communicating information, Figure 8. It is supposed to provide assistance to the buyer of the technology product in understanding the technology and how to get the intended benefit from the product.

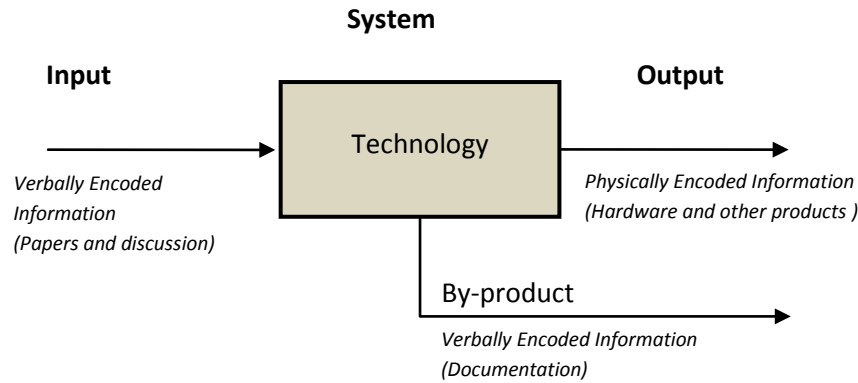


Figure 8: Information processing in technology (Allen, 1977)

However, documentation related to a technology product is seldom complete. It may not sufficiently explain the technology on its own. Due to embeddedness of the technology or knowledge in other technologies, organizational procedures and practices, the author may unintentionally leave out details necessary to comprehend the document in its correct sense. Hence in most cases, documentation related to a technology is only useful when the author is directly available to explain and supplement it (Allen, 1977). The tacitness in knowledge can only be overcome when communication between the owner and the recipient of the technology takes place face to face, so that all ambiguities are resolved on the spot with prompt personal feedback (Teece, 1981). This type of communication provides an opportunity in an unstructured or semi-structured way, something that is essential for the acquisition and transfer of tacit knowledge (Howells, 1996).

Allen (1977) further describes personal contact to be vital for information transfer in technology. He comments on how organizations involved in the development of technology impose restrictions on the communications beyond the borders of the organizations due to strategic implications, both business and security. Such 'localism' on the communication patterns of engineers need to be recognized when transferring information beyond the borders of the organizations involved in technology trade.

More often the transfer of technology involves the sending of skilled personnel to help assist in the understanding and integration of the technology. The extent to which the knowhow is easily taught determines the ease of transfer of the technology (Kogut & Zander, 1993).

3.4.2 KNOWLEDGE GAP

Learning depends on the knowledge and skill gap between the two parties; the larger the gap, the more difficult it is to transfer knowledge (Hamel, 1991). The disparity in the knowledge levels of the transferee and the recipient therefore needs to be reduced before any meaningful transfer of knowledge can take place (Cummings and Teng 2003). Cummings and Teng however also point out that scholars have warned of too little a gap as well. When the gap is too small then some unlearning of prior knowledge may be

required by the recipient. Also the recipient may lose interest if the knowledge levels are at par with each other. Cummings and Teng (2003) therefore suggest an adequate knowledge gap is necessary for the effective and efficient transfer of knowledge

3.4.3 NORM DISTANCE

When dealing with R&D knowledge transfer, the difference in the R&D contexts of the two parties involved can also pose a difficulty. The difference being that the output of the source R&D unit is the input of the recipient R&D unit, and if there exists no overlap between the R&D activities of the two parties then the learning from the transfer will be problematic (Cummings & Teng, 2003; Lambe & Spekman, 1997). The norm distance gauges the level of shared understanding of the knowledge and the transfer process (Cummings & Teng, 2003). A lesser norm distance would mean a more meaningful interaction and communication between the seller and the buyer. Therefore, before beginning any interactions on the actual transfer it would be more meaningful to initiate personal interactions to cut down the norm distance between both the parties.

3.5 MARKET CONTEXT

The trade of know-how can only be realized if an institutional framework exists '*to provide the appropriate linkage mechanisms and governance structures to identify trading opportunities and to surround and protect the associated know-how transfers*' (Teece, 1981, p. 84). Arora (2001) elaborates that the markets for technology trade differs from the typical definition of a market transaction, which is usually an arm's length and anonymous exchange of goods for money. Arora further points out that technology transaction on the other hand, involve length and carefully drafted contracts and may be accompanied with other agreements such as alliances and collaborations.

In context of the market for technology trade it may be worthwhile to investigate: What are the challenges and difficulties in the technology market? Do intermediaries play important role in this market? Which is the preferred mode of marketing technologies?

3.5.1 MARKET IMPERFECTIONS

Markets of technology have not matured yet because most firms focus exclusively on the application of the technology in their own products rather than putting them on the market (Lichtenthaler & Ernst, 2008). Companies developing complex technology products rarely market their know-how (Teece, The market for know-how and the efficient international transfer of technology, 1981)

Unlike classical markets, the embeddedness of the knowledge and technology in the source firm poses a key impediment in the flourishing of the technology trade market (Kogut & Zander, 1992).

Teece (1981) points out that the imperfections in the market for know-how arise from the commodity being traded i.e. the know-how. There are quite a few transactional difficulties associated when dealing with know-how transfer. These difficulties according to Teece (1981) can be summarized in terms of:-

- Recognition: For a market transaction to take place both the parties should be aware of the opportunity present. This opportunity can only be unearthed when one party can discover potential partners and mutually acceptable terms for the trade. It is imperative in this regard that the buyer recognizes the value of the technology and is ready to pay for it.
- Disclosure: For buyer to recognize the value of the product, sufficient information on the technology needs to be disclosed upfront so that the buyer is convinced of the incentives on offer. This issue in the trade of information gives rise to a fundamental paradox, i.e. *'its value for the purchase is not known until he has the information; but then he has in effect acquired it without cost'* (Arrow, 1971). It is often very difficult for the seller to disclose information on the technology for fear of compromising the firm's competitive edge.
- Team organization: The transfer of technology is often not possible without transfer of people, to cater for the tacit dimension in knowledge. Furthermore, most advanced technologies today are complex and multi disciplinary nature, and the key knowledge is distributed over a larger number of skilled personnel. Due to this wide distribution of knowledge in advanced technologies, in most cases instead individual support, team support is required to accomplish a transfer (Teece, 1981).

Teece further explains that the above difficulties are somewhat reduced when the know-how:-

- Is not new.
- Has been commercialized so many times that the intricacies involved are well understood by the buyer.
- The buyer has a high level of 'technological sophistication'.

3.5.2 MARKET INTERMEDIARIES

Market intermediaries such as technology consultancies can provide assistance in the transfer of tacit knowledge by supporting and conducting on-the-job training programs or through provision of diagnostic or problem solving services (Howells, 1996). Lichtenthaler and Ernst (2008), however highlight that their role in commercializing technology through the market place has generally been limited. They explain the following reasons for why the market intermediaries, especially internet intermediaries, have not met the expectations:-

- Potential licensors or sellers of technology are skeptical on the use technology market intermediaries such as technology trading internet websites because they

are unable to address specific technology customers; and that it only allows for their firms intent to market their technology too broadly to be attractive to a specific customer. Firms have an option to use a more proactive and systematic approach to market or seek technologies by targeting potential customers or suppliers, respectively, identified more directly through the firm's resources and business relationships.

- In most cases sources advertise only unattractive technologies which embody 'residual knowledge'. A firm is more likely to license its 'non-core' technology than its core technologies which are critical to its competitive advantage (Arora, Fosfuri, & Gambardella, 2001)
- Due to resource constraints and reluctance from the owners of the technology, sources have not marketed enough technologies, volumewise and sectorwise, to generate enough interest to result in transactions.

3.5.3 MODE OF MARKETING - LICENSING

If there is a substantial gap between replication and imitation then licensing the technology works at its best (Arora, Fosfuri, & Gambardella, 2001). Licensing requires that the underlying knowledge is well codified and intellectual property rights are well defined and protected so that the technology is easy enough to transfer to the buyer and replicate, but hard to imitate. Licensing therefore plays an important role in the chemical industry (Arora, Fosfuri, & Gambardella, 2001). This means that in order for licensing to work there has to be some mechanisms in place to provide the seller with sufficient leverage over the licensee, be that in the form of laws or critical parts of the technology which are not transferred to the licensee (but sold to them as a product).

3.6 BUYER CONTEXT

This section of the literature review aims to highlight the issues related to the buyer of the technology. It is important to investigate: What is the significance of readiness of the buyer in technology transaction? Does it help if the buyer has a related in-house research program? Does the scale of the buyer's company matter in their inclination to buy technologies from outside? What is the impact of use restrictions on a technology transaction? What are the available options to a buyer seeking external technologies? And which issues affect the buyer's decision on whom to buy from?

3.6.1 KNOWLEDGE ABSORPTION AND READINESS

Though the difference in knowledge and experience creates the opportunity for the trade of technology, it is the similarities in the same two characteristics between the seller and buyer that make the transfer more efficient in terms of cost (Teece, 1981). The more the buyer understands the language of the seller, the more knowledge about the technology

can be transferred in codified form. Consequently, more codification in the technology lowers the transfer cost of the technology. This emphasizes the importance of buyer readiness in a technology transaction.

Readiness in terms of some level of existing in-house research provides somewhat comfort and encourages the management of a company to acquire external knowledge where feasible. The acquisition of external research is not a substitute for internal research, rather it complements the internal research (Tidd & Trewhella, 1997). Arora, Fosfuri, and Gambardella (2001) also agree that internal and external R&D must be treated as compliments rather than substitutes. Substantial in-house technological expertise and skill is required to evaluate and later use externally acquired technologies (Cohen, and Levinthal, 1989). Without internal research a lot of extra effort is required to take advantage of the acquired technology. In fact empirical studies suggest that internal R&D plays a critical role in the evaluation and improvements of the acquired external technology (Sen & Rubenstein, 1990). Mowery (1984) highlights the importance of a firm's internal R&D with regard to its capacity to absorb an externally acquired technology. Cohen and Levinthal (1990) recognize this ability to absorb technology as the 'absorptive capacity' of a firm that is '*the ability to recognize the value of new information, assimilate it, and apply it to commercial ends*'. According to Cohen and Levinthal (1990), the absorptive capacity of a firm is a function of the following characteristics:-

- The prior related knowledge of the firm, e.g. basic skills, a shared language and knowledge of the most recent scientific or technological developments in a given field.
- The structure communication with the outside and within the firms.
- The character and distribution of the expertise within the firm.

3.6.2 SCALE OF COMPANY

Larger companies that can fulfill their technological need through their own resources have a lesser incentive to sell their technologies, and that is a reason why most buyers look towards smaller companies as potential sources of external technologies (Teece, 1981). Smaller technology developing companies which find it difficult to break in to mature consumer product markets dominated by larger companies are also increasingly looking towards selling technologies as this market provides them an opportunity to compete with the larger companies (Arora, Fosfuri, & Gambardella, 2001).

3.6.3 USE RESTRICTIONS

Teece (1981) is of the view that use restrictions foster and promote technology transactions as such conditions enable the protection of the transaction and the underlying know-how. Without such conditions the seller might not be encouraged to engage in a technology transaction for fear of losing the firm's competitive advantage in its own market. With such restrictions in place the seller can disclose more about the

technology thus making the process of technology transfer more efficient and fruitful. Furthermore, in technology transfers the buyer more often depends on the seller for further support down the line as technology is never stagnant unless it is obsolete. In order to ensure such support the trust of the seller that the buyer will not compromise the market objectives of the seller has to be protected. Use restrictions provide the seller that peace of mind while it compels the buyer to refrain from any such activities; thus creating a scenario where further cooperation is encouraged between both the parties.

3.6.4 TECHNOLOGY SOURCING STRATEGIES

In their study of acquisition strategies usually pursued among the British and Japanese firms Tidd and Trewhella (1997) highlighted the following as potential sources of external technologies:

- Universities
- Research consortia
- Licensing
- Equity and company acquisition
- Joint ventures and Alliances
- Contract research
- Intra-company transfer

They also highlight the following factors to affect the choice of the technology acquisition strategy

- Corporate strategy
- Management comfort
- Competitive impact
- Complexity of the technology
- Codification of the technology
- Credibility potential

3.7 CONCLUSIONS - LITERATURE STUDY

A summary of the potential issues associated the various contexts with regard the technology trade that were highlighted during the course of the literature survey is shown in Table 3. This list formed the basis of the interview guide that was conceived for investigating the practice of the case companies.

	CONTEXT	POTENTIAL ISSUES
1.	Strategic awareness	The awareness of an opportunity that the technology trade offers. An awareness of the potential of the existing technologies of the firm. An awareness of the potential customers
2.	Technology and knowledge extraction	How to manage the tacitness in a technology and the significance of codification.
3.	Appropriability and pricing	The pricing strategies of technology and related products. Significance of IP protection.
4.	Experience & Nurtured competence	The importance of and the effect of experience in technology transfer mechanisms. Ways and means of capturing, storing and using knowledge on technology transfer. The effect of competence on the performance of the transfer.
5.	Priority	The potential clash of technology trade with the primary products of a firm. Significance and effect of company priority on the technology trade business
6.	Transaction cost	Factors that influence the transaction cost. The significance of the transaction cost on trade.
7.	Transfer and management	The mechanisms for managing technology transfer, in order to ensure the achievement of the desired results in an efficient manner.
8.	Scope and nature of technology	The effect of complexity and modularity on technology transfer. Significance of core & non core technologies.
9.	Communication of information	The preferred mode and nature of communication in an inter firm technology transfer and its advantages.
10.	Knowledge gap	Significance and management of the knowledge gap between the seller and buyer of the technology.
11.	Norm distance	The effect of difference of everyday practices, cultures, work methodology and ethics, standards, etc on the transfer efficiency. The management of norm distance in a transfer context.
12.	Market imperfections	The problems and issues related to recognition of value, and disclosure of trade secrets on the trade of technologies.
13.	Market Intermediaries	The presence and awareness of intermediaries in facilitating technology transfer.
14.	Mode of marketing	The different modes of marketing technologies. The significance of licensing of technology.
15.	Knowledge absorption and readiness	Role of Internal R&D. the absorptive capacity of a buyer and its effect on transfer
16.	Use restrictions	The role of use restrictions on the trade.
17.	Technology sourcing strategies	The modes used to source out potentially interesting technologies that can be acquired from external sources.

Table 3: Summary of potential issues to investigate.

Due to scarcity of any direct literature on TAAP, most of the issues identified were investigated individually and were drawn from literature on knowledge and technology transfer. Due to this reason and the fact that the main aim of the literature survey was not to build a theory in itself but to mostly investigate any existing literature on issues that may be associated with TAAP, the survey in this chapter may not seem to be very cohesive.

Furthermore, not all issues are covered adequately in existing literature. Some issues are as follows:-

- In the Seller's Context (as per the study model) not a lot of information was found on the actual extraction of technology. Most of the literature dealt with issues of

tacit knowledge/information and the importance of codification. There were no tools found that may aid in the extraction of technology. Furthermore, the embeddedness of technology in a company's infrastructure, processes, and organization is also not covered that well in existing knowledge.

- Also, as mentioned before the package of a technology (that can be transferred readily to multiple buyers) is a key to the concept of TAAP. However, due to variance in the interpretation of the term 'technology' there wasn't much literature on the identification of the various elements and packaging of a technology.
- In the market context, there wasn't much literature on the various modes that can be used for marketing technology, apart from licensing.
- Also literature on market intermediaries and their issues were mostly related to the internet intermediaries such as technology market websites. Not much was found on the issues and role of consultancies that can facilitate the transaction and physical transfer of complex technologies.

4 INTERVIEW RESULTS

'A man who carries a cat by the tail learns something he can learn no other way'

--Mark Twain

This section of the report outlines the results of the interview process. It points out the important issues highlighted by the interviewees. The result and discussions are explained in detail in the following paragraphs. For simplicity in reading, the findings of all the interviews are summarized and grouped according to relevance. The topic headings have been kept consistent with literature findings outlined in the section 3 of this report, so that the reader can keep context between literature and observed practice in the case companies. Furthermore, after each section a small sub conclusion is presented on the basis of the interviewers understanding of the discussions during the interviews.

4.1.1 OPPORTUNITY AWARENESS

It was observed that the larger case companies were aware of their technologies that could be sold or licensed out as a product to other markets. Most of the companies were able to describe and identify such technologies within their folds. These technologies included hardware, process software and knowledge, configuration management software etc. The technologies are currently being used by the companies as tools in their development processes. CC1 currently provides manufacturing support to its licensees. This service of providing support in advanced manufacturing methods can also be extended to other industries. Even smaller and relatively young companies such as CC3 were able to identify the alternate applications and trade potential of technologies that it had developed for its own product through collaborations with other companies. Further although the strategy of CC3 is to provide a turn-key solution for power generation in the future, they realize that they may have to provide just technology and related services to other larger power utility companies.

The smallest and youngest company, CC5, had not researched any alternate application of their technology so far; although they had an idea of some potential applications. CC5 was more focused on the development of their product and so it seemed that they lack awareness of the market potential of their technology.

Since there is no formal strategy in place for marketing technology in the case companies apart from CC1, there has been no real effort put into identifying potential buyers of their technologies. However, most of the companies do have a fair idea of which sectors might have an interest in their technologies. Companies CC2, CC3 and CC4 have been approached by prospective buyers that have shown an interest in some of their developed technologies however they have been unable to entertain such requests. In general the companies are aware of the potential of their technologies in other markets. However, the major limitation that restricts the case companies in this regard is the unavailability of

resource, both human and monetary. Due to these constraints, the business strategies of all the companies are only focused on the development of their primary products, and no effort has been made to realize the potential of technology trade.

CONCLUSION: Despite having valuable technologies, most of the case companies are not in a position to benefit from technology trade because they do not have a strategy in place. Hence, a strategy and plan that supports technology trade is an important aspect for making technology a product. Without a formal strategy it is not possible to take advantage of technology trade. A strategy ensures the appropriate resources are allocated to assess and realize the business potential of selling technologies as products.

4.1.2 TECHNOLOGY EXTRACTION

Identification of Information

It was noted that in order to accomplish the task of successful identification and extraction of technology, the role of possessing human resource educated and trained in multidisciplinary fields is critical. At CC1, the participation of a representative from the Technology Academy¹ in the design and development of any engine from the very early stages is mandatory on every project. During the development process they continually extract information for future training and education. Most of the specialist trainers at the Academy have years of development experience in the company. Furthermore they also work in very close contact with the R&D dept of the company, so they get prompt and firsthand information. The Academy is located near the company's testing facilities which are readily accessible to them. The training material and documents is one of the major deliverables of any project at CC1

Furthermore, another aspect that can facilitate extraction of the technology and information was the similarity in the architecture and structure of the products or technologies. The fact that almost all the products of CC1 are structurally similar enhances the ease of identification and extraction of critical information. Hence, from experience the engineers can readily identify the necessary knowledge during the development, which has to be transferred to the customer in the future. For this purpose, a checklist has been devised from past experience to serve as a guideline of what information is to be delivered to the customer.

CONCLUSION: A multidisciplinary cross-functional team can play an important role in the identification and extraction of relevant parts of the technology to be transferred. In order to be effective it is better to engage such personnel from the very outset of technology development projects. A similarity in the structure of the technologies makes it easier to identify and extract information.

¹ This name is used for an institution in CC1 that has dedicated resources which specialize in the transfer of knowledge.

Tacitness and implicit knowledge transfer

In the very beginning when CC3 was setup, the parent company of the CC3 transferred the knowledge in the form of patents. To cater for the tacit knowledge, the inventor of the technology was always in contact with the project at CC3. He was on the Board of the company and a shareholder. Furthermore he held workshops and meetings with CC3 personnel to transfer his tacit knowledge. Similarly, IP4 also conceded that tacitness can hamper the development of their software at CC4.

None of the case companies intentionally encourage tacitness for strategic reasons. Most case companies were oblivious to the potential benefits given in the literature of having tacit knowledge.

The most common form of tacitness observed was implicit knowledge embodied in the development personnel. Other dependencies such as on the process or company procedures etc. were not observed that much. In almost all of the case companies such as the technology was dependant on key personnel. IP1 describes this phenomenon inevitable, as according to him only the very skilled human resource is able to develop outstanding and state of the art technology. The technology then consequently becomes coupled with the skill of the resource.

In CC3's case a lot of information would be lost if all the people disappeared. In order to mitigate the effect of reliance on only specific personnel, CC3 have opened up sharing so that many people are aware of what is going on. Similarly at CC4 also a lot of development depends on key personnel. Most of the knowledge is the tacit knowledge of these personnel. Whereas at CC5, almost all the knowledge is held by the inventor of the technology, and is highly tacit.

In some respects technology is dependent on specific resource at CC1. Furthermore, another issue is that not all information can be codified efficiently, such as the assembly process of an engine. According to IP1, capturing tacit knowledge is major challenge and greatly affects the transferability of the technology. CC1 have dedicated resources which specialize in the transfer of implicit knowledge. Their Technology Academy manages training sessions with training documents. One part of the Academy is concerned with increasing the licensee's knowledge on engine technology in general. The training includes imparting knowledge on how an engine works, how it is built and what are the related issues and challenges. The second part of the academy is concerned with education on how to handle and operate CC1's engines. This training is particularly important as there is general tendency among people not to read manuals. Hence more emphasis is placed on training the operators. Basic courses are done at CC1's premises and then other trainings related to the commissioning the engine is done on site. If there is a site office then its personnel are trained first who in turn then train the customer's personnel onsite.

The trainers at the Technology Academy are full time trainers, but for particular subsystems experts from the development team of the subsystems can be called upon to assist in the training process.

CONCLUSION: Dependence on specific human resource is an important and somewhat inevitable form of tacitness of a technology. This dependence can be resolved through the early identification and capture of such knowledge by specialists (i.e. dedicated human resource).

Codification

The technology that is expressed explicitly is easier to transfer than the technology that is implicit. The larger two case companies CC1 and CC2 have formal policies for documentation and codification of technology. There are configuration management processes in place to control the development of documents and the technology. Both these companies follow their relevant industry and company standards on documentation and there are templates for different types of documents such as test plans and report, manufacturing drawings, and manuals.

This strategy is important for CC1, as the main product of their development is the development documents that contain the information needed to produce the engine. Hence, documentation is a very important result of the technology development activities, and the information contained in them forms a major part of the product. Other issues related to project management are documented according to international standards. There is also a configuration management process in place for traceability of all the hardware and software.

In keeping with the norm in the aerospace industry, most technologies in CC2 are quite well described in the form of documents. The advantage with this codification is that most technologies in CC2 can be packaged and transferred to prospective buyers without much effort (as has been proven with internal technology transfers). Documentation of technology is very important unless the intended mode of transfer of the technology is a spin off. Even in the case of spin-off's, it is better to document the technology to a certain level as it mitigates any risk of losing the entire knowledge in case of a sudden human resource out-flux. The company being sold therefore becomes more attractive in terms of value to the prospective buyer. However IP2 noted that documentation can never be complete and there has to be cutoff point beyond which codification becomes unfeasible in terms of cost and the time required. At CC2 it is mostly left to the engineer and project managers to decide the appropriate level of documentation.

In contrast, at the relatively smaller and younger case companies, the codification processes were found to be not that well established. There were no company policies on formal document preparation. The codification processes in CC3 and CC4 are relatively basic, somewhere in between technical notes and formal documents. Both these companies attribute this weakness to the unavailability of resources required to establish and maintain a formal documentation process. IP3A contends that a formal documentation process will make the development process more bureaucratic and slow

down the development process unnecessarily. Both IP3A and IP4 admitted that though their current documentation processes satisfied their existing development requirements, at some point in the future they may need a more formal procedure for documentation to ensure an efficient development process. CC5 which was smallest of all the case companies mostly relies on technical notes for their development so far. IP5A admitted that in the future they will need formal strategies on codification.

CONCLUSION: Two of the case companies have formal codification practices, and it was observed that their technologies and knowledge are relatively easier to transfer to an external buyer, as compared to other companies where most of the knowledge is tacit. A formal strategy on codification may thus be important to ensure that a technology can easily be extracted. Codification however has a practical limit beyond which the cost of converting the implicit knowledge may no longer worth the value added.

4.1.3 APPROPRIABILITY AND PRICING

Different pricing strategies were observed in the case companies. The strategies included:-

1. Pricing per unit performance of the technology.
2. Pricing according the value the technology provided.
3. Pricing as per cost incurred with some overheads and a profit margin.

The technology at CC1 is priced as per Brake Horsepower (BHp), which is the industry norm in this business. The licensee has to pay CC1 a certain amount per BHp. The pricing rate is normally a market value parameter i.e. all three major companies in the market follow the same price rate. However if the production volumes are high then one can get some discount in the rate.

At CC2 they have a base price for the work an engineer does plus the company overheads plus a profit margin. In their business, the market does not set the price such as is the case in a consumer market. Negotiation is a key competence in determining the price of technology.

The strategy at CC3 and CC4 is to gauge the market value, i.e. what the market is willing to pay for the technology. Thus the price is very much market based and not product based. In the case of CC3 the final price will depend on the electricity price and the electricity need, a country's energy strategy and security of energy supplies.

IP1 further pointed out that the transaction cost for the seller is a function of the mistakes made by both parties. Mistakes by the seller in defining the part and delivering the wrong information, and mistakes by the customer in manufacturing the part and using the wrong information, are both likely to increase the transaction cost

Role of Monopoly: Monopoly plays an important role in the price determination for some case companies. Every company strives for monopoly in a technology, that way it can control the technology and its price. A supplier of CC2 is a casting company in North America and has a unique technology for large precision castings. Their market monopoly

is a key aspect of their pricing strategy; so much that it has forced CC2 to investigate alternate methods of designing their relevant structures in order to obviate the need for large castings. CC1 however presented a different view on how to take advantage of the monopoly in a technology. They do not take a cost advantage, instead they use this aspect in the marketing their product, to show that their product possesses a unique technology which no other company has. That way they hope to sell more licenses and engines and thereby increase their volumes.

CONCLUSION: There is no one way of pricing technologies. Thus the pricing strategy has to be well thought out according to the market and norm in the respective industry. Importance of negotiation is a key competence. Monopoly in the technology can influence the pricing. Cost is increased by mistakes of both parties during the transaction; on the seller's part in delivering the wrong information and on the buyer's part in using the wrong information. Clear and effective communication during the process is therefore critical.

Disclosure & Intellectual Property Protection

As noted in the literature the issue of disclosure affects the future appropriations from a technology. Unnecessary disclosure of information is an important issue especially when it concerns trade secrets or core technology of the company and can jeopardize the security of information. On the other hand it without disclosure it is not possible for the buyer to assess the value of the technology and for the seller to develop a deeper understanding of the context of the buyer's requirement.

Although CC2 has not yet experienced this issue in trading technologies, it has however dealt with this issue in their collaborative development. CC2 tackles this issue through contractual clauses, by specifically defining the boundaries of the information that is to be shared, by clearly stating the background and foreground knowledge. Still it finds it difficult to protect against leakage of IP, especially in co-development which depends on information sharing and exchange of knowledge, and requires an assurance to the owner of the project that the technology is capable of delivering the required results. But a line is drawn on which information shall not be disclosed at all costs. In this regard, CC2 as a policy does not share process knowledge which it believes is a critical factor an edge over the competition.

Another important aspect in CC2's case, which can be applicable for most companies, is that it is well understood within the industry that information security is most vulnerable at the lower levels of management mostly at the engineer level. However the dilemma is that contact at such levels cannot be avoided, as without it makes the process of information sharing too bureaucratic and in turn decreases project performance.

IP3A noted that this issue of disclosure stems from the fear of the seller that the buyer might steal the technology. Once the seller realizes that it faces no such threat by gauging the technical competence of the buyer in the technology and its application, then this fear is laid to rest. As a result the seller can then disclose more information and hence demonstrate the true potential of the technology to attract the buyer.

Companies however employ various measures to mitigate the effects of this issue on the trade. They can protect themselves with a Non Disclosure Agreement (NDA) signed before any negotiations take place. Other companies such as CC1 take measures to ensure that protected technology and data on such technology are not passed on to the buyers. Such critical technology parts are only manufactured at CC1's approved vendors. The licensee's are then restricted to buy the parts only from those approved vendors. Furthermore, there are other critical parts that a licensee can only buy from CC1 as it may be unique technology. CC1 can revoke the warranty incase the licensee uses another part that is not recommended. In order to allow the buyer to assess the value of the technology the potential licensee can browse through a limited software database, in which they explore the various possible configurations for the engine. In some technologies such as injectors or protected parts the customer may only get the dimensional drawing and not the detailed production drawings. The detailed production plans are only provided after the contract.

Another measure that can be employed to deal with the issue of disclosure is to stagger the delivery of information/knowledge, i.e. release the relevant knowledge and technology in parts as and when required, sufficient enough to keep the process moving. Similarly CC4 has also leveraged the requirement of support to protect their IP. Since all licensees depend on updates to the library and the software to main the utility of the product, they therefore do not venture in to using pirated copies of their product. The company therefore protects its IP by making the provision of support a critical part of their product. IP5A stated in order to obviate any untoward issues related to disclosure they try not to give any design details on paper. For their technology a high level verbal discussion on the design can suffice.

As IP3A pointed out the issue of disclosure not limited to the seller, and it may be critical for the buyer as well. CC3 is also apprehensive in disclosing information about their technology to potential suppliers as well who need to establish the context of their requirement. This apprehension is related to the fact CC3 deals with suppliers that are relatively larger and have more resources (technical competence and financial) at their disposal. Hence it fears that they have the potential to take advantage of any leaked information.

The issues of disclosure diminish with the maturity of the technology. Furthermore, the further you go in a relationship i.e. the more contract relations you have with a company, the more you disclose. Initially a company might not disclose that much but later it might disclose quite much when the relationship has matured.

The decision of what to disclose and what not to disclose is taken by the management in the smaller companies whereas in the larger companies it was noted that this decision is left to good judgment of the project managers and engineers.

According to IP4, Intellectual Property (IP) protection is not an issue if people obey the IP laws; however, respect of IP laws cannot be guaranteed and is sometimes overlooked. That is why companies take other measures to protect IP. The popular mode of protection

of IP noted is through patents. Patents offer an added advantage as the knowledge can readily be transferred to the licensee or the buyer. However patents have some limitations. In CC1's line of business e.g. an engine technology protected in Japan may be installed on a ship that sails to another country where the patent is not valid. There are often disputes among competitors over IP and technology ownership.

According to IP2, business values may differ from place to place, and it is always important to pay attention to the culture of the place where one is doing business. The strength of the IP laws have to be taken in to account when trading in technology.

IP4 highlighted that although piracy is an issue in other software applications, for them piracy by users is not an issue, since it's a niche product that is useful to only large companies that operate and manage airports. Furthermore their software is highly dependent on support in terms of updates. Companies therefore do not risk cracking the software for fear that they might be refused support from company which is vital for the utility of the software. Therefore the leverage provided by necessary support in a way protects their product.

CONCLUSION: The issue of disclosure and IP protection needs due attention on the planning level when a strategy is being devised for selling technology as a product. Such measures should aim to mitigate the negative effects of disclosure with upfront planning. Mitigating measures can include, well thought out contracts (NDA's), controlling the supply of critical information and hardware, and staggering the delivery of technology over the period of the contract. Another protection measure can be the inclusion of support (or an activity that is required after the transaction) in the product. With these measures in place the licensees remain committed to fulfilling the contractual obligations related to disclosure and protection of IP. When negotiating the sale of a technology it may be sometimes feasible to only hold verbal discussions on the details of the technology without giving any design documents.

4.1.4 EXPERIENCE

The transfer process becomes efficient and optimized with time as the company develops experience from transferring more of the same technology. This statement holds true for CC1 where it has been noted that the process of transferring the same engine technology to licensees becomes easier with time. Although CC2 doesn't have much experience in technology trade, however from personal study IP2 believes that the transfer of technology should become easier with more experience.

Therefore, an effort is always made at CC1 to ensure that past experience is taken in to account when information is transferred. But there is no formal procedure to write down the learning's in the form of a document after the conclusion of each transaction. IP1 noted that such a procedure would however be very useful in ensuring the experience is preserved in a uniform manner for future references. Furthermore at CC1, an effort is also made to share knowledge across the different projects. The project managers of most projects share office space so there is continuous sharing of personal and project

experience. Furthermore in-house forums and information exchange meetings are frequently held to share experience.

CONCLUSION: The transfer process becomes easier with experience gained from previous transfers of that technology or any similar technologies. Formalized procedures for documenting experience and the learning gained from past transfers can be useful in optimizing the process of identification, extraction and transfer of technology.

4.1.5 PRIORITY

At present CC1 only focuses on the licensing of its engine designs and then providing the related services to those engines. They provide support for the manufacturing of those engines to ensure that they are built efficiently and in the proper way. They haven't yet ventured in to selling the manufacturing process technology independently due to resource constraints. On a global level however, CC1's parent company has licensed manufacturing processes to potential customers/licensees. CC2 being also a large company with a long history in technology development has a wealth of technologies that it has developed for its self. However, the sale of technology has not been a priority so far and that is probably why not much resource has been signed to this business. A couple of years ago one person was assigned to look in to this trade, however the endeavor was not very fruitful without the prioritization of the upper management, where the focus has always been the engine development business. Hence CC2 has never developed a systematic approach to tap into the potential of this trade. The priority of the company with the technology is important. CC2 has been approached in a way that a buyer has expressed an interest in CC2's technology but at that moment it could not entertain that interest because the jet engine business takes up CC2's full time and focus. IP2 believes that his company (CC2) would probably benefit if they actively tried to find new ways of leveraging the technologies of the company, as a secondary product line.

At present technology trade is also not a priority for CC3 and it also has no formal strategy. Apart from the Managing Director there is no specific resource looking at the potential applications of the technology other than its current primary application. IP3A contends that the company is quite young and not ready to realize profits from noncore activities. With maturity of both their primary technology and their company however, he sees the prospects of such a trade in future. Similarly despite external interest in their software for other potential uses, CC4 has also not committed any resource to the idea. They also maintain that their current focus is their primary software products, and they cannot afford additional resources required to realize the potential of their technology in other markets.

Most of the case companies however are trying to patent any unique technology they develop so that they may be able to earn some additional revenue from it in the future.

CONCLUSION: It was observed that none of the case companies have any formal strategy for marketing secondary technologies. In the absence of such a strategy and formal backing from the top management they are unable to truly assess the potential of this trade. Hence a formal strategy and the backing of top management in terms of commitment of human, and financial resource, are imperative for this trade to succeed.

4.1.6 TECHNOLOGY TRANSFER AND MANAGEMENT

At CC1 the transfer is managed in a systematic manner. Usually there is an interface (designated personnel) on both sides (i.e. the buyer and the seller). The transfer management team thus is comprised of representative from both sides. In cases where the volumes of production are large or complex, CC1 also opens a site office for onsite management of the transfer process in order to ensure efficiency.

According to IP2 a dedicated team to manage the external transfer of technology can be very useful to ensure a systematic process. Allocation of such resource will enable nurturing of the competence and expertise in packaging, selling, and ensuring efficient absorption (by the buyer) of the technology.

CONCLUSION: Transfer should be managed in a systematic manner with a dedicated team with members from both parties. Site offices can increase the efficiency of transfer. Knowledge on the transfer process should be stored for optimizing future transactions.

4.1.7 STANDARDIZATION

Standardization in the process of development should make the extraction and absorption of the technology easier. In this regard, apart from following international and supplier process standards, CC2 has also developed its own standards to standardize the processes in the company. However according to IP2, process standards are quite difficult and expensive to develop as it contains a lot of knowledge and experience of the company; it is more or less the core knowledge of the company. Therefore a lot of effort is put in place to protect these process standards from unwanted disclosure, as they can provide key insight into the process related to the technology. IP2 narrated that in the past a company had attempted to copy one of their concept designs, However they didn't succeed because they didn't have the key process knowledge on the technology used.

Most of the engineering development hardware tools and software that are used at CC1, CC3, CC4 and CC5 are commercially available, and are their respective industry standards. According to IP1 their company encourages the use of standard knowledge e.g. for materials standard alloys are preferred. The list of standard and acceptable materials is provided to the design engineers, and the use of customized materials is only allowed in exceptional cases. Most of the case companies agreed that standardization does make it easier to understand the technology. However as IP4 put it, deadlines related to their primary products make it harder to follow and implement standards.

CONCLUSION: It is difficult and expensive to develop standards. Process standards can hold key knowledge on a core technology and can hence be very valuable. Industry standard software applications that are commercially available should be preferred in the development of a technology that the company might intend to market in the future.

4.1.8 MODULARITY

All the case companies informed that the concept of modularity plays an important role in their technology. According to IP2 modularity should affect the ease of transfer process as it enables the technology to be packaged in a clear and easily identifiable manner. CC1 have implemented the concept of modularity in their products. Their engine technology is very modular, with various subsystems integrated together. These subsystems allow CC1 to market the subsystems independently, e.g. on the service side of CC1's business, in which they provide support on retrofitting of older engines. It is very likely that such subsystems could have great market potential in other industrial sectors (something that CC1 can look into in the future).

The whole strategy about CC3's product is that it can be made in different sizes by combining different modules. IP3A highlights that although modularity has been used, it needs to be much further strengthened in their technology. There is no formal strategy on modularity in place at CC3 however according to IP3A they are moving in that direction for future development.

CONCLUSION: Modularity allows subsystems to be marketed independently. A formal strategy on modularity may be helpful in guiding the development team on how to capture the benefits of modularity.

4.1.9 PACKAGING

The two larger companies were observed to give due importance to the packaging of technology. However this aspect was less emphasized in smaller and younger companies. When asked what they would give to a buyer if they wanted to buy their technology in its current state, the common answer was 'the whole company along with the staff'. That indicates that the technology in the smaller case companies contains a major tacit element that has not been extracted and packaged.

All the smaller companies CC3, CC4 and CC5 can entertain alternative interests in their technology however; to transform their technology to a transferable state (technology package) will require time and effort. It was hard for CC5 to even identify the elements of the package since they had never even thought using their technology as a product other than their finished product. However after some discussion it was seen that their technology could also be packaged adequately and could have potential buyers.

According to IP2 in order to have technology as a product, the packaging of the technology has to be thoroughly thought through especially from the user's perspective.

You have to package it in an efficient way in order to enable the user to efficiently integrate it and achieve the desired results from it. However, packaging requires resources. Time and effort are required to understand the different uses of the technology and the identification of the different types of potential customers and what their requirements are. It takes resources to build that knowledge on these issues. The complexity of the content of the technology should desirably be kept to a minimum level. It could also be that the technology is really complex but the interface to the user looks is not complex and is easy to use.

For CC1 the general technology package includes access to all the drawings, to which CC1 provides regular updates. Also included in the package are software, hardware (comprising of the critical part they can only buy from CC1), support and knowledge. The specific package however depends on case to case e.g. in some cases CC1 can also open a site office if the volume of produced engines is large.

CC1 is continually trying to optimize the transfer package. Every effort is made to utilize the benefits of new information technologies to describe the package. According to CC1, any new advancement in information technology provides a new opportunity to update, adapt and optimize their transfer methods, and the packaging of their technology. The package of the technology at CC1 is currently being managed with the help of a software application that allows the user to input their requirement, and also ensures that the package is up to date with the correct versions of drawings and software etc.

IP1, IP2, and IP4 all pointed out that it is important that the specific package is only finalized during the transaction and not before that.

CONCLUSION: The technology package can be quite complex as it can include a variety of different elements such hardware, documents, software, etc. It is difficult to freeze the product package of technology, as it can only be finalized with the specific needs of the specific buyer. Information technology can play an important role in managing technology package. Software applications to this effect can enable the user to choose a configuration that suites him best. Thus it can efficiently address the needs of a variety of customers.

4.1.10 COMMUNICATION OF INFORMATION

According to IP3A communication plays an extremely important role in Transfer of Technology (TOT). Most engineers are not so good at communication. Personal contact is a richer and effective means of communication, which is why at CC3 they try to invite the suppliers so CC3's requirements and applications are well understood. The preferred mode of communication for most the case companies was personal face to face communications, however it has to be realized that it comes at the cost of time. If the volumes are high enough, CC1 establish site offices to speed up communication and ensure as much personal interaction as possible. According to IP1 the preferred mode of communication in the initial phase of every transaction is face to face meetings, so that both parties can become familiar with each other. Two issues that decide the type of communication is the tacitness and the codification in the technology.

CONCLUSION: Personal/ face to face contact is an efficient means of communicating tacit knowledge to the buyer. Face to face communication in the initial phase of a transaction can be extremely helpful to build a solid relationship for the future.

4.1.11 KNOWLEDGE GAP

Knowledge is a large part of the technology and so the issues related to the transfer of knowledge are also relevant in TOT. IP2 believes that knowledge gap is always a problem when the transfer involves people. At CC1 if the knowledge gap is too large, then the customer is educated in order to decrease in the gap since mistakes in the process of transfer can have appreciable cost implications. According to IP1 the ideal scenario is where the buyer understands enough but not too much. Because too much knowledge can be a problem as it may enable the buyer to come up with additional demands beyond the scope of the transaction. Managing a large number of licensees, each with special demands, can then become a hassle. Furthermore when the licensees have sufficient knowledge they can modify and customize engine designs which is undesirable for CC1 as it cuts them off from the service market of that engine.

CC3 have tried to narrow down the gap before any acquisitions in the past. This gap is narrowed down by relevant training and employing more people well versed in the technologies that a company intends to acquire.

According to IP3A if one is not sure of which technology to acquire, then it is hard to write any requirements specification and assess whether the technology works or not.

CONCLUSION: The knowledge gap between the seller and the buyer should be minimized for an efficient transfer of technology and knowledge. However too narrow a gap can also be detrimental to the process of technology trade. The gap can be reduced with training, or hiring relevant specialists.

4.1.12 CULTURE AND NORM GAP

An effort is also made to fill in the norm gap that may exist between the buyer and CC1. When CC1's personnel visit a customer about a specific engine they try to arrange the information in such a way that it is easily understood by the customer. Furthermore every effort is made to keep the information in standard format. There have been some problems in the past caused by small things such as difference units and material specifications.

According to IP1 all customers have to be dealt with differently depending on the country, the mutual relationship and the cultural background. For example it is understood a Japanese customer has difficulty in building an engine if each and every detail is not finalized, whereas a European customer will start building the engine even when the information is not complete.

CONCLUSION: Transfer is easier if both parties have similar norms and culture. It is to be understood that different customers may have to be dealt with differently. It is important these gaps are resolved before the transfer in order to obviate any miscommunication or misunderstandings

4.1.13 MODE OF MARKETING

Licensing was the common mode of marketing noted from the interviews of the case companies. CC1 and CC4 presently use licensing as a mode of marketing their products. CC2 has acquired licenses from the owners of patented technologies.

IP2 pointed out that documentation i.e. the transfer of tacit knowledge is a major hurdle in most forms of marketing technologies as compared to patents and spin offs. In the past CC2 has transferred technology by setting up new business areas or spin offs. These spin offs have later been sold off for good profit once the technology matured. CC3 is also the result of such spin offs from one of its holding companies. The main advantage with spin off's that people are also included in the package to be sold, and so the implicit knowledge is also transferred efficiently and completely.

However spin off mode of transfer cannot be applied to technology as a product since it only caters for a one time technology transaction to a single buyer, as compared to repeated transactions to multiple buyers that is required in technology as product.

CONCLUSION: Licensing is one of the most commonly used modes of marketing technology.

4.1.14 KNOWLEDGE ABSORPTION AND READINESS

It is very important to build an in-house capacity before the acquisition of a technology from an external source. The buyer should be able to assess and evaluate the technology it wants to acquire to ensure that it meets its requirement so that the transaction can be a success. According to IP2 such a capacity can be built using a stepwise approach, in which initially internal R&D may be started with help from external sources such as through collaborative studies and research. Later, once the basic knowledge level is achieved it may be advanced solely in-house. Some of CC1's customers like the Japanese take pride in understanding what they do and they have some research programs in related technologies, whereas others just build engines.

To ensure readiness, CC3 tries to invite their suppliers early on to educate them on how their technology works e.g. CC3 has in the past invited generator manufacturers to teach them how their generator will work in CC3's system. It becomes easier for CC3 then to integrate the technology in their system.

CONCLUSION: The transfer process is more effective and efficient when the prospective buyer has an in-house capacity to readily absorb and apply the technology that is being transferred. An effort should be made to educate the buyer if the knowledge gap is too wide.

4.1.15 SOURCING & ACQUISITION STRATEGY

This strategy has various aspects, none more important than deciding when to buy from an external and when to develop in-house. As the literature suggests in the previous chapter, it is more than useful to have some level of in-house research even if you decide to acquire technology from external sources. None of the case companies have a formal criteria to evaluate the question of whether to acquire or to develop; however some of them do have some pattern to their decision making process. At CC1 two types of technologies are bought from external sources, one is the radically new technologies that have potential in their products, and the other is the existing technologies for which the specifications have changed. The issue of when to acquire technology and when to develop technology in house is not that structured at CC2. It is dealt with on a case by case basis. However IP2 agrees that a criteria to determine when to develop and when to buy could be very useful. Nonetheless a key question in the decision at CC2 is whether the company wants the required technology to be a core technology of the company or not. If yes, then it will decide to develop the technology and build an expertise in-house. If no, then it would be expedient to acquire the technology from external sources as technology as technology development from scratch requires a lot of time and money. Similarly at CC3 and CC4, if it is a technology that it wants to have as a core technology, then it will be developed in-house. Otherwise if it's one of the base technologies that are readily available (such as cables, generators, or turbines etc. in the case of CC3 or the license module in the case of CC4), then it will be acquired from external sources.

The other aspect of an acquisition strategy is how to search out useful technologies? This first issue with this question is who is entrusted with this responsibility? None of the case companies have dedicated resources for this type of investigation. A common solution is the delegation of this responsibility to the individual designer. The onus is placed on the design engineers to explore and find interesting new technologies that can be used in his related development work. In some cases related to CC1 and CC3, suppliers themselves approach the developer when they have an interesting technology to offer. However CC1 finds most of their technology suppliers through their own research, since there are only a handful of suppliers in the engine development business. At CC2 technology competence centers are used to assist in the process. These competence centers in CC2 keep themselves abreast of the advancements in technologies related to the company's core business. These centers employ specialists engaged in active research on related technologies (such as materials, aero thermodynamics, manufacturing methods etc.), often in leading technical universities.

The second issue is related to the mode used to investigate for potential technologies. The mode most frequently used by all the case companies to search for useful technologies and potential supplier is a general internet search. The search engine Google is mostly used in this regard. Another mode most commonly used for exploring new technologies is through established contacts with existing or previous suppliers or industry partners. In this regard CC1 have a part category management system (database) at their parent company of. Here all subsidiaries communicate their suppliers for various categories of

parts and technologies. Whenever any subsidiary has a requirement for any technology, it can browse through the database for potential suppliers. There is a similar group of specialist who assist development engineers with technologies at CC1 also.

CONCLUSION: There is lack of a formal criteria to help reach a decision on outsourcing. The responsibilities of finding technologies are usually delegated to relevant engineers. Non-structured internet searches are mostly used e.g. Google search. Importance of improving search ranking on search engines is thus imperative for technology suppliers. Internet use also highlights the importance of company websites for technology suppliers. Database of previously tested suppliers can be useful in investigating suppliers for new technologies. Competence groups can assist in the process of acquiring the right technologies.

4.1.16 USE RESTRICTIONS

As is evident in the literature review, use restrictions can be a seller’s main tool for IP protection and safeguarding against undesired competition from the buyer. All Interviewees agreed with this notion. In some cases it was also noted from the interviewees that when acquiring technology form external sources, use restriction may influence the decision of which technology to buy from multiple options. However as IP2 pointed out, in the end it is the company that has to decide whether the laid down terms are acceptable or not. And if the company has no intention to use the technology in the undesired way anyways then it is not an issue.

CONCLUSION: Use restrictions can protect against unwanted competition from the buyer. They can also influence the decision of a buyer of whether to buy a technology or not.

4.2 SUMMARY OF CONCLUSIONS

The findings of the are briefly described in Table 4

S#	ISSUE	CONCLUSION
1.	Strategic awareness	<ul style="list-style-type: none"> • A formal strategy and plan is necessary for marketing technology as a product. • Assignment of resources is imperative for business success.
2.	Technology and knowledge extraction	<ul style="list-style-type: none"> • Tacit part of the technology needs to be managed. <ul style="list-style-type: none"> – A dedicated multidisciplinary team to identify and extract technology elements can be very useful. – Involve the team members in technology development from the very beginning. • Codified technology is easier to extract. A formal strategy on codification can be very useful.
3.	Appropriability and pricing	<ul style="list-style-type: none"> • No single pricing mechanism exists • Art of negotiation is a key competence to determine price • Monopoly in technology can influence its pricing

		<ul style="list-style-type: none"> • Transaction cost increases with delivering or using wrong information. Clear and effective communication is a must during transfer.
4.	IP protection & disclosure	<ul style="list-style-type: none"> • Contracts should be thoroughly deliberated • Non Disclosure Agreement's (NDA's) can be used • Control technology delivery process. Provide necessary information or elements of the technology as and when required. • Post sales support can be used as leverage to protect IP
5.	Experience & Nurtured competence	<ul style="list-style-type: none"> • Transfer process becomes easier with experience • Capture and use learning from earlier transactions. The dedicated multidisciplinary team can be useful to ensure experience is captured and taught..
6.	Priority	<ul style="list-style-type: none"> • Formal backing from the top management is required for successful business.
7.	Technology Packaging	<ul style="list-style-type: none"> • Technology can be very complex with multiple elements • Final technology package depends on the buyer 's requirements . • Use of information technology can make the package more efficient.
8.	Transfer and management	<ul style="list-style-type: none"> • The transfer of technology should be managed in a systematic manner. • A team comprising of members from both parties can increase efficiency in transfer. • Establishment of a site office at the buyers premises can be useful. • Capture and store transfer knowledge for future optimization.
9.	Communication of information	<ul style="list-style-type: none"> • Face to face contact can be an efficient means of communication especially in the initial phases.
10.	Knowledge gap	<ul style="list-style-type: none"> • Knowledge gap must be minimized before transfer of the technology. • Too narrow a gap can also be detrimental
11.	Norm distance	<ul style="list-style-type: none"> • Transfer is easier if both parties have similar norms and culture. • Norm gap should be resolved before the transfer.
12.	Knowledge absorption and readiness	a) Relevant in-house research capability positively affects the buyer's ability to absorb external technology.
13	Technology sourcing and acquisition strategies	b) The buyer usually sources the required technology through an internet search, previous or other technology suppliers, or competence groups.

Table 4: important conclusions from the interviews

4.3 REFLECTIONS ON INTERVIEWS

Observed relevance to the topic: As mentioned in the methodology section (Chapter 2) of the report, the case companies were not selected after a review of the relevance they offered to the study. In fact the selection was based on the availability and willingness of the companies to participate in the study. Therefore during the course of the study an important task was to establish the level of relevance of these companies to the topic of study to make a more meaningful proposition. The relevance of the case companies observed after the interview process is summarized in Figure 9.

	Case Company 1	Case Company 2	Case Company 3	Case Company 4	Case Company 5
1. Strategic Awareness	X	X	X	X	X
2. Technology and Knowledge Extraction	X	X	X	X	X
3. Appropriability And Pricing	X	X	X	X	X
4. Experience & Nurtured competence	X				
5. Priority	X	X	X	X	
6. Scale of Company					
7. Transaction Cost	X	X			
8. Transfer and Management	X	X			
9. Scope and Nature of Technology	X	X	X	X	X
10. Communication of Information	X		X		
11. Knowledge Gap	X	X	X		
12. Norm Distance	X				
13. Market Imperfections	X	X	X	X	X
14. Market Intermediaries	X	X	X	X	X
15. Mode of Marketing	X	X	X	X	
16. Knowledge Absorption and Readiness	X	X	X		
17. Use Restrictions		X			
18. Technology Sourcing Strategies	X	X	X	X	

Figure 9: Observed relevance of issues to case companies matrix

It can be readily seen that the data obtained from CC1 and CC2 was found to contribute most to the topic. This was expected since these are large and major companies in their respective markets. They both have a wealth of mature technologies, most of which have potential to be marketed as products. CC1 was slightly more relevant since they are presently engaged in the marketing of technology as their primary product. CC2 on the other hand are not marketing the know-how aspect of technologies to external clients, however they have conducted some internal technology transfers within the parent

company. Furthermore, the collaborative nature of their core business, where they have to work with other companies to co-develop engines, does involve relevant and important issues related to inter organizational information and knowledge flow. CC3 and CC4 are younger and smaller companies working in a relatively niche markets. The relatively lesser contribution of these companies can be attributed to the fact that they have developed only a few technologies. Both companies were found to be interesting by providing an insight into equally important perspective of the buyer, since these companies at present acquire technologies for their ongoing development work. Although CC5 only has a single technology, it provided a rare insight into the awareness issue related to companies in their infancy about technology trade. It was observed that CC5 had not even reached a stage where they could seriously explore the trade of technology. They thus outlined the problems with the market related to awareness. Despite their lack of familiarity of technology transfer, the experiences of the small companies shed light on an interesting aspect; the lack of readiness of the companies to market their technologies, and the issues and limitations that contribute to this aspect. Their technologies were found to be more tacit, heavily reliant on key personnel and thus relatively harder to extract. It showed that if technologies are to be marketed as products, companies need to plan accordingly while developing the technologies to make them more extractable and transferable.

Without undermining the importance of the issues highlighted by the smaller companies, it is however felt that if there were more case companies which had sold technologies, the results of the framework would have been more meaningful in capturing the process of transferring technologies. Hence if the study were to be conducted again it is recommended that due importance be paid to the selection of the case companies, to ensure that they have direct relevance to the primary issue.

A comprehensive single case study: In hindsight, it is believed that a detailed case study of CC1 would also have been useful, since it's primary business is selling engine technology. It would have been interesting to have a detailed insight into how they intertwine their technology development and technology marketing activities efficiently. Their Technology Academy, which is team of dedicated specialists, plays a pivotal role in their business. A further investigation into how this Academy is staffed, organized and operated could have provided valuable information on how practically implement TAAP.

Interview cycles: In this study there was only one interview cycle. During the interviews and after the data of the interviews was compiled and analyzed, it was observed that some issues needed further investigation. An effort was made to address the issues with a second round of literature study. However the findings could not be validated from the interviewees. As an afterthought, the results would have much more useful if there had been a second round of interviews.

5 DISCUSSION

'Learning without thought is labor lost'

--Confucius

The diversity of the companies led to some interesting results. Even though most of the companies are not currently engaged in selling their technologies, it was nevertheless interesting to note why these companies were not able to take advantage of the potential of technology trade despite that fact that most of the companies recognized its value and potential. Only one company (CC1) was actually taking advantage of the potential. It was interesting to note the difference in approach towards the trade. The results of the study lead to some interesting themes shown in Figure 10. These themes form the basis for elements of the proposed framework. Hence after a discussion on each theme the recommendation for the related element of the framework are pointed out.



Figure 10: Important themes observed during interviews

5.1 AWARENESS

The awareness that extra revenue can be generated by selling technology was found to be critical in smaller companies. CC5 which was a startup company had not even contemplated the sale of technology. Even if it is understood that technology can be sold, it may be difficult for new companies to comprehend as to how much revenue is associated with this trade. This relative unawareness of opportunity may be a reason why some companies shy away from the sale of technology even when some literature

suggests that it may be relatively easier for smaller and younger companies to break in to the technology trade market as compared to the finished goods market (Arora, Fosfuri, & Gambardella, 2001). It was observed that the smaller companies were thus less willing to venture in to the technology trading.

It is therefore proposed that awareness of the:- 1) opportunity, 2) potential applications of the existing technology and, 3) markets for those applications is imperative for a company to realize the potential of technology trade in to profits.

5.2 IMPORTANCE OF STRATEGY

The foremost theme that resonated among the case companies and something that differentiated CC1 from the rest of the companies was the presence of a formal strategy of regarding the trade in technology as a viable means of earning revenue. As explained in Chapter 3 of this report, literature also supports the value and importance of 'priority' for any idea to reach its potential of being a successful revenue generating source for a firm. The formal blessing and support of the top management has been seen to be imperative for success, which results in the allocation of valuable human and financial resources to the trade. During the interviews the lack of interest of the top management was identified as a critical hurdle as to why the companies were not able to convert potential into revenue when it came to trading technologies. Literature and practice of the companies seem to suggest human resources that specialize in various aspects of the technology trade can be critical for an efficient translation of the associated business potential in to actual benefit. The Technology Academy at CC1 demonstrates the advantage such a team brings to the trading of technologies. The identification of, prospective technologies internally within a firm, and then buyers for those technologies is very difficult without dedicated and specialized human resource; a resource that can accumulate and build on the knowledge and experience gained during the course of time. The Technology Academy at CC1 is an established center for fostering such a specialty. As explained by IP1 the members are full time specialists at the Academy and have years of experience in the company. This non-temporary assignment of their responsibilities ensures that they build on their knowledge with time. They thus have become specialists in capturing and transferring tacit knowledge efficiently.

The issue of pricing also needs to be dealt within the initial stages while formulating the strategy. It was seen from the literature and experiences of the companies that pricing of technology is not that straight forward and there can be different approaches to cater to the respective market conditions. It therefore seems important to assess the intended market of the technology to be marketed to devise a workable pricing strategy.

Another aspect also noted during the interviews was that although most companies realize the importance of codification, standardization and modularization in extracting and transferring technologies and knowledge, however, without formal company policies on these issues the potential benefit is not achieved. There has to be a common

understanding within the company on what is required for the fulfillment of these issues; an understanding that is well thought through and meticulously formulated to make it easier for the personnel to follow.

Furthermore what makes a technology transaction different from other general goods transactions is that it is not normally an arm's length transaction and involves a lot of interaction between the parties which is governed by well thought out contracts (Arora, Fosfuri, & Gambardella, 2001). According to IP2, contracts are very important documents that define the boundaries of the interaction between the two parties and cover critical issues in order to avoid any confusion at a later stage. As noted in the Results section of the report there are a lot of complex issues associated with knowledge and technology transactions, such as information disclosure, IP protection, pricing, support and warranty, etc. IP2 pointed out that such issues can be addressed in a well drafted contract document. Hence it makes more sense to formulate strategies on such issues and incorporate them in a draft contract, so that mistakes and wastage of time are avoided at the stage of the transaction.

5.3 TECHNOLOGY EXTRACTION & PACKAGING

As mentioned earlier in its definition, a technology can be a combination of a number of different elements, such as implicit knowledge, hardware, process data, software, etc. in order to make a product out of it. Once the technology is identified and evaluated in terms of viability as a marketable product, the issue of extraction of the technology comes into focus. The better the technology is extracted and all the inherent elements are identified, the lesser problems will arise after the transfer. The literature and interviews highlight two important issues related to the nature of technologies: 1) Embeddedness, and 2) Tacitness. These two issues are somewhat related. Embeddedness refers to the dependencies of the technology on other elements within the organization such as the process, company procedures, work ethics and methodology, human resource, other technologies, etc. Similarly tacitness also refers to the implicit knowledge related to the technology. It is important that before any transfer process can take place all the dependencies (embeddedness) and tacit knowledge are identified and resolved. For example dependence on specific human resource can be resolved by either, including that resource in the product packaging (to provide on the job training to the client during the transfer process), or codifying the knowledge of the resource, or having that critical resource train other personnel who can transfer the knowledge, as suggested by IP2. Here again the importance of a dedicated human resource is highlighted. As seen in CC1, a cross-functional team that has been engaged in the development of the technology from the very start can play a critical role in effectively identifying elements of the technology in order to ensure that the technology transfer results in a success in the future. A point to note here is that some interviewees highlighted the fact that requirements for the final package, i.e. the elements of the technology depend on the specific buyer and thus can only be determined once the buyer has been assessed to ascertain what it would take for the buyer to successfully absorb the technology, i.e. the specific use of the technology and the

knowledge & norm gaps are known. Nonetheless, before this stage it is important that various elements of the technology are identified and extracted beforehand, e.g., the relevant hardware has been identified, the implicit knowledge has been converted to a more explicit form where feasible, the tacit knowledge that cannot be codified has been captured in the form onsite trainers and training programs etc.

Once all the elements are in place and the buyers requirements are known it becomes easy to package the relevant parts of the technology to allow for:- ease of transfer, ready absorption, and reducing the after sales support requirement. The transfer package may include elements such as hardcopy documents, software, manuals, test and qualification data/reports, equipment/ hardware, etc. As highlighted by IP1 and IP2, the package of the technology transfer can only be finalized once the buyer's requirements and condition are known. Also as highlighted by both literature and interviews the efficient absorption of the technology by the buyer may depend on issues such as knowledge gap, norm gap, and culture gap. It may therefore be worthwhile to identify these gaps as will most likely determine the scope of the transfer package.

Furthermore from the interviews it may be argued that modularity can be useful in the technology package. This enables the final package to be readily configured according to the specific needs of a buyer efficiently. It must be emphasized that the building blocks would be the same as mentioned by CC1 and it is best that these building blocks are in place so that it is easy at the final moment to customize the package from these building blocks that are ready

5.4 TRANSFER PROCESS

According to literature and the interviews, it is very useful to have a dedicated team (on the seller's side) to manage the transfer process. As with extraction this non temporary job responsibility of the personnel ensures that important knowledge about transferring the technology is captured appropriately. This knowledge, apart from optimizing the transfer process, may also be useful in the extraction and packaging processes as it may help identify and manage the undiscovered tacit knowledge through the buyer's feedback as implied by Cummings & Teng (2003). The transfer management team which may include members from both parties can provide a forum where both can communicate issues more efficiently to ensure that the technology is readily absorbed by the buyer. All this may lead to a reduction in the transaction cost; as IP1 highlighted that the cost is increased due to mistakes, on the part of the seller by passing on the wrong information, and on the part of the buyer's part by using the wrong information. Working within a team any miscommunication or misinterpretation can be resolved readily and efficiently.

5.5 POST TRANSACTION SUPPORT

As with finished goods technology transfers also require post contractual support. CC1 has an active Support system in place to help ensure that the technology has been absorbed properly and the buyer has no problems running the plant for manufacturing the engines. With the help of the Technology Academy they provide training and education to the personnel of the licensees. CC1 also supports the onward sale and marketing of the engines produced by its licensees to shipyards and vessel operators. All this ensures that the technology is optimally utilized without any problems. The issues of warranty and spares of hardware are also covered in the support activities of a company.

6 PROCESS FRAMEWORK

*'Daring ideas are like chessmen moved forward,
they may be beaten but they may start a winning game.'*

--Johann Wolfgang von Goethe

This section of the report outlines a process framework for addressing the issues related to selling technologies as products. The first part of the chapter discusses the proposed process framework for TAAP, resulting from the literature survey and the interview process. In the latter part, the proposed process framework is compared to the set of good practices for the management of selling of technologies prescribed by Bianchi, Chiesa, and Frattini (2011) in their recent study.

6.1 PROPOSED PROCESS FRAMEWORK FOR TAAP

All the issues highlighted in the discussion (chapter 5) so far have been framed in terms of framework for the trading of technologies as a product. The importance and validity of each element of the framework is described in view of the literature survey and the interview data. The proposed framework, shown in Figure 11, has three basic elements for managing TAAP, i.e. the process, tools, and organization.

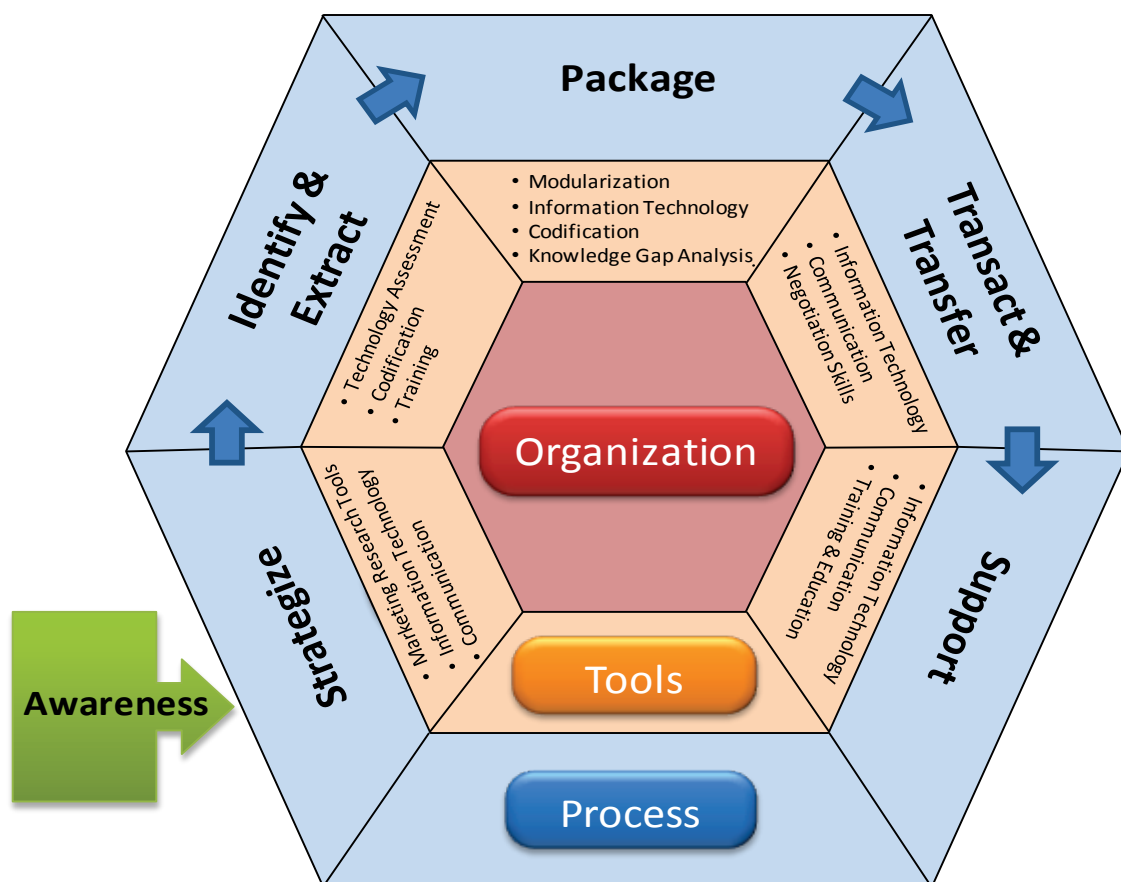


Figure 11: Proposed process framework for Technology As A Product (TAAP)

Although awareness of the opportunity or the potential benefits is not an element of the framework, it is a precondition for the technology trade to occur. It is therefore proposed that awareness of the opportunity, potential applications of the existing technology and markets for those applications (buyers & competition) is imperative for a company to realize the potential of technology trade in to profits.

6.1.1 PROCESS

This is the primary element of the framework as it describes the requirements for process to be followed if a company desires to sell its technologies as products. This element was the primary focus of the study, and attempts to address most of the issues related to TAAP highlighted in the previous chapters. The process highlights how the business may be planned and executed.

Strategize

The strategy for accepting technology as a product should cater for the following:

1. *Formal inclusion in the business plan of the firm.* With the formal inclusion in the business plan of the company it gets the formal backing of the top management. Furthermore, as a result of inclusion in the business plan, vital resources both human and financial can be assigned to foster and manage this business..
2. *Formulation of policies on codification, standardization and modularization for the development of technologies,* so that there is a common and homogenous understanding within the company of what is required in order to effectively enhance extraction and transfer capabilities.
3. *Storage and dissemination of knowledge related to the technology trade and transfer,* in order to ensure that knowledge and skills in technology transfers are fostered as a specialty.
4. *Pricing of the technology.* It is imperative that a pricing strategy be meticulously thought through and chalked out for each technology, in accordance with its respective market. This may involve studying the potential market of the technology, in terms of nature and type of competition, effect on other products of the company, value the technology can provide, etc.
5. *Contracts with buyers.* It is proposed that the client's contractual clauses need to be formulated after due deliberations taking into consideration the issues of:-
 - a. Disclosure and IP protection. This has been an important issue for the scholars on the subject of technology transfer. It is important to ensure that no unnecessary information is disclosed unless it is required.
 - b. Pricing.
 - c. Delivery of the technology, a staggered delivery process may sometimes be useful for protecting IP, i.e. delivering information only as and when is required in the transfer. Therefore in some cases it may be useful to plan the deliverables of the contract carefully, in order to obviate any chances of

transfer of any unnecessary information, and also to ensure that the buyer remains committed throughout the duration of the contract.

- d. Support and warranty. Apart from being an essential part of any product, support can be leveraged and used to protect against any violations of IP clauses of the contract.

Identify and Extract

The next stage in the framework after the formulation of a strategy is the identification of the technology (internal) and its intended market (external)

Internal Identification: For companies that already have technologies that are used internally for product development, it is important to 1) identify and evaluate the potential of the technology to be sold as products, in terms of market potential and cost of transfer, and 2) identify the elements of the technology that complete the specific technology description. A specialist team (experts in the technology trade and associated knowledge) as highlighted in the previous section 5.1 may have an important role in this regard as they may readily identify the requirements for a successful transfer; and subsequently evaluate the viability of the technology as a product in light of their past experience and knowledge.

External Identification: In order to realize the potential of the trade it may be important to investigate the potential market of the technology; and subsequently scour the market for potential buyers of the technology. This investigation may also be helpful in determining the appropriate pricing mechanism as highlighted by some of the case companies.

Extraction: Once the technology elements have been identified, they then have to be extracted in a way that the technology can easily be absorbed by the buyer and deliver the intended results. To summarize we can say that extraction of the technology is to:-

- Identify dependencies (on process, on specific human resource etc.).
- Resolve dependencies.
- Capture or manage tacit knowledge.

Package

Before a technology can transferred it has to be packaged appropriately in order to ensure that it can be efficiently transferred and absorbed. Although the associated elements of the technology are identified early in the process, however as opposed to other product packaging, a technology product package can only be finalized once the buyer's requirements are known. Hence the final packaging of the technology can be said to involve the following three steps:-

1. Identify requirements of Buyer.

2. Identify Knowledge Gap , Norm Gap , Culture Gap.
3. Determine scope of transfer, i.e. determine which elements such as software, hardware, trainings, documents, processes etc. need to be included in the package to satisfy the Buyer's requirement.

Transact & Transfer

At this stage of the framework the technology is packaged (i.e. all the elements have been defined and extracted) and is ready to be transferred. During the transfer of technology two issues need focus and require dedicated human resources:-

1. Transfer management, i.e. the transfer needs to be managed in a formal and well planned manner. It has to be ensured that communication between the two parties is efficient and unnecessary time is not wasted.
2. Capture and store transfer knowledge, so that the knowledge gained from each transfer process can be used to optimize the process and reduce the transaction cost in future.

Support

Once the technology is transferred an effective support mechanisms need to be in place to ensure that intended results are achieved and a sound buyer-seller relationship is established. Such a support mechanism with dedicated human resources needs to cater to the following three activities:-

1. Ensure absorption of technology, by actively monitoring the progress of the buyer in the use of the technology.
2. Training & education of the users of the technology, to ensure that the technology is used to its maximum potential.
3. Warranty and spares of the hardware supplied.

6.1.2 TOOLS

This element of the framework prescribes some tools that may be used to implement the process. Please note that is not a final complete list of tools that have to be used to ensure an effective process.

Communication

The issue of communication plays a important part in the entire framework. The preferred mode of communication recommended by both scholars and the interviewees is personal contact, as it provides an efficient means to transfer tacit knowledge. It is for this reason that CC1 build site offices if there are high volumes at stake. As explained before the role of inter-organizational communication may be critical during the transfer stage. The

personnel managing the transfer management must therefore be adept at both communicating externally with the buyer to capture the issues, and internally to seek solutions and disseminate the knowledge that is gained from the transfer.

Negotiation skills

In the interviews it was noted that negotiating skills may play an important role in determining the price of a technology especially when the price is not fixed. Furthermore during the study it was noted that during transaction negotiations, it is imperative that the seller's team is aware of the right amount of information to disclose. Too much disclosure may jeopardize the worth of the transaction by providing the buyer key information at no cost, whereas too little disclosure may not be enough to attract the buyer towards the transaction. Also recognizing the importance of the difference in culture is an important aspect that needs to be taken into consideration when negotiating a transaction.

Information Technology

The application and advancement of Information Technology (IT) has been highlighted to be an important tool in most of the stages of the process. In the Strategize stage IT can play an important role in investigating the potential of the business, such as identification of alternate applications of existing technologies, identification of potential buyers and competition. IT was highlighted by IP1 as one the important factors that has an indelible effect on the package of transfer and transfer process. Furthermore, the efficiency and nature of the mode of communication may also be determined by the advancement in IT. It was also observed from the interviews that for most case companies the buyers themselves had approached the company and expressed interest in their technology. Furthermore the preferred mode employed by most of the case companies for finding interesting technologies externally was an internet search using general search engines such a Google and Yahoo. Internet based IT therefore may play an important role in attracting potential buyers. That is why due emphasis should also be placed on improving the search rating of the company with key words of the technology.

Codification

As explained before codified knowledge about technology is much easier to transfer as compared to tacit knowledge. Codification lowers the transaction cost of technology transfer and thus allows a company to gain higher profits and field a competitive product in the market. From the experience of the case companies it was observed that companies that had formal policies on codification were much better at codifying knowledge efficiently and effectively. Formal templates for documents can serve as mediums to reposit and pass on knowledge gained from past experience. Codification may affect the workload for extraction and nature of packaging of the technology.

Modularization

Modularization of the technology can be an important tool in the packaging of most technologies. It can enable the package of the technology to be more easily tailored to the requirements of a specific buyer. In other words a modular technology may provide more flexibility with regard to packaging and cater to a larger market.

Market research tools

While developing the strategy or planning for the potential sale of technologies it is imperative that the possible markets be identified and researched comprehensively. It is therefore proposed that market research tools be used for:

- 1) Analyzing the competition (using SWOT, PERT, etc.).
- 2) Determining prospective user/buyer's requirements (using structured surveys, interviews, focus groups etc.).

Technology assessment

During the identification and extraction stage, it is proposed that the readiness of technology be assessed. In this regard the Technology Readiness Levels (Mankins, 1995) can be a useful tool in gauging the maturity and usefulness of the technology. Technology assessment may also provide an indication to the scope of work needed to extract the technology and whether any modification is required to an existing technology to make it marketable.

Knowledge gap analysis

As explained in section 6.1.1, the package of the technology to be delivered can only be finalized once the requirements of the buyer are known. These requirements are dependent on the knowledge gap between the seller and buyer, as they determine the scope of work required to enable the buyer to successfully absorb the technology. It is therefore proposed that a knowledge gap analysis is carried out during the packaging stage to assess the scope of the technology transfer.

Training

Training and sharing of experience play an important role in two stages of the framework in transferring critical tacit knowledge. As noted in the literature and interviews, the tacit knowledge of technologies is usually present in the form of skill in personnel that are critical to the process of development of the technology. Such people can rarely be spared to train the buyer's personnel on a regular basis. The dilemma is that if technology is to be sold as a product to multiple buyers, the engagement of skilled personnel who embody tacit knowledge may have to be part of the technology package. Hence it is proposed that training be used in the Identify and Extract stage, to extract knowledge from skilled and

critical technology development workforce to dedicated personnel that are part of the technology package who can transfer the knowledge to the buyer. Training and education may also be used in the support stage to ensure that the technology is absorbed and utilized to its true potential.

6.1.3 ORGANIZATION

importance of site offices...

This element forms the core of the proposed framework. This element emphasizes on the organization of teams for efficiently selling technologies as products. From the discussion up till now the importance of a dedicated team, to handle technology as a product, must now be very evident. It is once again highlighted that only a dedicated team can ensure that the learning from the process is captured, stored, and used effectively to lower the transaction costs. The team has to remain involved and drive all the stages of the framework. From the very beginning members of this team should be embedded within technology development projects. The roles of the TAAP team are as follows:

1	Optimize the TAAP process with knowledge gained from experience, and recommend tools for the implementation of the process.	Pre Transaction
2	Readily assess the potential of the technology as a product,	
3	Identify the elements of technology to ensure extraction later on	
4	Guide the technology development team on how to make the technology more easy to transfer and package	
5	Extract material and information for the formulation of user and training manuals	
6	Take part in the negotiation with the buyer during a transaction	Transaction
7	Carry out assessments for knowledge gap and norm distance	
8	Lead the technology transfer process and capture/store transfer knowledge.	
9	Conduct trainings to ensure that the technology is absorbed efficiently and tacit knowledge is transferred.	
10	Support the buyer post transaction troubleshooting related to the technology, and.	Post Transaction
11	Capture any new requirements of the buyer when it is using the technology	

Table 5: Roles of TAAP team

6.2 COMPARISON TO A SIMILAR PROCESS (BIANCHI ET AL., 2011)

In the final stages of the study it was discovered that in early 2011 a similar process for managing the sale of technologies was proposed by Bianchi, Chiesa, and Frattini. In the study, which spanned over two years, they investigated technology transactions of around 30 companies. In this section of the report a comparison between that process (Bianchi et al. 2011) and the process framework proposed for TAAP is presented to highlight some similarities and differences.

Their process is based on the major stages, identified by Lichtenthaler (2008), for successful technology sale transactions; and is comprised of five phases, shown in Figure 12. They identify the main tasks, managerial challenges, and good practices for each of the phases.

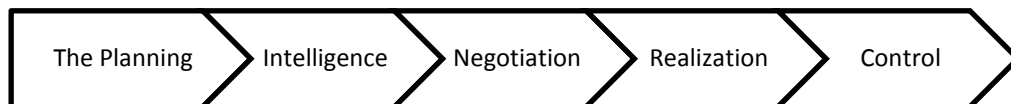


Figure 12: The technology sale process prescribed by Bianchi, Chiesa, and Frattini (2011)

The focus of the study conducted by Bianchi, Chiesa, and Frattini is more inclined towards technology transaction that takes place in collaborations and joint ventures. The technology that is delivered is expected to be further developed by the partner (buyer). Hence there is quite a lot emphasis laid on controlling and monitoring the post transfer activities and behaviour of the partner, and establishing working relationship. Whereas the primary goal of TAAP framework is to cater to issue of multiple transactions to various buyers. The focus is more on general technology transfer and is not focussed on collaborations or joint ventures. The following provide an insight in to some of the similarities and differences in the two processes.

Please note: Only for simplicity in referring to the process proposed by Bianchi, Chiesa, and Frattini (2011), it shall hereinafter be referred to as the 'reference process'.

6.2.1 SIMILARITIES

Although both processes may differ in primary focus, it is however very interesting to note the similarity in issues they address. A correlation of similar issues is shown in Figure 13.

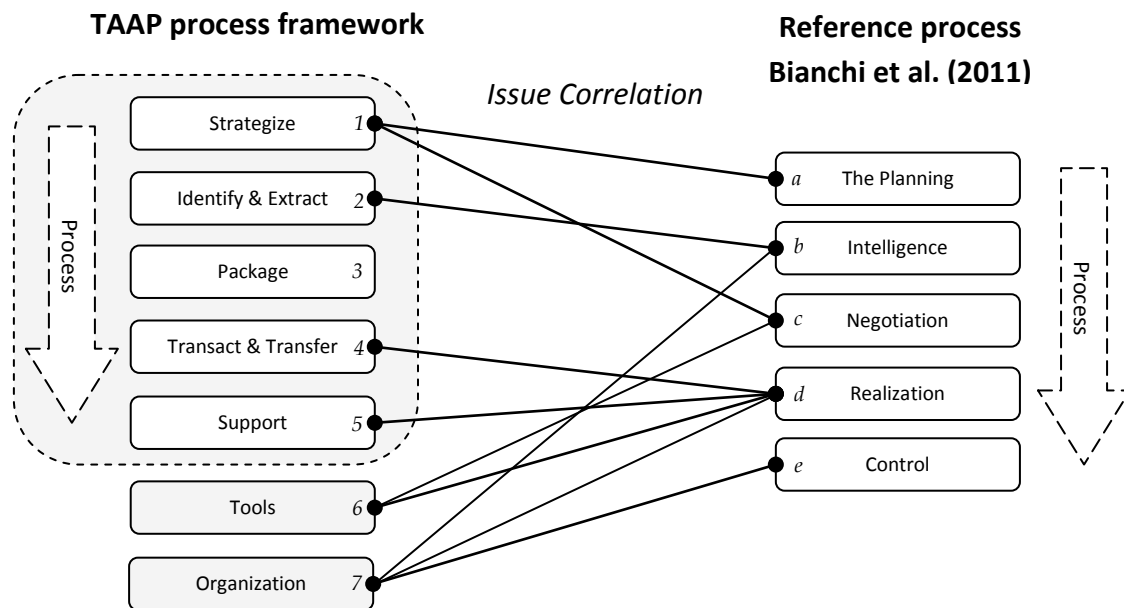


Figure 13: Similarity correlation between proposed TAAP framework and process by Bianchi et al. (2011)

The similarity correlations are explained in detail in the following Table 6.

Table 6: Detail descriptions of similarity correlation

Correlation	Description
1-a	Both processes advocate the involvement and support of the top/ senior management for success. The TAAP framework calls for the formal of the top management at the Strategize stage to officially include the trade in the business portfolio and assign resources. The reference process recommends the use of steering committee's for overseeing technology sale.
1-c	The tackling the issues related to disclosure of information, formulation of contracts, pricing are addressed in the strategy/ planning stage of the TAAP framework. The same issues are addressed in the negotiation phase of the reference framework
2-b	The identification of potential technologies and the investigation of alternate uses are emphasized in the Identify and Extract stage of the TAAP framework, whereas similar issues are addressed in the Intelligence phase on the reference process.
4-d	The Transact and Transfer stage of the TAAP framework and Realization phase of the reference process address issues related to the actual transfer of the technology from the seller to the buyer.
5-d	Both processes emphasize the importance of building a lasting seller-buyer relationship.
6-c	Negotiation and communication skills are recognized as a key competences in both processes
6-d	During the transfer face to face communication is recommended by both

	processes. Also, both highlight the importance of human contact for transferring tacit knowledge and absorption of the technology by the buyer.
7-b	The TAAP framework requires that a dedicated specialist multidisciplinary team be organized to investigate the trade potential of the company's technologies. Similarly The reference framework recommends a multidisciplinary panel of technology experts for the same task
7-d	In order to manage the transfer effectively, the TAAP framework proposes the formation of a joint transfer management team with members from both parties. With a similar approach the reference process to some extent also recommends joint development committees and alliance managers to collaborate and work more effectively with the buyer. Their approach however caters more to collaborations and joint ventures where the sale of technologies require further development by the buyer.
7-e	Both processes give due importance to the experience and competence of the personnel involved in the transaction process. The TAAP framework highlights the importance of specialized team to ensure efficiency in the process. Whereas the reference process attributes success to experienced personnel monitoring the contractual obligations of the buyer and the seller.

6.2.2 DIFFERENCES

The main difference as explained in section 6.2 is the fundamental issue each process addresses. Due to this difference, the TAAP framework and reference process have some differences which are as follows:-

- a) There reference process calls for a systematic approach towards reaching decisions on whether the technology should be sold or not. It highlights the usefulness of a criteria for such decision making. The TAAP framework however does not address the specific decision making process directly but broadly calls for the trade to be included in the business plan and an assessment of the trade potential of the technologies.
- b) The reference process is more oriented towards trade in technology development collaborations/ joint ventures and the transaction. Hence there is quite a lot of emphasis placed on:-
 - carefully selecting the buyer (partner) in the transaction, so that the seller's business objectives are not compromised,
 - transaction issues such as contracting, negotiation, and pricing. Skills such as mixed-motive negotiation techniques are a very useful practice in the transaction negotiation process.
 - post transfer control, to ensure that the buyer adheres to the contractual obligations, and does not infringe on the seller IP rights. Therefore this control phase is quite well defined in the reference process and is lacking in the TAAP framework.

Whereas, in the TAAP framework the emphasis is more on building a framework that can aid the development of technology so that it is easier and more efficient to extract, package, and sell.

- c) Both processes address the use of specialized teams in various stages/phases, however due to the collaborative development orientation the reference process proposes transfer of key personnel which may sometimes be unfeasible for TAAP. The TAAP framework focuses more on optimizing for repeatability. It therefore advocates the formation of a dedicated team for TAAP so that knowledge is captured as experience is gained and it is used to optimize the various stages of the process.
- d) The issues with transfer management related to the management of risk and challenges are addressed quite well in the reference process as compared to the TAAP process.
- e) In the TAAP framework the focus is more on the technology itself, i.e. identifying the elements of the technology and how to manage the tacit element of the technology so that it can easily be extracted and packaged. In this regard the importance of codification is highlighted. In the reference process although the tacit element is mentioned, it is not elaborated that much. The in-house activities related to the technology such as the management of extraction of the technology, are not addressed between the intelligence phase and negotiation phase.
- f) The Package stage is a very important element of the TAAP process. The technology package ensures that the technology can be traded efficiently multiple times as a product.

6.3 REFLECTIONS ON TAAP PROCESS FRAMEWORK - PERCEIVED LIMITATIONS

The proposed TAAP framework evolved a number of times while it was being formulated. Of the three elements, the process element was the first to be derived out of the data from the interviews and the literature. Consequently, this element is relatively more stronger in terms of support from the interview data and the literature. The other two elements i.e. Tools, and Organization were devised later in order to address the issues related to the implementation of the process. Although issues which the tools address were investigated to some extent in the interviews, however the usefulness of the specified tools could not be validated because there was not any second round of interviews. Furthermore the basis for the Organization element was the experience of just one case company i.e. CC1, and some practical knowledge of IP2. It remains to be determined how the roles of the team highlighted in section 6.1.3 can be accomplished, whether as one large team or as smaller teams working under a steering group responsible for TAAP. The list of tools and structure of organization recommended in the TAAP framework is therefore a preliminary proposal which have room for further improvement.

Also, after analyzing the process proposed by Bianchi, Chiesa, and Frattini (2011) it is felt that certain issues have not been adequately addressed, namely the issues related to decision making, control in the process, and marketing mode complexities.

- The TAAP framework does not account for the complexities arising from the various modes of marketing of technologies. Some modes require more post sale control over the use of the technology to ensure the desired returns, whereas other modes achieve the desired profits upfront.
- The decision making process on whether to sell a technology or keep it for strategic/economic reasons needs to be addressed in a systematic manner. Although the market and potential buyers are identified in the Identification and Extraction stage, the TAAP framework does not adequately cater for careful assessment of the buyer to ensure that it is not a direct threat to the seller's business. A criteria as mentioned by Bianchi, Chiesa, and Frattini (2011) which can aid in the decision making process may be very useful in this regard.
- The issue of control over the process especially in post sale activities is not addressed directly. The TAAP framework does not address the monitoring of the activities of the buyer to ensure that IP is protected and contractual obligations are adhered with. As implied by by Bianchi, Chiesa, and Frattini (2011), this aspect may be critical in situations where the technology sold may potentially have a major impact on the competitive edge of the seller if it is leaked, or the contractual binding is not adhered to, by the buyer.
- It is felt that issues related to the management of the actual transaction with the buyer at the Transact and Transfer stage of the TAAP framework need further attention. The practical issues related pricing, negotiation, and undesired disclosure of critical information need to be managed more adequately at this stage of the framework.

7 CONCLUSIONS

*'The greater our knowledge increases the more our
ignorance unfolds'*

--John F. Kennedy

The technology requirements of modern day complex products have increased manifold in the recent years. It has become increasingly difficult for any single company to develop all the technologies associated with the development and manufacturing of such complex products. Technology trade therefore is hard to avoid in the current scenario and presents a great opportunity for companies to leverage their technologies.

This potential can be leveraged much more profitably if technology is treated as a product which requires a more systematic approach. However, there are more issues to contend with treating technology as product as compared to a one-off technology or knowledge transfer. The processes of internal identification, extraction and packaging of technologies have to be optimized to handle the repeatability associated with technology as a product more efficiently and effectively. It should also be understood that it is difficult to build and manage a systematic approach to technology trading without assigning dedicated financial and human resources to address the relevant issues of the trade. The main purpose of the approach should be to lower the transaction cost by making the technology easy to extract, adapt, package, and transfer repeatedly.

Strategic awareness of the company is noted to be an important aspect in the success of this type of trade. The weak markets of technology may undermine the potential of the technology trade. However, it is important that the company is aware of the opportunity this trade presents and takes it as a serious business by assigning dedicated resources. Since resources are not allocated, the business opportunity is not adequately gauged for the top management to become aware of the true business potential of technology as a product. In most case companies it was seen that either they had not thought about the concept of selling technology or it was not a priority.

The importance of a dedicated team to oversee all the elements of the framework is very important. This ensures continuity in learning over the course of time. In conclusion, a practical framework can facilitate the requisite systematic approach for selling technologies as products by highlighting the issues associated with repeatability in TAAP such as the processes of internal identification, extraction, and packaging of technologies.

Last but not least, the packaging of the technology is very important if it is to be considered as a viable product. As mentioned previously, although the package is finalized in the latter stages, i.e. once the requirements of the specific buyer are known. However work on packaging of the technology should be initiated early on so that all the elements of the technology are identified and extracted. In other words the building blocks of the package should be ready once the technology is marketed as a product; so

that once the buyer's requirements are known these blocks can be readily combined efficiently and quickly to form a final package that conforms to the requirements of a specific transaction.

8 FUTURE WORK

'Nearly every man who develops an idea works it up to the point where it looks impossible and then he gets discouraged. That's not the place to become discouraged'

--Thomas Edison

During the course of this thesis, various future work avenues were identified. Some of the main avenues for future work on TAAP are briefly described in this section of the report.

8.1 VALIDATING AND IMPROVING THE FRAMEWORK

As mentioned earlier in the purpose of this thesis, the framework described in the Section 5.7 is a proposal and it requires validation. The study for validation should ideally be quantitative study to comprehensively explore all the issues highlighted in this thesis and any new issues as well. The results should be based on participation of at least 20 technology companies to build a generalized framework for TAAP.

Furthermore the Tools and Organization element of the framework require detailed research of their own. As mentioned before the present list of tools prescribed in the framework is a preliminary result that has to be investigated further to give a comprehensive list of tools for the practical implementation of each stage of the TAAP process. Also, questions on how to manage and organize teams to cater to all the stages of the TAAP process while ensuring a fluency in capturing, storing and using knowledge gained from experience, need further research.

8.2 EXPLORING PACKAGING

Technology packaging has been noted to be one of the under-investigated areas of technology transfer. The package becomes significant whenever the tradable goods are regarded as a product. In this thesis, the term technology package means combination of the elements of the technology that need to be transferred as shown in Figure 14.

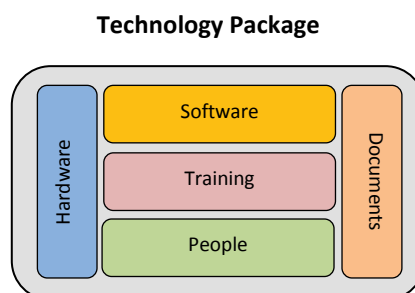


Figure 14 Technology Package

It would be worthwhile to investigate the following issues on the packaging of the technology:-

1. **Cost:** The cost of the package has been found to be an important aspect of the package. It would be interesting to investigate which issues affect the cost of the package the most.
2. **Time:** Various times frames, such as that for extraction, transfer, and absorption of the technology by the buyer, may have significant effects on the cost of the technology package. During the interviews during a discussion with IP2, it was highlighted that some time frames such as that for the transfer of technology may also be strategically used to protect against unnecessary disclosure. This means that during the transfer, some of the elements technology can be transferred in a specific order serially only when the need for the element arises.
3. **Absorbability:** It would be interesting ascertain how the package of the technology affects the absorbability of the technology. The effect of standard interfaces and standard elements in the technology package on the absorbability of the package needs to be determined.
4. **Adaptability:** It would also be interesting to determine how a package can be made readily adaptable to the needs of the various buyers.
5. **Decreasing after sales support:** It may be economically feasible to decrease the need for after sales support. Hence it would interesting to investigate how a package can be as complete as possible so that lower after sales support is required for it.
6. **Content complexity:** It would be interesting to investigate the effect of complexity, of any technology with numerous elements, on the overall package.

8.3 CHANGE MANAGEMENT FROM A FINISHED PRODUCT ORIENTATION TO TAAP ORIENTATION

It was found that CC1 had transformed over the years from developing and manufacturing large engines to just developing and selling engine technologies, that are manufactured by the licensees. They thus transformed their business model from a finished engine product orientation to a TAAP orientation; where now selling technology is their primary product. It could be interesting to observe how this sort of change of business orientation is managed; and what are the associated challenges, when a business orientation is transformed from finished product to TAAP.

8.4 THE TAAP TRANSFORMATION FUNNEL

A product or process development funnel outlines the stages of development of a new product or process; where at the mouth of the funnel a broad range of ideas are fed and a select few refined and feasible projects come out from the other end (Wheelwright & Clark, 1992), see Figure 15. Although the development funnel can be used for new technology development, it could be interesting to adapt the funnel for transforming existing technologies into technology products. An idea for a hypothetical adaptation is shown in Figure 16.

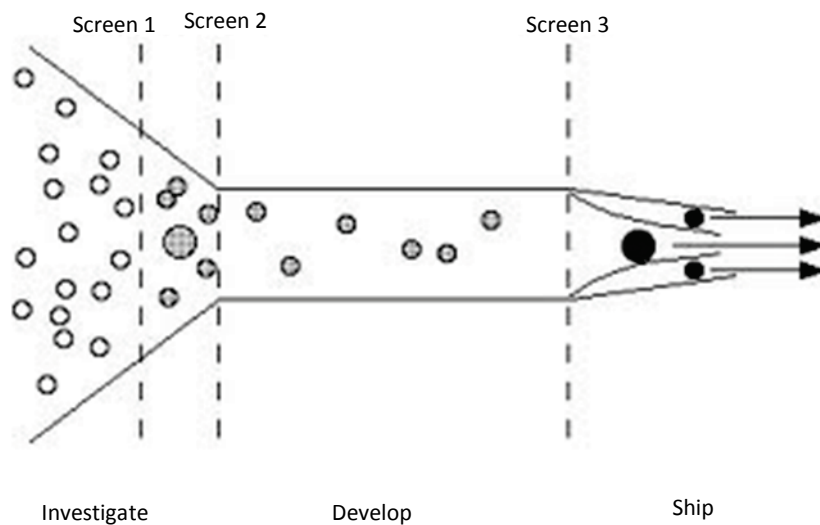


Figure 15: The development funnel - Model 1 (Wheelwright & Clark, 1992).

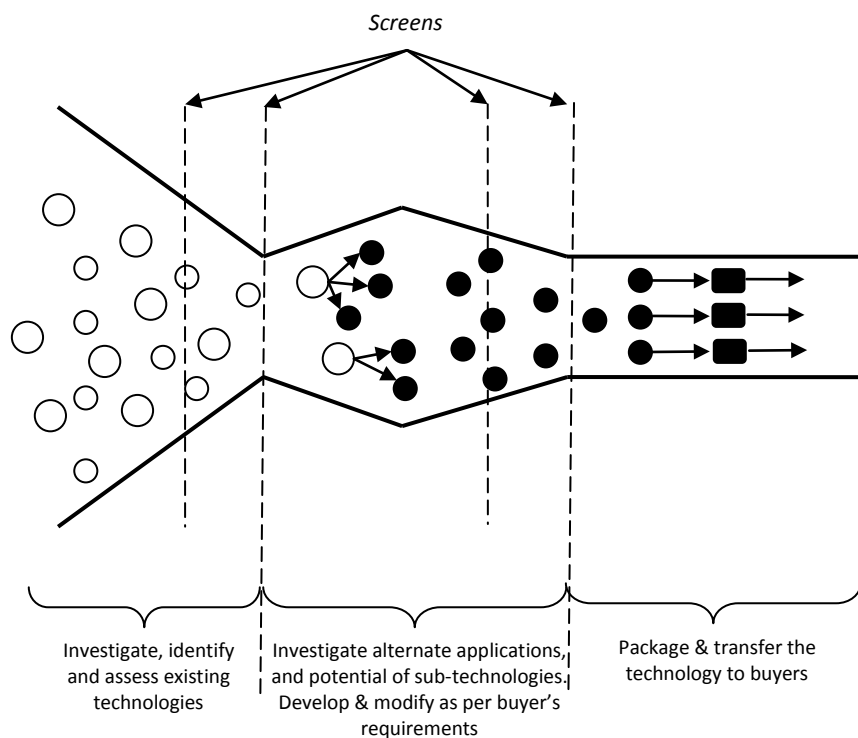


Figure 16: Idea for TAAP transformation funnel; adapted from the development funnel

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ANNEXURE-I MASTER QUESTION LIST

CONTEXT	QUESTION	TARGET
MARKET CONTEXT		
Competition	Do you target a buyer with a specific set of characteristics?	Both
	Do you include any legal clauses in your contract to stop any leakage of the technology?	Seller
Strength of intellectual property right	Do the strength of IP laws (in a specific country) have an impact on how you market the technology?	Seller
	What effect does the strength of the IP laws have on the complexity of the product package?	Seller
Intermediaries of market	Are you aware of any intermediaries for you technology trade?	Both
	If yes, do you find them helpful...in what ways?	Both
	If no, have you made an effort to find any intermediaries?	Both
Sale restriction regulations	Do sale regulation affect the technologytrade?	Both
	If yes. How do you work around or deal with sale restrictions on parts of the technology?	Both
Imperfections in the market	Are you aware of any market for your (requisite) technology?	Both
	How do you search for prospective buyers/sellers of technology?	Both
	Is it easy to find prospective buyers/sellers of the required technology?	Both
	How much information about the technology would you disclose upfront to attract or convince the buyer?	Seller
	Are you willing to disclose (trade secrets embedded in the technology) to attract buyers?	Seller
	Do you think sellers disclose enough information about the technology for you to assess the worth of the technology?	Buyer
	How do the disclosure issues change with the age of the technology?	Both
	Does the transfer process become easier with the number of transactions?	Seller

	Do you find it easier to buy technology from a company that has sells it regularly (i.e. it is not new to this type of trade)?	Buyer
	Do you feel the majority technologies advertised in the market worthless, or outdated technologies?	Buyer
	Would you market some of core technologies, that are critical to your competitive edge in the market?	Seller
	Do you feel that you get intended results you pay for? That is do you fee you got what you paid for?	Buyer
	How do you price your technology?	Seller
	If you have unique technology do you take advantage of your monopoly in the pricing of your technology?	Seller
	Does monopoly of the seller of technology affect the price of the technology? How do you negotiate the price?	Buyer
	Do you think the price of the technology is determined/affected by the negotiation skills?	Both
	Does the market provide an input on the pricing of the technology?	Both
SELLER CONTEXT		
Technology and Knowledge extraction	Do you feel your technology is embedded is the routines or processes of your organization?	Seller
	How do you extract technology that is embedded	
	Is there any tacit knowledge part of the technology? Does the customer require any support during the transfer in terms of training? Do you think the technology can be transfered at arms length?	Seller
	Is it easy to transfer technology that is embedded? How do you proceed?	Seller
	Is the embeddedness intentional or accidental, i.e. is part of the knowledge strategically kept tacit to avoid leakage?	Seller
	Is there a formal strategy to transform the tacit knowledge to a codified form to make it easy to transfer to the customer? Who does it? At what stage does he do it?	Seller

	Can the technology be easily taught to the customer?	Seller
	How much of the technology is based on standard knowledge (available in the market)?	Seller
	Does standard knowledge on the market have an effect on the package of the product?	Seller
	Do you feel your technology is context fixed and cannot be adapted for other uses?	Seller
	How do you ensure context independence? (<i>standardized interfaces etc.</i>).	Seller
	What effect does the conversion of the tacit and context dependant knowledge have on the complexity and the price of the product?	Seller
Priority & business strategy	Is the sale of technology your primary or secondary source of revenue?	Seller
	Is priority a problem in making good products out of technology	
	Have you explored the idea of making additional revenue from the sale of technologies you have developed for your processes or products?	Seller
	If yes, how do you identify possible technology products? Is it intentional or accidental?	Seller
	Do you have dedicated team with dedicated resources to explore for possibilities to make technology products from the technologies you use or have developed for your own products? (<i>inhouse capability identification</i>)	Seller
	Do you have dedicated person(s) and resources to scout for prospective clients for your developed technologies.	Seller
	When developing a technology (for your process or products), is its possible future sale kept in mind? Is there an emphasis on codification and context independence from the beginning (of the development of the technology)?	Seller
	Who makes the decision of whether to market or not market a technology? (<i>Are the possibilities vetted by a management committee?</i>)	Seller
	Do you fear that too much focus on making technology products may divert the attention from the development of your core portfolio products?	Seller
	Do you think that your company has the time and resources to take advantage of additional prospective technology products, especially if they require some level of modification or further development to make it a marketable product?	Seller
Appropriability	How do you determine the price of knowledge and other intangible goods such as design	Seller

	ideas etc.?	
	Do you feel presale disclosure of the knowledge to the buyer for the sake of value assessment can affect the appropriations from the sale of the technology?	Seller
	How do you determine how much to disclose so as to allow the the buyer to assess the value of the knowledge/technology without leaking any critical information to the buyer for free?	Seller
	How do you manage the appropriations from the sale of the technology? <i>Do have the total price paid upfront? Do you keep the critical information till the end so that the buyer remains committed to the agreement for the duration of the contract? Do include some penalties for prematurely cancelling the contract? DO you protract the delivery of the technology in parts so that you receive the desired appropriations</i>	Seller
	Do you fear that the buyer can opt out of the contract mid way through the transfer process if he feels he has acquired enough knowledge to develop/copy the technology himself?	Seller
	How do you ensure the protection of the Intellectual Property?	Seller
	How is the appropriation affected by the strength of the IP laws of the country?	Seller
	How does the ease of imitation affect the price of the technology?	Seller
	How does the ease of replication affect the price of the technology?	Seller
Codification	Is codification emphasized from the beginning of the development of the technology?	Seller
	What do you think is the importance of an early start to codification, is it worth the scarce resources in the beginning	
	Do you a set of standards (both internal and international) or procedures for codification of the different parts of the technology? (<i>documentation, software coding standards or procedures etc.</i>)	Seller
	What part of the technology is codified so far? And in which form (<i>drawings, software codes, manuals etc.</i>)?	Seller
	Can the technology be codified any further? What are the impediments, <i>why hasn't it been done so far?</i>	Seller
Trade experience and trade cycles	Do you think the transfer process becomes more efficient and easier with every transaction?	Seller
	Have you developed stable and dedicated teams /specialists for the transfer of the	Seller

	technology?	
	Have you developed standard procedures for the transfer of the technology?	Seller
	Has the experience in trade of other products helped you in the trading of technologies? What would you say has been the difference between the two?	Seller
Use restrictions	Why would place use restrictions if you were to place them?	Seller
RELATIONAL CONTEXT		Seller
Knowledge gap	Does the buy have any experience with the same technology?	Both
	Does buyer have any internal R&D relevant to the technology?	Both
	Do you think any additional training or knowledge was required by the buyer before the transfer of the technology	Both
	Is there a possibility that some unlearning may be required on the part of the buyer to absorb the technology?	Both
	How does the knowledge gap affec the package variables?	Seller
Norm Gap	Do both parties have the same understanding of the contents of the technology? Do they use the same technical knowledge terminologies?	Both
	Do both parties follow the same standards on process, software, testing etc.?	Both
	Do both parties have the same CAD (or other relevant process software) package ?	Both
	Is communication easier when you have the same knowledge?	Both
	Are there any other problems or issues due a norm gap? How do you deal with them?	Both
Difference in culture	Do both parties have a similar organizational structure?	Both
	Do both parties have similar internal communication patterns and protocols?	Both
	Is the culture in both companies bureacratic or open?	Both
	How does a difference in workethics between the parties affect the effieciency of the transfer?	Both
	What is the effect of a difference in power distance to the transfer?	Both
Communication	Do both parties have the same first language for communication?	Both

	What are the types of communication that exist between the buyer and seller? Which type is used more often? What are the strengths of this type of communication over the others?	Both
	How many face to face meetings take place in a typical transfer, and what level and at what stage of the transfer of technology? Are such modes of communications difficult to manage? <i>(due to personnel availability and costs)</i>	Both
	Does the transfer of human resource increase the richness of communication?	Both
	Is there any formal guideline or training for personnel that visit the buyer's premises to train their personnel? <i>(to ensure the training is adequate and that no unnecessary information or knowledge or trade secret is leaked to the buyer)?</i>	Seller
	Who trains the buyer? Is there a dedicated team for training and communicating with the buyer? Are the original owners of the technology part of that team?	Seller
BUYER CONTEXT		
Knowledge absorption and readiness	Do you have an established R&D resource relevant to the acquired technology? If no, do you try to enhance the knowledge and skill level of your personnel before acquiring the requisite technology? Do you think it is important?	Buyer
	Does the buyer have expertise in all the disciplines related to the technology?	Buyer
	Do you have a specific team to whom the technology is transferred? If yes, what was the criteria on which the team was selected?	Both
	Does the buyer have the capability to any changes or adaptation to the technology?	Both
	Who evaluates the technology? Who grants an acceptance certificate that the transfer has been completed and the desired results met? <i>Does the buyer employ consultants or experts from other parts of the company in this regard?</i>	Both
Technology strategy (sourcing, etc.), intended use	For what purpose is the technology acquired from external sources? <i>(For enhancing or upgrading internal R&D or product development)</i>	Buyer
	Do you actively scout useful technologies?	Buyer
	Is there a dedicated person or team (with dedicated resources) for scouting prospective technologies that can be acquired? How is their performance measured?	Buyer
	Are intermediaries or consultants used for scouting useful technologies?	Buyer

Use restrictions	Do use restrictions enhance or restrict technology trade?	Both
	Do use restriction protect the seller's IP and obviate the seller's fears of any negative effect on its competitive advantage in the longterm due to the transfer?	Both
	Do use restrictions work? Can or do some buyer's ignore them after some while? If yes how do they do that?	Both
	How does the seller ensure that use restrictions are adhered to? What are measures taken? <i>(like legal clauses)</i> .	Seller
	Is future support or delivery of the technology conditional to the adherence of the use restrictions?	Both
Human factors	Do you feel the owners of technology are reluctant to give away the technology? Do they try to keep critical information on the technology from you?	Buyer
	Do you feel that people at the buyer's premises are enthusiastic about externally acquired technology? Is there a feeling or fear that the buyer is not getting anything special from the external technology?	Buyer
	Do people need any motivation to accept and use external technologies? If yes, how do you achieve that?	Buyer
TECHNOLOGY CONTEXT		
Transfer management	Is there a joint management team that oversees the transfer process?	Both
	Does the seller remain on the premises of the buyer after integration to solve any teething problems?	Both
Transaction cost	What do you think affects the transaction cost the most?	Both
	Does the transaction cost discourage this type of trade?	Both
Type of technology	What types of knowledge disciplines are used in the development of the technology?	Seller
	Is the technology product based on a platform? Is it modular?	Seller
	Do different disciplines in the technology have different issues?	Seller
State & stage of technology	Is the technology fully developed and fixed?	Seller
	What are the options for flexibility for different uses ? How much effort and resources are required to make a change?	Seller

	How does the stage of the development of the technology effect the ease of transferability	Seller
Mode of marketing (seller)/ acquisition (buyer)	What is the mode of marketing your technology? Why is this mode preferred over other modes? (<i>benefits and drawbacks</i>)	Seller
	Does the mode of marketing have an impact on the contents of the transfered product? (<i>Do have to include more or less technologies /knowledge with other modes</i>)	Seller