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Key issues in managing technology transfer projects

Experiences from a Canadian SME

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Abstract

Purpose – This paper aims to explore and illustrate the technology transfer (TT) experiences of a small to medium-sized enterprise (SME), Rayton Packaging, using the stage-gate approach to TT as an inquiry lens.

Design/methodology/approach – The approach described in this case conceptualizes TT as a process consisting of a set of stages and decision gates.

Findings – A TT project cannot be considered to be effective unless it also leads to profitability and growth for the firm. In today's global business setting, TT should be seen only as a component of business strategy and not in isolation as a technology project.

Originality/value – This paper describes the stage-gate approach which has been successfully used for managing new product development programs in large firms.

Keywords Small to medium-sized enterprises, Canada, Technology led strategy, Process planning

Paper type Case study

1. Introduction

In today's dynamic and fast changing business landscape, technology transfer (TT) is an important part of a firm's business strategy. Firms are increasingly dependent on TT for dealing with the enhanced product complexity, greater customer requirements for timely and better service, and increased competitive pressures. However, many of these TT projects fail to produce desired results due to lack of careful planning (Kumar *et al.*, 2007). We found that firms, particularly small and medium-sized enterprises (SMEs), often treat TT projects as commodity buying projects and often miss several important activities associated with the TT that are critical for the quick deployment and success of the new technologies being transferred.

Generally defined as firms having fewer than 500 employees and less than $50 million in annual revenues (Huot and Carrington, 2006), SMEs are important players in national economies as they provide the foundation for economic growth (Amboise, 1991; Balderson, 2003; Iacovou *et al.*, 1995; Longenecker *et al.*, 1998). A majority of

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SMEs use TT as a key strategy to reduce their research and development costs and quickly respond to changes in the competitive landscape. However, as Swanson and Ramiller (2004) emphasize, managers should seriously guard against the bandwagon "me too" phenomenon and carefully consider the outcomes and implications of these decisions. There is a strong need for a systematic approach that can aid effective management of TT by providing a much sharper focus on resources and key constituent activities in this strategic process. This case study explores and illustrates the TT experiences of a SME, Rayton Packaging (RP), using the stage-gate approach to TT as an inquiry lens.

The stage-gate approach has been successfully used for managing new product development programs in large firms. This approach has been adapted and developed by Jagoda and Ramanathan (2005) for managing TT projects efficaciously. The approach described later in this case conceptualizes TT as a process consisting of a set of stages and decision gates. The case study is organized into five sections. The next section describes the stage-gate approach as applied to the context of TT. Section 3 briefly describes the methodology and provides the background information of the company. Section 4 describes RP's TT experience using the stage gate approach as a reference lens. The last section provides a brief discussion and conclusion to the case.

2. Stage gate model for technology transfer

The stage-gate approach was originally developed as a guide to effectively manage large and complex projects. Later it was made popular by Cooper (1993, 2001, 2008) in managing new product development processes. It assists managers in studying a process in terms of activities, milestones, and decision-point sequences. Jagoda and Ramanathan (2003, 2005) adopted this conceptual model to develop a systematic approach for managing TT. They provided an operational framework consisting of six stages and gates. Each stage consists of prescribed activities and tasks, and the collection, integration, and analysis of information to be carried out by the TT team for decision making at the subsequent gate. At each gate, the go/kill/recycle or hold decision is taken. It is envisaged that when effectively managed, the stage-gate approach will assist in identifying under-performing projects early, and a decision could be taken to kill or send them back to rework before further resource commitment is made. This model allows companies to minimize the risk of failures in TT projects.

To adapt the model to the SME context of the case study and make it more easily comprehendible, we further adapted the stage gate model proposed by Jagoda and Ramanathan (2005) into three interconnected phases: initiation, planning, and execution. The stages were grouped into the three phases based on the key focus of the management team in each stage. This regrouping helped us in making the model more suitable to SMEs and easier to understand. SMEs facing resource constraints can decide to combine the stages and gates within the phases. The model is represented schematically in Figure 1 and a brief description of each stage and gate is provided below. Our reasons for evolving the model further into phases are provided in the proceeding sections where we discuss the observations made in this case.

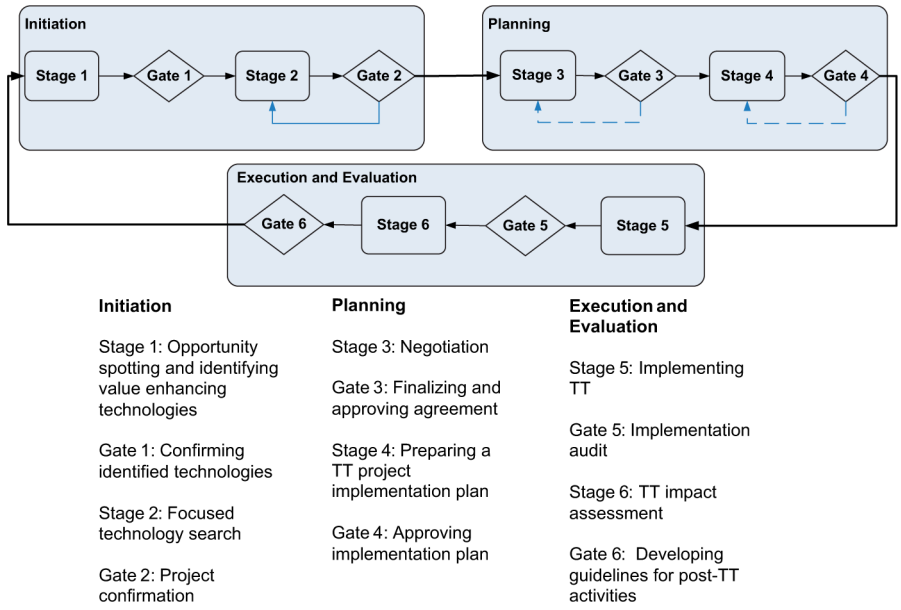

Figure 1.
Stage-gate model for international technology transfer

Stage 1: opportunity spotting and identifying value enhancing technologies
This is the starting point of any TT project. Previous research has shown that in the majority of TT projects (Jagoda and Ramanathan, 2005) this stage is initiated by the CEO or the operations manager. At this stage, the project team critically evaluates the market trends and shifts in customer preferences, competitor technology trends, and changes in government initiatives and regulations to identify the potential technologies. The major activities of this stage consist of:

(1) setting up a TT steering committee (TTSC) to manage the TT project;
(2) developing technology roadmaps to identify the future trends;
(3) carrying out a preliminary market assessment to identify the customer trends and preferences; and
(4) carrying out a technical assessment to identify the potential skills and resources required.

At the end of this stage, the project team develops a preliminary proposal that will then be submitted to the top management team.

Gate 1: confirming identified technologies
At gate 1, the top management team evaluates the preliminary proposal based on the company's strategic and operational criteria. It will also evaluate the financial feasibility of the proposal using project evaluation tools. If the go-ahead decision is given, top management may provide additional resources and formally confirm the composition of the TTSC.

Stage 2: focused technology search

By using project planning and management tools such as checklists, scoring models, and analytical hierarchy process (AHP) TTSC prepares the detailed business case for the identified technologies. It may include technology specifications, project financials, the project plan, and the business case. The major activities of this stage consist of the following:

- Establishing a clear set of specifications for the technology under consideration.
- Detailing how the technology sought is expected to enhance competitiveness.
- Evaluating the extent to which the abilities to use the technology are available in-house, the gaps to be bridged, and the resource commitments.
- Developing a preferred supplier profile and a list of firms that are capable of transferring the desired technology.
- Investigating and assessing the potential assistance that may be available from local and provincial government institutions.

Gate 2: project confirmation

Gate 2 is a critical stage as it provides the approval for heavy resource commitment. The top management team carefully evaluates the business case presented by the TTSC. The TTSC also has to convince the top management team of any additional resources needed to move the project ahead. Based on the firm's technology strategy, a priority list of suppliers will be developed and assessed. If top management is not satisfied with the business case presented, they may send the project back to stage 2 for revisions. If the go-decision is given, the TTSC will be converted to a full TT project team.

Stage 3: negotiation

Stage 3 begins with the initiation of negotiation with the short-listed suppliers. This process will continue until it leads to satisfactory outcomes for both parties. It is also common for companies to start negotiation with multiple suppliers at the same time. The valuation of technology plays a critical role in negotiation. The transferor can deploy ownership of a desired technology, reputation, and international market access to increase its bargaining power while the transferee can use local knowledge and networks, as well as access to local markets, raw materials, and low cost labor in their favor. In order to effectively manage this process, frequent contact and communication between both parties is required. The major activities in this stage are given below:

- Finalizing a basis for valuation of the technology and intellectual property protection.
- Agreeing on each party's contribution and responsibilities.
- Setting up mechanisms to transfer codified and un-codified aspects of technology.
- Creating effective channels of communication between both parties.
- Consulting government authorities to ensure concurrence with government policies.
- Deciding the most appropriate mechanism(s) for transferring the technology.
- Reaching agreement on payment amounts, procedures, and time frames.
- Preparing a detailed TT agreement.

Gate 3: finalizing and approving agreement
The outcome of this stage is the signing of a detailed agreement. The TTSC, working jointly with top management, will carefully evaluate: the comprehensiveness of the detailed transfer agreement, the appropriateness of the proposed mechanism(s), and the affordability of the payment amounts and time frames. If these are found to be inadequate the project will be sent back to stage 3 for revision.

Stage 4: preparing a TT project implementation plan
The activities of this stage are aimed at creating a sound organizational infrastructure. The TTSC will work closely with the transferor to draft a preliminary TT implementation plan. The activities during this stage include the following:

- Determining changes to be made to the organizational structure and work design.
- Identifying changes to be made in the knowledge management system and policy regimes.
- Developing pragmatic training and education schedules for the workforce.
- Establishing measures to build good relationships among the transfer personnel.
- Formulating a realistic TT project implementation plan.
- Establishing milestones to help strengthen project management and control.

Gate 4: approving implementation plan
The top management team and the TTSC will critically evaluate the feasibility of the project timelines and schedule, and the adequacy of training. This is normally conducted with the consultation of the transferor. The transferee should be careful not to rush this gate as it could lead to complexities at the implementation stage. If top management is not satisfied with any of the activities it may ask the TTSC to redo some or all of the activities of stage 4. The initial payment to the transferor is also approved at this stage.

Stage 5: implementing technology transfer
TT implementation requires good project management. The training needed must proceed without delay. Furthermore, the timely arrival of allied materials, parts, and services is essential to ensure that the commissioning occurs as planned. Important activities in this stage include the following:

- Identifying changes to be made to the product or process to suit local conditions.
- Recruiting skilled personnel not already available within the organization.
- Conducting training programs for existing staff.
- Developing an improved remuneration plan.
- Formulating arrangements with ancillary suppliers of materials, parts, and services.
- Maintaining links with government authorities.
- Commissioning the transferred technology on or before schedule.

Gate 5: implementation audit
This gate is aimed at gaining an understanding of barriers to successful implementation of TT. Top management may set up an internal audit committee or an external auditor to compile an audit report outlining the lessons learned. The report may focus on the implementation experience with respect to critical factors such as commitment displayed by both the firm and the supplier, conflicts experienced, maintenance of timeframe integrity, costs incurred, quality achieved, extent of learning and skill upgrading, new knowledge generated, and communication effectiveness.

Stage 6: technology transfer impact assessment
Assessing the impact of a TT project is difficult because it is a complex process with multiple outcomes that could emerge throughout the life of a project. Also, the intangible benefits of a TT project are difficult to evaluate. It would be prudent to use a balanced scorecard approach to assess the impacts of a TT project from market, financial, technological, and organizational perspectives. The following activities may be carried out at this stage:

- Assessing the actual outcomes of the TT project from market, financial, technological, and organizational perspectives.
- Identifying variances (if applicable) between actual and expected outcomes.
- Evaluating the adequacy of corrective measures.
- Examining the feasibility of improving the transferred technology.
- Identifying new or complementary technologies that could be transferred to consolidate the gains made.

Gate 6: developing guidelines for post-technology transfer activities
At this gate, important decisions have to be taken as to whether to continue to use the technology by improving it incrementally or go for another TT exercise. A successful TT project could lead to a strong partnership between the partners and new projects could be initiated. In such a situation, guidelines may be formulated by top management in consultation with the TTSC for post-technology transfer activities. These activities may include a new TT project, improving the technology through internal research and development, or using a mix of both in partnership with the transferor of technology.

The stage-gate approach for TT was deployed as a theoretical framework in this case to illustrate the TT experience of RP. The following section analyzes the TT experience of RP. We compare the process undertaken by RP with the activities suggested in the stage-gate approach for TT. Close attention to the issues emerging has been paid by examining the activities in various stages as delineated by Jagoda and Ramanathan (2003, 2005). The implications of not using some of the activities and tasks are also discussed.

3. Methodology and case study background

We used a single exploratory case study to illustrate the TT experiences of a Canadian SME in the packaging industry. According to Yin (2003), the case study strategy is most suitable when the research involves why or how questions. Case studies over the past decades have gained considerable acceptance in business research, particularly as

a method of choice for holistically examining complex phenomena in real life settings (Benbasat *et al.*, 1987; Yin, 1994). RP was selected as a case study site as the authors had access to this market-leading SME. The company provided us an excellent view of several strengths and weaknesses in the TT processes. Multiple semi-structured interviews with the CEO and senior managers were done to collect data for the case study. The stage-gate approach was used to develop a probe and interview protocol to guide the data collection process. These interviews lasted from 45 minutes to 2 hours. We also had access to several project related documents that were very useful in triangulating the information.

RP is a medium-sized, flexible packaging manufacturing company. It is based in the fast-growing Western Canadian city of Calgary, Alberta. Its annual sales reached more than CAD 20 million (approximately US$18.5 million) in 2007, and it is considered to be one of the largest packaging companies in Western Canada. It offers a full range of packaging products and services, including printed and plain packaging products. In its 80,000 square foot production facility, RP produces more than 10 million pounds of packaging productions annually. It began as a supplier of packaging products to supermarkets in Western Canada. In the last three decades it has expanded its product range to include medical specimen bags, polyethylene sheets and tubes, polyethylene bags, produce packaging, re-closable bags, and permanent packaging.

RP established themselves as the dominant packaging supplier in the food industry. The majority of its revenue comes from companies in Western Canada – the provinces of British Columbia, Alberta, Saskatchewan, Yukon, Northwest Territories, and Manitoba. Calgary, being the commercial capital of the oil rich province of Alberta is home for many warehousing and transportation companies that require large quantities of packaging materials. RP was able to establish strong long-lasting relationships with these companies and was considered their preferred supplier of packaging materials. RP also has offices in Eastern Canada, in particular Toronto and Montreal. Its international customers include companies in the US, Mexico, Chile, the UK, and Australia.

In order to keep its market leadership, RP invested heavily in innovation and new product development. Its in-house R&D team developed several patented packaging solutions. RP's major competitors are located in Vancouver, British Colombia. Overall, the packaging field consists of several small companies which produce specialized products. With increasing globalization, RP faces a stringent challenge from businesses in low-cost manufacturing countries such as China and Mexico. Increasingly, some of its clients are procuring commodity products such as grocery bags in large quantities from overseas firms. However, many customers still require small quantities of customized, higher quality products. These types of products are very difficult to get from overseas and even across the country (eastern Canada) because of the shorter lead-time requirements. The competitive strategy of RP is to diversify into this higher value-added market. They seek to capture this segment of the market by developing flexible manufacturing capabilities so that they can turn over highly customized jobs quickly. Continuous innovation through acquisition of new technologies plays a key role in implementing this strategy.

In order to enhance its competitive position, RP continuously introduced new manufacturing technologies to its production process. In this case study, we focus on a TT project carried out by RP and analyze it using the stage-gate approach. The

technology that is being transferred is a "process printing" technology. It uses a series of miniscule dots allowing for a vast arrangement of colors to be created, resulting in clearer and more diverse images. The original technology producer is Bielloni of Italy, a world leader in printing equipment. However, in this case the transferor is a subsidiary of General Electric (GE), which has signed a ten-year lease with the original supplier and is extending it to RP. GE is an international conglomerate, and has plants in various parts of the world. The total transfer cost is approximately CAD 1.3 million. Interestingly, this TT presents a win-win opportunity for both companies. While the transferor is able to leverage an under-utilized technology by offloading it to another company, RP, as discussed in the case later, sees this as a strategic opportunity to upgrade its technology portfolio. This technology offers RP much needed flexibility to take up multi-colour printing jobs at significantly lower prices. Process printing technology also allows RP to take up more complex color jobs with high quality requirements.

4. Analyzing the technology transfer process at RP using the stage gate approach

Initiation

Initiation is the first phase in TT projects. This can be started as a result of previous TT process or in response to a change in the competitive landscape. Generally, resource commitments for this phase are relatively low and can be completed in a short period of time. This is an important phase of the TT process, and it consists of two stages and gates as described in the following text. The activities in this phase are critical for laying a strong foundation for success of the overall process as the firm in this phase proactively educates itself on the potentials of TT and builds a case for it. In this process the firm proactively tries to find out a strategic fit between the technology and its business.

Stage 1: opportunity spotting and identifying value enhancing technologies. This TT project was initiated in the fall of 2005, when RP was approached by another packaging supplier to fill some of its orders that had previously been filled by a packaging firm in Eastern Canada. RP sensed in this deal an opportunity to grow, but the existing technology deployed by RP was only capable of line printing, while the new job required more advanced printing methods. It was deemed necessary for RP to acquire process printing technology in order to meet the new needs. This project was deemed strategic as it would increase revenues substantially.

Already a market leader in Western Canada, RP was striving to retain and grow its market share through improving productivity and reducing delivery lead-time. Its market analysis showed that several of its clients were filling their process printing needs from manufacturers in Eastern Canada. The company's CEO concluded that by acquiring process printing technology they would be able to garner additional business from some of their existing clients who will be able to meet their local process printing demand.

RP had considerable knowledge in printing-related technologies. The proposed process printing technology would allow them to print several colors at a time as opposed to line printing which allowed just one color at a time. This technology was clearly needed for meeting client requirements. The new process printing presses that were available were capable of printing 10 different colors, and they could run at

2,000 ft/minute. However, these capabilities were in excess of the demand laid by RP's packaging business, and the firm felt that a used or older model press would be sufficient. A leading packaging manufacturer in Western Canada, RP was closely connected to several printing machine manufactures and their agents who had been providing information on process printing and regularly approached the firm to sell their technology. The new business expected from the deal was estimated to generate approximately $3 million in revenue a year. However, with an average price tag of $4 million for a new printing press this was not considered a financially viable approach.

The firm found that process printing at 800 ft/minute with a range of eight colors would be more than sufficient to meet the demands of RP's clientele. This prompted the company to initiate a TT project to acquire process printing technology that suited its needs. The firm created a cross-functional committee of top executives to oversee this project. This committee included major functional managers who were deemed to have a key role in the process. These managers included the printing manager, since he had experience in process printing; the sales manager, so that he would be aware of the new process and products that could now be sold; and the production manager.

Gate 1: confirming identified technologies. Since the CEO initiated and championed this project, the go-ahead was given relatively easily by the board which was essentially comprised of the firm's owners. Adequate funding was also allocated for this new process as this technology was deemed a strategic investment. The key argument, which provided a strong business case to acquiring the new printing technology, was that it allowed them to strengthen their reputation, grow their business, and increase their bargaining power both locally and globally.

Stage 2: focused technology search. As indicated earlier, RP had maintained frequent and close contacts with the sales agents of original equipment manufacturers. This helped them to get quotes on different presses. However, most of these suppliers have moved ahead in terms of RP's identified technology need. They, therefore, never completed a full evaluation of their suppliers. At the time of their research for this project, the firm also found three brokers that bought and sold used printing presses. Although RP was in contact with these brokers they were not able to come to an agreement. Internet-based research proved to be RP's most successful tool as it helped them recognize the press which they finally purchased.

Interestingly, the company saw the printing press as a transfer of a machine rather than as a transfer of technology. RP's focus on the machine rather than the transfer of technology, proved to be their largest downfall, as they took a learn-and-solve as you go approach. This also affected the post acquisition lead-time in putting the technology to use. The committee never considered seeking assistance from technology intermediaries and/or government institutions.

The committee considered this as a simple project and assumed that they had adequate in-house expertise. RP did not investigate the opportunity of applying for the tax concession plans or any other program support offered by the provincial and federal governments to SMEs.

Gate 2: project confirmation. Through their analysis and research the committee established the need for a used process printing press. Although new machines had higher printing capabilities and output, they exceeded both RP's client demands and

budget. The machine RP agreed to acquire was a ten-year-old lease return from a Wisconsin-based subsidiary of GE. The machine was originally manufactured by Bielloni of Italy, a leading supplier of printing technology; the specific model type was Lisa-95. There were no trade barriers to the purchase as it was bought from the USA which is one of the NAFTA countries. The only issue that arose was that some repairs and maintenance were required on the machine.

4.2 Planning

Planning is the second phase in TT projects. This phase begins after the firm decides on the technology to transfer. This phase is focused on drawing the blueprints of how the TT project will be executed and evaluated in the next phase. This is an important phase of the TT process that provides a structure to the future activities. It consists of two stages and gates, as further described below. The firm negotiates the finer details of the TT agreement and puts a plan in place for TT. It is a critical phase, as we found out in this case where the firm failed to incorporate several key components of TT in their agreement with the transferor and in their implementation plan.

Stage 3: negotiation. In this TT project, there were only two parties involved: RP (transferee) and GE (transferor). Due to similarity of trade systems, the negotiation process was relatively simple and easy. The CEO of RP had more than 20 years of experience in the industry, which allowed him to accurately estimate the price of a second-hand lease return printing press. At the end, RP was able to acquire the machine for half the originally quoted selling price of the press. The transferor wanted to get rid of the printing press, and agreement was reached on price. For the transferor this price was still a good deal as it was just over the lease buyout price.

The negotiations were limited to price. There were no discussions regarding warranty, parts, or servicing. If a new printing press had been acquired, there would have been several negotiations regarding warranty, parts, support, and maintenance. However, this purchase was seen only as the purchase of a piece of machinery; therefore, no other information was sought.

Codified knowledge pertaining to operations and maintenance was expected to be transferred through operating manuals. These manuals would include the original manuals from when the machine was originally purchased ten years earlier. The manuals were in English, as the machine was acquired from within the USA. Interestingly, no agreement was put in place to transfer un-codified knowledge, and this created delay in latter stages when the firm tried to put the technology to use.

Lean communication was the form of communication throughout the entire process. This was not the ideal method. All discussions were done through telephone calls, and confirmations were processed through email. Senior RP executives traveled to Wisconsin to visit GE's factory to see the machine.

No major barriers were seen in the government policy or regulations, as this was simply a transaction within countries bound by NAFTA. Both companies were familiar with cross-border transactions, and this did not pose any difficulty.

The transfer mechanism selected was the purchase of plant and machinery. This was as simple as RP sending the money and GE sending the machine in return. The machine was stored in a warehouse; GE paid for the load up, and RP covered the shipping. RP had to send the full payment for the technology before the transferor

would send RP the machine. RP had enough finances to cover the cost of the machine. As soon as the money was received, GE arranged to send the printing press to RP.

Both parties were familiar with this type of transaction. As both companies were involved in cross-border transactions regularly, this did not create any problems. The entire agreement took two weeks and was completed quickly. There were no intellectual property issues to be dealt with in this agreement.

Gate 3: finalizing and approving agreement. This gate did not pose difficulties due to the continuous communication between the parties. The agreements were approved quickly. Both parties treated this project as a simple purchase of plant and machinery. The transferee was eager to acquire the technology to start production of a new product line, and it appears that they did not pay enough attention to components of technology (i.e. the knowledge required to operate, organizational changes required, technical know how) other than getting the machinery.

Stage 4: preparing a technology transfer project implementation plan. Before the machine was purchased, RP had to rearrange the plant layout to incorporate the new piece of machinery. A hole needed to be dug, and a large slab of concrete poured. Also, a natural gas line was installed, and the ventilation system was upgraded to account for the increased exhaust fumes. A lot of physical changes had to be made to the plant. With the printing press came the need for a better artist. The organization was fortunate that a spouse of one of the employees was trained in this profession. She was easily hired and filled the role perfectly.

The operating instructions in the manual and standard operating procedures had to be assimilated by the operating and printing managers. RP had the practice of carefully recording such instructions for training purposes. They had adopted a similar approach in previous TT projects, and the managers knew how to record and codify relevant materials for updating the knowledge management system.

It was decided to carry out training in house. The printing manager, who was quite familiar with the technology, developed the training plan and conducted all training in house. This included safety considerations, machine operation processes, and adjustment processes.

As mentioned earlier, this was treated simply as a business transaction to purchase a piece of machinery. RP was confident that they could handle the installation and operations by themselves. No specific measures appear to have been taken and none were negotiated initially.

Lack of interest in formulating a realistic TT project implementation plan proved to be detrimental. The only relationship between RP and GE was purchase and delivery. Since there was no established relationship, RP did not receive any additional support with its new technology.

The main milestone was the delivery of the machine and installation. The new piece of machinery showed up disassembled on seven semi trucks. The installation process went relatively trouble free and was finished slightly behind schedule. However, it took the firm several more months to integrate the machine into its production process and put the machine to actual use.

Gate 4: transfer schedule finalization. It appears that this gate did not cause any delay, and approval was granted. Management felt that since they had assembled an experienced team of senior managers and technical staff they could expect implementation without delay.

4.3 Execution and evaluation

This is the last and final phase in TT projects. The complexity of the TT project in this phase depends on how well the firm executed the previous phases. The firm relies heavily on the ground work done in those phases to execute this phase well. The transferee firm comes to terms with the new technology and associated change in this phase. When the transferee puts the technology to use they may uncover several contextual challenges. The firm reminisces and evaluates the TT experience in this phase. Successful outcomes and knowledge gained in this phase often lead to extensions and future projects.

Stage 5: implementation. The process itself was very standard, but one issue that occurred was with the inks. The inks had been tested at sea level and the result was that the bulk of the research and knowledge were only effective at that altitude. As Calgary's altitude is significantly higher, the result is that the inks evaporate differently. This caused them to perform differently than expected; after experimental testing the product eventually worked in line with expectations. Due to the altitude in Calgary and the lack of local suppliers of high-end printing plates, RP faced this challenging issue. Through substantial trial and error procedures, RP finally adapted an ink for the change in altitude, as the industry standards were all tested at sea level.

The process printer required high-end printing plates that could not be found locally. After several low quality batches with blurred and distorted images, RP concluded that the standard printing plates were insufficient. The major issue with upgrading the printing plates was that the only supplier was in Eastern Canada. With only one company in North America that repairs these highly specific printing presses, any critical work could require a year of waiting time. Another major issue was lower quality of the standard ink. The new ink for the process printing press was three times the price, and this was not calculated in the initial expenses. However, each of these steps had to be integrated in order for the process printer to perform to industry standards and client expectations.

RP was very fortunate to have staff in the facility that were trained and experienced in running the new press. The only issue that arose was acquiring an artist to create the complicated artwork associated with process printing. Fortunately, they were able to hire someone close to the organization to fill this role and did not have to allocate many resources to recruit this individual. The transfer project was treated as an addition of a machine to their existing production process. The workers were reallocated to the new process. There were no major changes in the remuneration structure.

RP viewed this only as the purchasing of machinery, and it never became obvious to them that any type of government intervention was an option. However, at the time of the transfer, the provincial government had introduced several policies that aid creation of new jobs and adoption of new technologies through grants and/or tax benefits. Firms may stand to lose a significant opportunity if these grants and tax benefits are not explored.

The printing press had arrived on time. There were few problems in installation as RP's implementation team, which had little installation experience, damaged the drum during the installation. However, even when the drum repairs were taken care of, it took the implementation team over a year to gets the printing press running to its potential. The lack of un-codified knowledge transfer meant that the firm had to

integrate the technology itself. This elongated the implementation process by six months over the expected time.

Gate 5: implementation audit. When it came to problem solving, or any issue for that matter, the transferor did not play any role after the shipment arrived. RP had expected there would be minor issues with the printing press as they were buying a ten-year-old press. Initially, the main issues were the bearings not running 100 percent; this was a quick fix and the least of their worries. Running the printer in process printing mode and understanding all the inputs required was the main issue. After 12 months of trial and error, the press was running at full capacity in the process printing mode. All problem solving had been undertaken by RP.

Stage 6: technology transfer impact assessment. No new measurements needed to be developed as RP already had measurements in place on the impact that customers had with the business. RP had a very extensive system for performance measurement that was applied on a machine-by-machine basis with customized parameters. As a result, RP had more than enough data so that any issue could be assessed quickly without any real problem. When the new printing press came and they started measuring all the costs involved, the startup cost was substantially more than expected. Once the machine was up and running, it took several months before they received any revenue from it.

However, the initial plan to supply the output of the process printer to the client whose order initiated this TT project was short-lived this client was soon purchased by a US-based company which had in-house process printing capabilities. Fortunately, they were able to find new customers that allowed them to cover the initial costs. Although profits were slim, in the initial two years they were still able to make a profit from the process printing press.

RP has concluded that the reason they were unsuccessful was due to the initial lack of knowledge in process printing. It took RP over a year to understand the process printing process; this meant that revenues took more than a year to initiate. As a result, significant amounts of money were lost in the initial year.

Corrective measures were needed as the firm learned more about the new technology. The fact that the firm was unsuccessful in turning their profits to the expected level suggests that the corrective measures were ineffective. At the time of the research, RP was in the beginning stages of the learning and operational areas of the technology. RP's main aim was to master the operations of the machine rather than making changes in the design of the machine.

RP decided to focus on correcting their existing process and finding new customers for products manufactured using the new technology. When the study was conducted, they did not have a plan to improve the transferred technology or search for another TT project.

Gate 6: developing guidelines for post-technology transfer activities. Based on the experience of this project, the president of RP felt that it could have managed the TT project differently. He felt that RP should have acquired a brand new machine with warranty. The possibility of acquiring auxiliary items to supplement the process printer was considered; however, no firm decision had been taken.

5. Discussion and conclusion

We used the stage gate approach provided by Jagoda and Ramanathan (2003, 2005) to study the TT experience of RP in this paper. Based on the application of stage gate

approach to this case, the following key issues affecting the success and failure of TT at each phase were identified. In general, the TT process was carried out relatively well in the initiation phase where most of activities identified by Jagoda and Ramanathan for the two stages in that phase were carried out by RP. Being in the industry for more than two decades helped RP as the firm was able to identify the appropriate technology. However, as this project was started as a response to a new customer request, limited effort was out to develop an extensive business case. The firm did not evaluate fully the options and potential benefits of acquiring a state-of-the-art process printing technology. It also appears that RP under estimated the resources required for operating the older technology they eventually acquired from GE. For example, they had not taken into account the graphic designer's position which had to be created to support the operations of the process printing technology. We found that the following key issues could be linked to the activities specified by the stage-gate approach in the initiation phase:

- The close contacts and frequent communication between top-level managers helped to easily establish and operate the TTSC at stage 1. Being closely knit, the top management team informally shared information on various aspects – such as financial, operational, and marketing – thereby reducing delays. The experienced members of the TTSC were able to identify and evaluate the resources available in house and the gaps that needed to be filled at stage 2.
- Knowledge and experience in other printing techniques and good knowledge of the local market and customer requirements helped the transferee to identify technologies needed. Strategic changes in the product portfolio were a major factor in the decision to acquire new technology.
- RP did not develop a comprehensive business case in gate stage 1. Also, gate 2 did not question the assumptions made in developing the case, due to the eagerness of top management to acquire printing technology quickly and en-cash the available business opportunity from new customers. A tacit assumption had been made that new customers would provide enough business to cover the initial cost. There was no elaboration on customer expectations, and there was no evidence that the transferee looked at alternative scenarios.
- It appears that the transferee had overlooked Asian suppliers from whom it could have obtained the machinery at lower cost. One reason for this restriction was, however, that the transferee was reluctant to experiment with unknown suppliers and buying something within the NAFTA countries was easier.

Compared to the initiation phase activities specified in the stage gate approach in the planning phase were carried out poorly by RP. Negotiations made were focused mainly on the price and other key factors such as transfer of un-codified knowledge were ignored. It appears that due to the apparent urgency created by the need to fulfill market requirements, the TTSC decided to accelerate this phase and move quickly into the next phase. Several key activities therefore were either poorly performed and some of them were even completely overlooked. We found that the following key issues could be linked to the activities specified by the stage-gate approach in the planning phase:

- The availability of a trained and educated workforce in house was an important component. In addition, RP was easily able to find the required skilled workers not available in house (graphic designer). This helped the company to implement the project without a delay.
- The decision to acquire used machinery without any agreement for un-codified knowledge transfer also created problems in installation as operations procedures had to be adapted and developed afresh. This could have been avoided by purchasing new machinery with warranty.
- As the transferee had limited contacts with the original equipment manufacturers of technology, it was difficult in stage 3 to develop an appropriate plan to transfer codified and un-codified knowledge. Relying on RP staff to uncover this knowledge caused several problems in stages 5 and 6 that delayed the deployment of the technology. This eventually forced the transferee to develop the procedural manuals by themselves. The transferee's late changes to the loading system made it necessary for the transferee to redesign the system and this caused delays in implementation. Lack of a proactive knowledge search in the initiation phase (stages 1 and 2) could be partly attributed as a cause of this problem.

As outlined in the model, non-fulfillment of activities in earlier phases created difficulties at the execution and evaluation phase. Although RP was able to integrate transferred technology into their technology portfolio, it would have been more effective if they have followed the stage-gate model. Evaluation seems to be carried out poorly:

- It also appears that the transferee did not carry out a proper TT impact assessment at stage 6. An assessment that examines the impact of the TT on productivity, quality, output, costs, profits, process performance, skill upgrading, customer satisfaction, etc., would be valuable in planning future TT projects.
- The transferee was not able to achieve the technological targets in stage 6, due to problems in the installation and operation of the machine in stage 5. An appropriate implementation audit was not carried out, and the targets were not set with linked timelines. This omission in stage 4 made stage 6 difficult.

The stage-gate approach provides a normative framework for planning and managing a TT project. It is envisaged that if top management and planners of a TT project use the proposed stage-gate sequence and carry out recommended activities, then problems can be minimized and, wherever needed, proactive means can be taken to avoid problems. This case provides interesting facets of an international TT within the region covered by NAFTA. The failure factors bring out two significant points. Firstly, there is a crucial need for planners of TT projects to develop good skills in analyzing the TT initiative in relation to business results by critically examining customer and market expectations. Secondly, when new technologies are being brought in to cater to a new market, parallel efforts in market development are needed to ensure congruence with technological efforts. A TT project cannot be considered to be effective unless it also leads to profitability and growth for the firm. In today's global business setting,

TT should be seen only as a component of business strategy and not in isolation as a technology project.

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