CUSTOMER FAMILIARITY WITH NEW INDUSTRIAL PRODUCT TECHNOLOGY AND ITS INFLUENCE ON ADOPTION: THE CASE OF DE BEERS DIAMOND EXTRACTION EQUIPMENT[#]

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ABSTRACT

An investigation was conducted into the influence of industry customers' familiarity with new technology on their decisions when purchasing discontinuous industrial products. This was done in the context where the supplier and customer organisations are entities in the same company. Even in this favourable context, continuous products remained successful despite a better solution being available. Literature on this close type of relationship is sparse, mostly because information on such internal processes is generally regarded as competitive. The case investigated was the DebTech division of De Beers, and their experience with products that they design and manufacture for the global diamond mining industry. Product developer and customer data from applicable projects was analysed, and interviews and observations were conducted. The results indicate that familiarity with the product technology favourably influences perceptions of newness, safety, and the ease of integration of a product. Familiarity increases customers' propensity to recommend and purchase new-technology products.

OPSOMMING

Die invloed is ondersoek van vertroudheid met nuwe tegnologie op nywerheidskliënte se aankoopbesluite van diskontinue nywerheidsprodukte. Dit is gedoen in die konteks waar die verskaffer- en kliëntorganisasies entiteite in dieselfde maatskappy is. Selfs in hierdie gunstige opset is ervaar dat kontinue nywerheidsprodukte meer verkoop, al is 'n beter oplossing beskikbaar. Literatuur oor hierdie tipe verhouding is skaars, hoofsaaklik omdat inligting oor sodanige interne prosesse normaalweg as mededingend beskou word. Die geval is ondersoek van die DebTech-afdeling van De Beers se ervaring met produkte wat dit vir die internasionale diamantmynbedryf ontwerp en vervaardig. Produkontwikkelaar- en kliëntdata van toepaslike projekte is ontleed, aangevul met onderhoude en waarnemings. Die resultate toon dat kliënte se vertroudheid met die produktegnologie hulle persepsies van nuutheid, veiligheid, en integreerbaarheid van nuwe-tegnologieprodukte gunstig beïnvloed. Tegnologievertroudheid verhoog hulle geneigdheid om nuwe-tegnologieprodukte aan te beveel en te koop.

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1. INTRODUCTION

Companies innovate to achieve and maintain a sustainable position in their markets. Technological innovation is an important strategic element for this purpose. This also holds true for the industrial equipment market. However, as long ago as 1979 Cooper [5] observed that the high incidence of industrial new product failure had long been acknowledged. After a much-quoted empirical study on the dimensions of new product success and failure experienced by industrial product producers in Ontario and Quebec in Canada, he stated that the secrets to success in industrial product innovation remained a mystery, as the problem was very complex. In 1998, based on a study of seven discontinuous product projects targeted at consumer, commercial, and industrial markets, Veryzer [21] found that lack of familiarity was a key reason for customers resisting discontinuous ('really new') products. That this remains a challenge is evidenced by a study, reported as recently as 2011, on customers' information needs during innovation adoption (Talke & Colarelli O'Connor [19]). Similar resistance to technology innovations led to recent research in the industrial project [13] and industrial service [12] domains. A discontinuous (radically innovative) product is less likely to succeed because of insufficient understanding of the complex qualitative reasoning that the customer tends to pursue in arriving at the decision to procure it. The two classes of technology involved, also referred to as evolutionary and disruptive (Tolfree & Jackson [20]), influence the decision-making process, as any new acquisition has an impact on the existing business environment.

The first author also observed the phenomenon of unexpected sales failure of discontinuous products at DebTech (De Beers Technology), a subsidiary of the De Beers group, while employed as an electronics engineer working with information relating to continuous and discontinuous products developed over the previous decade. Even in this favourable context, continuous products remained successful despite a better solution being available. Literature on this close type of relationship between product-developing and customer organisations is sparse. This can be ascribed to a significant degree to information on such internal processes normally being regarded as competitive [22]. Against this background, it appeared that a case study on this phenomenon could be a useful resource to assist further research in this context.

De Beers is the world's leading diamond mining company, with operations in Africa, Russia, and Canada. It is made up of many companies in various geographic regions. DebTech is the technology division, forming the research and development arm of De Beers. It has an annual turnover of USD 30 million and a staff complement of about 150 – mainly engineers (2008). More detail on the industry context can be found in [14] and [2]. The main focus of Debtech has always been the diamond industry. It was formed in 1948 as part of the De Beers Diamond Research Laboratories, and is based south of Johannesburg, South Africa. DebTech competes with free market equipment suppliers, since the operations are not obligated to purchase exclusively from DebTech. Competitors such as Flow Sort and Ultrasort have become significant players in the diamond-sorting equipment supply industry.

For the first 60 years of its existence, DebTech's products and services were available only to the De Beers family of companies around the world; but in 2008 it started making selected products and services available to the broader market. These included diamond x-ray sorting technology, the Scannex low dose x-ray body scanner, the magnetic roll separator, dense-medium controllers, and its metallurgical service. More than 400 products currently operate in the many De Beers mines. These products have been researched, developed, and manufactured, and are serviced and supported, by DebTech. It procures from key technology suppliers while implementing products in collaboration with relevant De Beers business partners. Different equipment uses different technologies such as laser, x-ray, nucleonic radiation, and induction. More than 99% of De Beers' diamonds are recovered by DebTech technology, with some of its units having been in operation for more than 20 years. DebTech also offers a full after-sales service.

Robertson [16] details the classification of innovations as continuous or discontinuous as follows:

- A *continuous* innovation has the least disruptive influence on established behaviour patterns. Alteration of a product is involved, rather than the establishment of a new product.
- A *dynamically continuous* innovation has more disruptive effects than a continuous innovation, although it still does not generally alter established behaviour patterns. It may involve the creation of a new product or the alteration of an existing product.
- A *discontinuous* innovation involves the establishment of a new product and of new behaviour patterns.

By classifying the product range of DebTech as continuous or discontinuous, this study seeks to determine whether the continuous or discontinuous technology on which the product is based is related to its sales via the factor of technology familiarity.

Rogers [17] deals extensively with the effect of the attributes of innovations in a more general context: on their rate of adoption, in the categories of relative advantage of the innovation over its predecessor; compatibility with existing values and experiences of customers; complexity; trialability (degree to which it can be tried out, experimented with); and observability (degree to which its results are visible to customers). Familiarity would be related to, or be promoted by, these characteristics.

A distinction should be made between the familiarity that the developing firm has with the new technology, and the technology familiarity of the potential adopter. Danneels & Kleinschmidt [6] deal with the former in an analysis of 262 industrial projects from 125 firms, concluding that it does not correlate with enhanced market performance.

In recent work on customers' information needs during innovation adoption in a sample of 112 industrial product development projects in Germany in six broad industry categories, Talke & Colarelli O'Connor [19] found that technical message elements were counter-effective, while usability information and financial arguments were highly relevant to market performance. In a recently-published case study on Fujifilm Corporation's domination of the medical computed radiography market since introducing digital medical x-ray imaging systems in 1983, Koh & Miki [11] concluded that Fujifilm's success over five major competitors was related to their devoting significant resources towards tailoring their communication to the customers' evaluation axes. Athaide & Klink [1] studied seller-buyer relationships during new product development in 334 small- to medium-sized firms in technology-based industrial settings. One of the situational characteristics considered was that of buyers' unfamiliarity with the innovation's underlying technology. However, this did not result in outright preference for any particular relationship. Talke & Hulting [18] investigated the influence of addressing a broader set of stakeholders than only customers in managing diffusion barriers related to industrial product launches. In a cross-industry study in Germany, they collected data from 113 new product development projects. While finding support for targeting multiple diffusion barriers, lowering customer adoption barriers remained dominant.

Similar challenges were encountered in inter-company knowledge transfer of discontinuous product technologies, such as those found in studies on industrial equipment product development projects in the United States [4]. In the case of 3M Corporation [7], a dedicated technology transfer group is proposed in the context of a large corporation with widely diverse products in multiple sectors. Against the background of the above information from broader markets, this study sought to determine – in an intra-company relationship between industrial product supplier and customer – whether the customer's technology familiarity was a relevant factor to take into account, and to which to allocate resources, in planning product development. This type of relationship is not uncommon in the minerals processing environment. It differs from that of independent companies developing and supplying industrial equipment, or of the inter-company situation in the large diversified corporation covered in existing literature.

1.1 Objectives

These observations from industry led to a statement of the research problem: Discontinuous industrial products appear to be less readily purchased by intra-company industrial customers than would be expected by product developers.

The research questions derived from the research problem and the related literature survey were:

- Does a lack of familiarity with a new technology lead to intra-company customer resistance to acquiring discontinuous industrial products using the new technology?
- How does the level of familiarity with a technology influence the level of recommendation for that technology when embedded in an industrial product?
- How does the level of familiarity with a technology influence the perceived level of newness of that technology in the context of industrial products?
- How does the level of familiarity with a technology influence the perceived level of safety of that technology in the context of industrial products?

By answering the research questions, the objective of this study was to understand whether, and to what extent, enhanced technology familiarity would influence the adoption rate of discontinuous industrial products. The resulting proposition is:

- *Lack of familiarity with a new technology leads to intra-company customer resistance to discontinuous products using the new technology.*

1.2 Factors that affect product sales

It is recognised that many factors influence whether or not the customer decides to purchase products. Cooper [5] lists 21 variables in five groupings from prior work on new product success, and continues to study the effect of 18 empirically. Rogers [17] lists five categories of variables determining the rate of adoption of innovations, including the perceived attributes detailed above. In summary, some of the customer factors that affect product sales are the customer's economic environment, demographics, and environmental concerns. Product factors include quality, value for money, performance, after-sales support, compatibility with the customer business, and technology and product familiarity.

Based on the literature above, technology familiarity was proposed as an important factor contributing to discontinuous product sales in the context of the case studied.

Based on Park & Lessig's work [15] on product familiarity, it is proposed that technology familiarity can be measured by:

1. *How much a person knows about the technology,* and
2. *How much a person thinks he/she knows about a technology.*

From this logic, the following working definition of technology familiarity was adopted for this study:

> *Technology familiarity is the acquaintance with or knowledge of a product, process, tool, or method employed in the creation of goods or services, based on previous interactions and experiences that a person has, or is assumed to have.*

It appeared that a gap existed between past research and that of the topic of this case study: technology familiarity within the context of a long-standing intra-company relationship between industrial product supplier and customer. Little information could be found that analysed unfamiliarity and its effect on continuous and discontinuous innovation of products. The intention was for this case study to add to the body of knowledge on the effect of customer familiarity with new technologies on the adoption of discontinuous products incorporating those technologies.

2. CONCEPTUAL MODEL

Using a linking logic structure recommended by Cavaness [3], a diagrammatic model (Figure 1) was constructed to represent the conceptual elements, the relationships between them, and the attributes of each element. The identified components that make up product and technological unfamiliarity, particularly regarding discontinuous products, are listed. Sources of information for the research and items that would need to be addressed are listed, and the guideline theories to be employed are indicated.

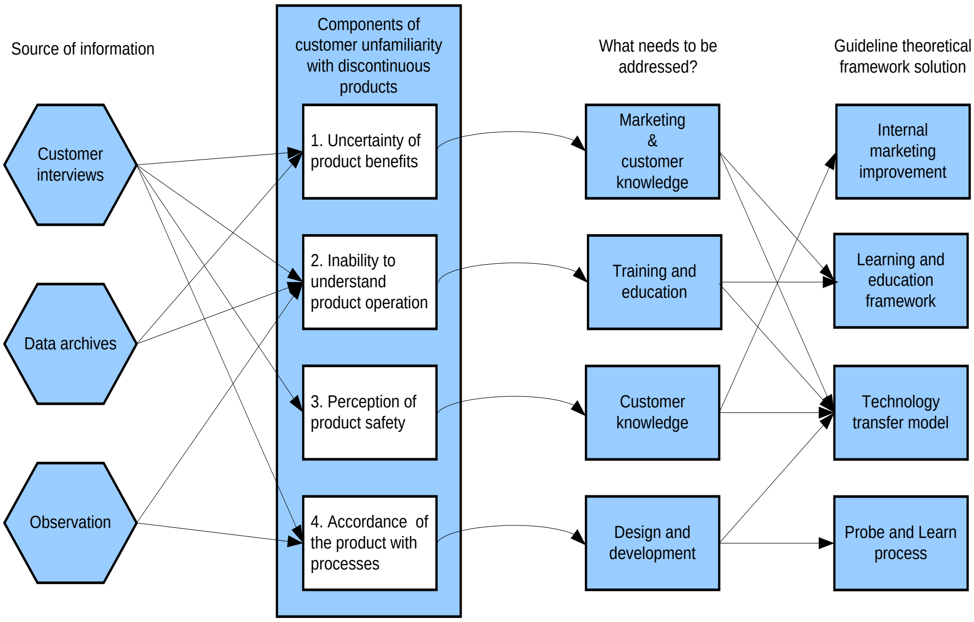

Figure 1: The conceptual model

3. RESEARCH METHODOLOGY

3.1 Type of research

A single case, DebTech's development of continuous and discontinuous technology products, is investigated. The single case approach was assessed to be appropriate because the input was perceived to have been the same in the instances considered, yet the outputs differed. Also, the input was from a compact focused entity with a long-established method of operation, so its work methods in general could be assumed to be coherent and consistent, not presenting less obvious or hidden variables that were not accounted for. According to Hussey & Hussey [10], the case study approach provides for an extensive examination of a single instance of a phenomenon. It provides for rich detail by allowing a phenomenon to be explored within a particular context.

According to Flyvbjerg's [8] classification of case selection, the case study presents the characteristics of a critical case, i.e. providing information that permits logical deductions of the type, "if this is valid for this case, then it applies to all cases". This is proposed because of the close relationship over an extended period of time and the levels of trust in DebTech evidenced by the adoption of its continuous-technology products. If technology familiarity is a hurdle even in this favourable adoption environment, it is also likely to be so in a large body of supplier-customer relationships, whether long-standing or more recent.

Flyvbjerg [8] also points to the potential benefit for enhanced learning when the researcher is within the context that is being studied, thus gaining advanced understanding. Experience indicates that the case study method contains a greater bias towards falsification of conceived notions than towards verification.

3.2 Methods of data collection

Being a case study, various methods of data collection were used to obtain answers to the research questions. Case study research theory [22] indicates using evidence from multiple sources for the investigation. The data collection approach consisted of collecting evidence from DebTech's project database documentation and archives; interviews with DebTech project managers, senior staff and customers; a customer questionnaire; informal discussions; and direct observation. More detail on these data sources is provided below.

3.3 Triangulation of data sources

Yin [23] advises on achieving triangulation by using multiple sources of data to obtain convergence. Since different methods have their own strengths and weaknesses, multiple sources of data that converge on the same deduction strengthen the findings of a case study.

As mentioned above, archive data, interviews, questionnaires, and observation data were employed to achieve triangulation. Observation and archival data were used to formulate the questionnaire questions. Feedback from the questionnaires was used as input to the questions for semi-structured interviews. The analysis and conclusions integrated the results from the observation, archival data, questionnaires, and interviews into a consistent set.

3.3.1 Data archives

Data archives at DebTech contain a comprehensive record of documents relating to many aspects of the organisation – from technical product make-up, to project management records, to sales and marketing information. The data archives store historical information that could not have been collated as primary data at the time of data collection for this study, because the people involved might no longer have been available. The archives were analysed to extract information relating to product sales, cost of products, relative competitor prices and technologies, technology employed in products, quantities of units sold, customer acceptance and feedback, and time-based acceptance of technologies employed in products. The fact that the data archives were so comprehensive enabled the researcher to skip (some) primary data collection and focus on deriving conclusions from the analysis of data gathered by many personnel over an extended period.

3.3.2 Questionnaires

Two questionnaires relating to the research questions and research variables were compiled and used to acquire feedback from DebTech staff and customer representatives. The questions are recorded in Table 1, questions 1.3 to 1.5, and in Table 2. The questions were designed to allow for category data to be provided, in order to limit ambiguity and ease completion, and so enhance the response rate.

The customer questionnaire was distributed by electronic mail to a selection of 26 DebTech customers from a population of about 40. The selected recipients were responsible for about 80% of DebTech's sales revenue. The customer mines not approached were smaller operations in remote locations around the world with limited Internet connectivity, that presented language barriers. Three customer questionnaires were completed in a structured interview format.

3.3.3 Observation

The purpose of using direct observation was to examine directly what people do, as opposed to asking for their verbal interpretation of what they do. Direct observation was used to verify respondent information obtained from interviews. It consisted primarily of monitoring trainee technicians and their reaction to continuous and discontinuous products, as each type was presented to them during formal product training sessions. It also included observations obtained from the DebTech training, customer support, marketing, sales, and engineering departments.

3.3.4 Interviews

Semi-structured interviews using the DebTech questionnaire were conducted with the DebTech customer support manager and with senior staff from training, sales, marketing, and engineering. This allowed comprehensively diversified views and assessments from all of the customer-facing functions. As mentioned above, semi-structured interviews were also conducted with three customer senior staff to obtain a deeper understanding of how respondents would interpret the questions.

The interviews allowed for person–to-person interaction, and the researcher could probe information given by the interviewee to obtain a rich understanding of the respondent's perception [9]. In this way, the interview methodology offered an adaptive means of obtaining new information that might not have been identified by a structured questionnaire.

3.4 Limitations and assumptions of the study

The scope of the study is limited to the intra-company context, as described above. It might not apply in closer supplier-customer relationships, or where one or more of the other factors described in paragraph 1.2 above exert an inordinately large influence.

4. RESULTS

All projects undertaken at DebTech between the years 1999 and 2009 – about 20 altogether – were considered for study by screening records in the data archives. This time period was selected because of the meticulous record-keeping, especially in electronic format, over this period. It was also the last decade in which DebTech's market was primarily the De Beers companies, allowing for a consistent intra-company supplier-customer relationship to be studied. Ten projects were excluded due to there being no company or customer staff still involved or available, or due to technical or sales failure. From the remaining projects, two technologies were chosen that would accurately represent a continuous and a discontinuous technology at a particular time. X-ray technology represented a continuous technology, and its product range could also be regarded as continuous in nature. It had been in the market for 31 years, with 40% of its sales occurring in the last five years of that period, showing increased sales as its later developments moved from being perceived as discontinuous to continuous. Laser technology represented a discontinuous technology, as its product range could be regarded as discontinuous. Examples of applications of the technologies are:

X-ray-based diamond sorter - The x-ray-based diamond sorter has a feeder assembly that conveys material in a mono-layer and allows free-fall down a chute. Here the aggregate passes through an x-ray beam that induces luminescent particles (predominantly diamond) to emit light. A detector assembly detects the emitted light. After a preset travel delay to the ejection zone, a corresponding air jet ejector is activated, and diamond and other luminescent particles are deflected into a concentrate chute for further sorting.

Laser Raman spectroscopy sorter - The laser Raman spectroscopy sorter is a single-particle sorter for final recovery of diamonds from x-ray concentrates. It replaces hand sorting. Single particles are sent through laser beams, where diamond particles shift the wavelength of the reflected laser beam in a characteristic manner. The shift is identified electronically, and the diamonds are ejected by a mechanical or air ejector to concentrate.

The x-ray and laser technologies have many similarities in market appetite, product size, complexity, cost to manufacture, and level of competency required (from the technical and support personnel) to operate and maintain the units. Because of these factors, a comparison between x-ray and laser technologies was assessed to offer an example of technology familiarity and its influence on customer resistance to new products that employ continuous or discontinuous technologies.

4.1 Feedback summary

4.1.1 DebTech data

Data extracted from the archives (Q1.1 and 1.2) and from interviews conducted with key DebTech representatives (Q1.3 – 1.5) was used to obtain the information regarding the research variables listed in Table 1.

Table 1: Research variables quantified by DebTech

Variable name	Measurement indicator	Results
Proportion of successful continuous products. (All technologies)	Q1.1. For what proportion of all continuous products developed has DebTech sold more than 1 unit?	Of a total of 7 continuous product ranges (limited to those developed over the last 10 years), a total of 6 product ranges have sold more than 1 unit. This represented a proportion of 0.9.
Proportion of successful discontinuous products. (All technologies)	Q1.2. For what proportion of all discontinuous products developed has DebTech sold more than 1 unit?	Of a total of 14 discontinuous product ranges (limited to those developed over the last 10 years), a total of 4 product ranges have sold more than 1 unit. This represented a proportion of 0.3.
DebTech technology newness rating. (X-ray/Laser)	Q1.3. How do you rate the newness of this technology? -New invention -Technology improvement -Mature technology -Aging technology	X-ray: Rated between mature technology and technology improvement Laser: Mature technology
DebTech safety rating. (X-ray/Laser)	Q1.4. How do you rate the safety aspects of this technology? -No risk -Low risk -High risk	X-ray: Low risk Laser: Low risk
DebTech integratability rating. (X-ray/Laser)	Q1.5. How do you rate the ease with which this technology can integrate with the customer environment? - Cannot integrate - Easy to integrate - Difficult to integrate	X-ray: Easy to integrate Laser: Easy to integrate

From these archive results, it can be seen that continuous products achieved a much higher sales success ratio than discontinuous products. The interview results showed that x-ray product innovations were assessed at the technology improvement (novel) or mature technology application level, with a low safety risk, and were easy to integrate. Laser technology-based product innovations were assessed at the same levels, except that technology newness was assessed at the mature level.

Perspectives gained from the DebTech interviews were:

Training: Only after comprehensive demonstration and familiarity with the new technology it brings, are customers' perceptions that it will cause additional work or disrupt existing workflow patterns removed, and they become keen to adopt it.

Customer support: Customers are very sensitive to the impact that a new technology will have on their facility. Mining plants are very capital intensive, and a change to a single piece of equipment may have severe repercussions on other pieces of equipment (from other suppliers) with which it integrates. New technology may require modification of the services (compressed air, chilled water, power). Because the decision regarding the procurement of large assets at the mine rests with an executive committee, a formal risk assessment is usually needed to propose any new technology. Yet customers actively require new technologies where the current technology is proving to have a negative impact on production output (technology pull).

Marketing: Cost of equipment plays a major role when a new mine is being constructed. Often separate teams construct and then operate and maintain the mine. The construction team usually prefers a reduced upfront cost (which reflects favourably on their project budget). However, when the team that operates and maintains the equipment makes the purchasing decision (as in the case of a facility upgrade), factors such as running cost, reliability, efficiency, and maintainability are most important.

Technology familiarity plays a minor role when the construction team makes purchase decisions, but a major role when the operating team makes this decision.

Sales: In the construction of a new mine or sorting facility, two types of teams could be involved with the project: either the owner's team, or the project team (usually consisting of a consulting project house). These two teams approach the selection of technology differently. The project team may be more aware of the latest technology available, while the owner's team is more concerned with getting the technology that fits their workflow and has the necessary track record of reliability and efficiency. The owner's team tends to stick with what they know. Any new technology must have advantages (cost, security) over the old, and must not require additional work – an issue that the owner's team is more sensitive to.

Engineering**:** Customer familiarity plays a major role in the design of new equipment. Often the underlying technology has to be masked with an easy-to-use interface. Complexity is hidden. The customer's perception of a technology is used to engineer the product. For example, if the inherent safety risk of a technology is a concern, then the engineering effort may focus on incorporating redundant safety sub-systems, or an external safety authority may be used to approve the design in order to build the customer's confidence in the product. Customer familiarity levels are determined before product development; they influence the design of the equipment in order to increase the likelihood of acceptance of the product.

4.1.2 Customer data

The customer responses reported in Table 2 were obtained from 13 respondents (three by interview) after distributing 26 questionnaires. Given the limited number of companies involved, and the advanced level of contextual experience of the respondents, it was assumed that the information obtained would support its summary interpretation in the sections that follow.

Respondents to the questionnaire indicated a 0.7 level of familiarity with x-ray technology (continuous technology) and a 0.2 level of familiarity with laser technology (discontinuous technology).

In the following sub-paragraphs, these familiarity ratings are compared with the feedback regarding the four dependent variables in Table 2, viz.

1. the level of recommendation for the technology
2. the perceived level of newness of each technology in contrast with the actual level of newness determined by DebTech
3. the safety rating of each technology
4. the integratability of the technology

Each is related to the applicable elements in the conceptual model in the relevant sub-paragraph below.

Table 2: Research variables quantified from customer responses

Variable name	Measurement indicator	Results: x-ray (Agreement*)	Results: laser (Agreement*)
Technology familiarity: Customer awareness of technology	Q2.1. Are you aware of this technology? (Y/N)	1.0	1.0
Technology familiarity: Customer knowledge of technology	Q2.2. Do you understand this technology? (Y/A little/N)	0.5	0.5
Technology familiarity: Customer comprehension of technology	Q2.3. Have you ever used this technology? (Y/N)	0.9	0.6
Technology familiarity: Customer application of technology	Q2.4. Does your workplace currently have this technology? (Y/N)	1.0	0.8
Customer technology recommendation rating	Q2.5. Would you recommend this technology for your workplace? (Y/N)	1.0	0.6
Customer technology newness rating	Q2.6. How do you rate the newness of this technology? ___ New invention ___Technology improvement ___Mature technology ___Aging technology	New: 0 Improving: 0.3 Mature: 0.5 Aging: 0.2	New: 0 Improving: 0.7 Mature: 0.3 Aging: 0
Customer safety rating	Q2.7. How do you rate the safety aspects of this technology? ___No risk ___Low risk ___High risk	No risk: 0.1 Low risk: 0.6 High risk: 0.3	No risk: 0.1 Low risk: 0.5 High risk: 0.4
Technology impact: Technology accordance	Q2.8. Does this technology seamlessly integrate with your workflow patterns? ___Cannot integrate ___Difficult to integrate ___Easy to integrate	Integrate: Cannot: 0 Difficult: 0.2 Easy: 0.8	Integrate: Cannot: 0 Difficult: 0.5 Easy: 0.5

* Level of agreement: 1.0 indicates all agreed; 0 indicates none agreed.

4.1.3 The level of recommendation of a technology

The level of recommendation of a technology relates to questions on both the 'Uncertainty of product benefits' and 'Inability to understand product operation', as listed in the conceptual model (Figure 1). The level of recommendation gave an indication of the number of respondents who would motivate for this technology to be purchased.

Taking the question *Would you recommend this technology for your workplace*?
The responses were as summarised in Figure 2:

X-ray technology: 10/10 respondents would recommend this technology.

Laser technology: 6/10 respondents would recommend this technology.

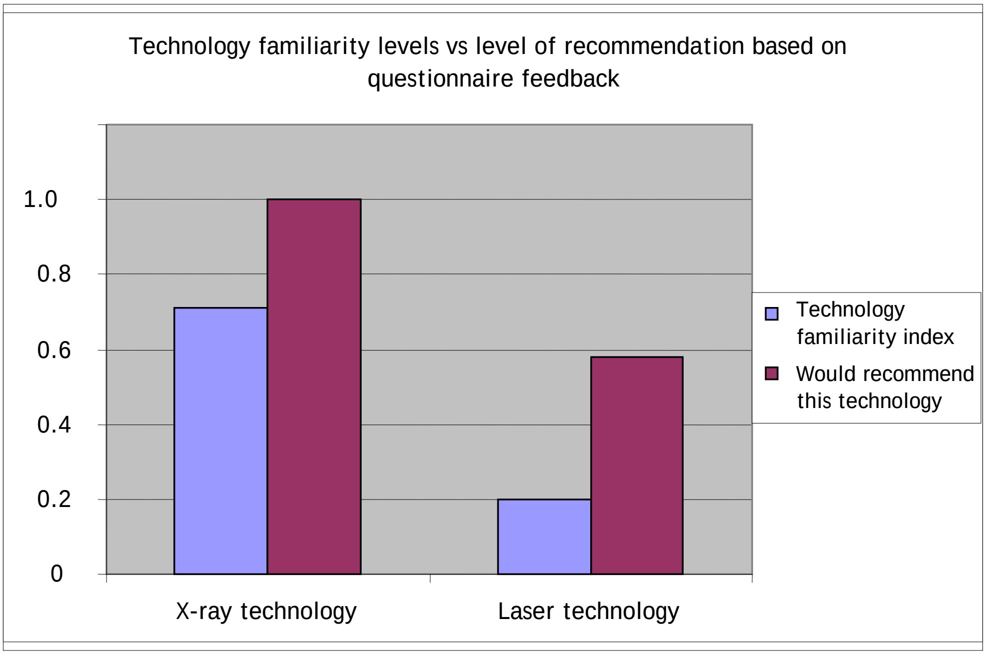

Figure 2: Technology familiarity levels and the levels of recommendation for two technologies

It can be seen that higher levels of familiarity with a technology correspond with an increased likelihood of recommending that technology.

Because the decision to purchase equipment for a mine is a collective one, higher levels of recommendation can be construed to increase the likelihood of a decision to purchase the product.

4.1.4 The perceived level of newness of a technology

The perceived level of newness of a technology relates to questions on the 'Uncertainty of product benefits' and 'Inability to understand product operation', as illustrated in the conceptual model (Figure 1). The rating of DebTech and that of the customer regarding the newness of x-ray and laser technology is shown in Figure 3:

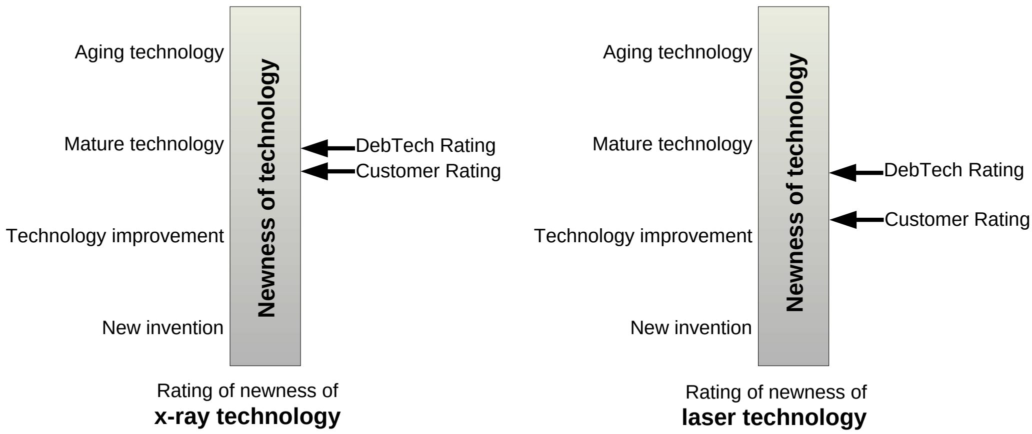

Figure 3: Rating of newness of technology by DebTech and the customer

It can be seen that in the case of x-ray technology, where the customer has a higher level of familiarity with a technology, the corresponding rating for the newness of a technology is closer to the DebTech assessment level. In contrast, in the case of laser technology, where the customer has a lower level of familiarity, the customer sees the technology as newer.

4.1.5 The perceived level of safety of a technology

The perceived level of safety of a technology relates to a question on the 'Perception of product safety' as illustrated in the conceptual model (Figure 1). The rating of DebTech and that of the customer regarding the safety of x-ray and laser technology is shown in Figure 4:

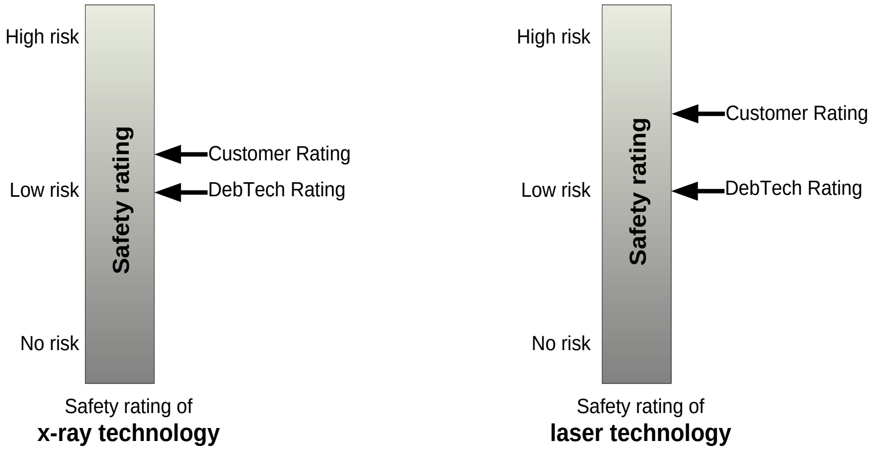

Figure 4: Rating of safety of technology by DebTech and the customer

In the case of x-ray technology (continuous technology), where a customer has a higher technology familiarity rating, the customer rates the safety level of this technology at a similar level to DebTech.

In contrast, the rating of the customer regarding laser technology (discontinuous technology) – bearing in mind that the customer has a lower level of familiarity with this technology – tends towards rating this technology as a higher risk. The indication is that when a customer is less familiar with a technology, the customer sees this technology as a higher safety risk. The DebTech rating is taken as the more reliable one because DebTech, as the manufacturer, has access to more extensive and reliable information to support its rating.

4.1.6 The perceived level of integratability of a technology

The perceived level of integratability relates to questions on 'Accordance of product with processes' as illustrated in the conceptual model (Figure 1). The respective ratings of DebTech and the customer of the integratability of x-ray and laser technology are shown in Figure 5:

Indications are that the more familiar a customer is with a technology, the more the integration of that technology into their workflow is seen as easy to accomplish. Customers are more likely to pursue such technologies, decreasing the resistance to products with this technology.

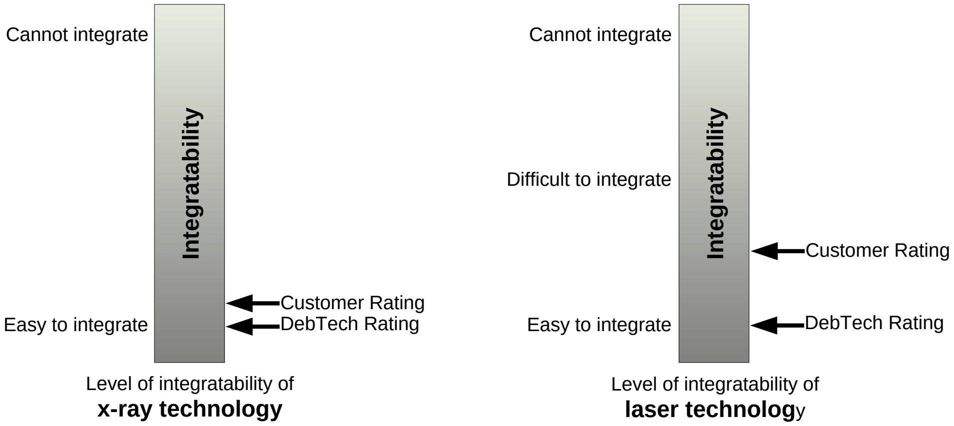

Figure 5: Rating of integratability of technology by DebTech and the customer

4.2 Familiarity, recommendation, and product sales

Taking the independent variable of 'technology familiarity' and the dependent variables of 'continuous products sold', 'discontinuous products sold', and 'level of recommendation', the relationships depicted in Figure 6 were deduced from the feedback to the questionnaire (and confirmed in interviews and observation). Product sales data was extracted from DebTech's data archives.

From Figure 6 it can be seen that higher levels of technology familiarity are associated with a higher likelihood to recommend that technology. Subsequently, with increased recommendation levels, more products (embodying that technology) are sold – as explained in paragraph 4.1.3.

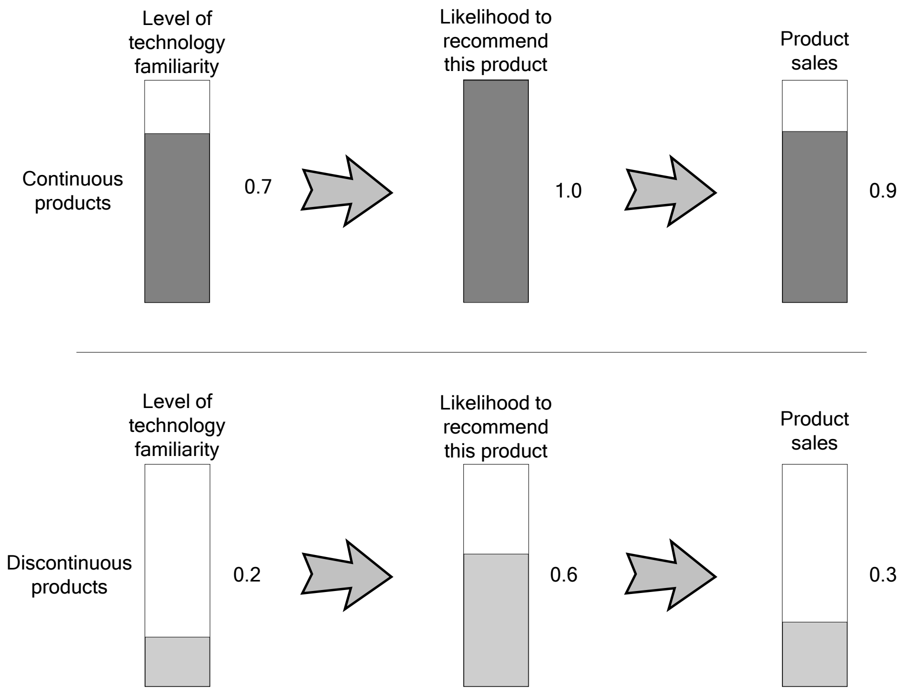

Figure 6: Relationship between familiarity, likelihood of recommendation, and product sales

5. CONCLUSIONS AND RECOMMENDATIONS

Even in the context of a particularly close intra-company relationship between the industrial product supplier and customer (as with DebTech and the De Beers mining operations), reduced customer familiarity with the technology on which the product was based was found to lead to elevated customer perceptions of the newness of the technology and reduced levels of safety and integratability in their operations, when compared with the assessments by the entity that developed the product. Reduced customer familiarity with the technology also led to reduced likelihood of recommending the product, resulting in increased customer resistance to purchase the product based on discontinuous technology. Product development managers in such contexts may be tempted to rely on intra-company allegiance, and not to allocate adequate resources to technology transfer. Consistent with the framework of the conceptual model, following a technology transfer process is crucial to addressing the disparities that exist between the capabilities of the recipient and the expectations of the technology provider.

Where the market is limited and homogenous, the developer would do well to design the solution to integrate fully with the customer work environment, incorporating solutions that would normally be beyond the scope of the product.

Where possible and appropriate, the masking of detailed complexity of a technology will prevent the customer from being overwhelmed by it, as indicated by the input obtained from the DebTech engineering department and supported by recent findings in [19] and [11]. Providing an easy-to-use interface can also assist with this.

The literature on discontinuous technology product adoption in the intra-company context appears to be sparse. The above case-based findings are presented as a potential resource to assist further research in this context. Additional research, preferably empirical in nature, is recommended to address the limited literature on the intra-company adoption of discontinuous technology based products.

REFERENCES

[1] **Athaide, G.A. & Klink, R.R.** 2009. Managing seller-buyer relationships during new product development. *Journal of Product Innovation Management,* 26, pp 566-577.

[2] **Bain & Company.** 2011**.** *The global diamond industry - Lifting the veil of mystery.* Bain & Company, Inc. and Antwerp World Diamond Centre private foundation (AWDC). Accessed via www 2012-06-13.

[3] **Cavaness, C.** 2004. *Programming Jakarta Struts*, 2nd edition. O'Reilly**.**

[4] **Colarelli O'Connor, G. & McDermot, C.M.** 2004. The human side of radical innovation. *Journal of Engineering and Technology Management,* 21, pp 11-30.

[5] **Cooper, R.G.** 1979. The dimensions of industrial new product success and failure. *Journal of Marketing*, 43 (Summer 1979), pp 93-103.

[6] **Danneels, E. & Kleinschmidt, E.J.** 2001. Product innovativeness from the firm's perspective: Its dimensions and their relationship with project selection and performance. *The Journal of Product Innovation Management*, 18 (2001), pp 357-373.

[7] **Figueroa, E. & Conciecao, P.** 2000. Rethinking the innovation process in large organizations: A case study of 3M. *Journal of Engineering and Technology Management*, 17, pp 93-109.

[8] **Flyvbjerg, B.** 2006. Five misunderstandings about case-study research. *Qualitative Inquiry*, 12(2), pp 219-245.

[9] **Frauendorf, J. & Kleinaltenkamp, M.** 2006. *Customer processes in business to business service transactions.* Springer.

[10] **Hussey, J. & Hussey, R.** 1997. *Business research: A practical guide for undergraduate and postgraduate students*. Palgrave Macmillan.

[11] **Koh, Y. & Miki, T.** 2011. *Technology innovations and customers' knowledge accumulations: Analysis in a case study of Fujifilm computed radiography*, Proceedings of PICMET '11, pp 1440-1446.

[12] **Korhonen, H.M.E. & Kaarela, I.** 2011. Corporate customer resistance to industrial service innovations. *International Journal of Innovation Management,* 15, pp 479-503.

[13] **Lehtimäki, T., Simula, H. & Salo, J.** 2009. Applying knowledge management to project marketing in a demanding technology transfer project: Convincing the industrial customer over the knowledge gap. *Industrial Marketing Management*, 38, pp 228–236.
[14] **Loch, C.H. & Tapper, U.A.S.** 2002. Implementing a strategy-driven performance measurement system for an applied research group. *The Journal of Product Innovation Management*, 19, pp 185-198.
[15] **Park, C.W. & Lessig, V.P.** 1981. Familiarity and its impact on consumer decision biases and heuristics. *The Journal of Consumer Research*, 8 (2), pp 223-230.
[16] **Robertson, T.S.** 1967. The process of innovation and the diffusion of innovation. *Journal of Marketing*, 31, pp 14-19.
[17] **Rogers, E.M.** 2003. *The diffusion of innovations*. 5th edition. The Free Press, New York.
[18] **Talke, K. & Hulting, E.J.** 2010. Managing diffusion barriers when launching new products. *Journal of Product Innovation Management,* 27, pp 537-553.
[19] **Talke, K. & Colarelli O'Connor, G**. 2011. Conveying effective message content when launching new industrial products. *Journal of Product Innovation Management*, 28, pp 943-956.
[20] **Tolfree, D. & Jackson, M.J.** 2007. *Commercializing micro-nanotechnology products*. CRC Press: Boca Raton.
[21] **Veryzer, R.W., Jr.** 1998. Key factors affecting customer evaluation of discontinuous new products. *The Journal of Product Innovation Management*, 15, pp 136-150.
[22] **Von Hippel, E.** 1988. *The sources of innovation.* Oxford University Press, New York.
Yin, R.K. 2002. Case *study research: Design and methods*. 3rd edition. Sage Publications.