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Technology Shift and Business Operation Interdependence: The Case of Internet in Securities Trading

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Abstract

Companies today use IT extensively, especially so in the financial industry. This makes managing technology an important management issue. When new technologies arrive managing technology shifts prudently becomes vital for gaining or sustaining competitive advantages. This paper addresses the interdependences between such technology shifts and the business operations by using the world wide web and securities trading as an example.

The first main argument made in the paper is that characterizing technology shifts as such is less fruitful than relating the technology shift to the business of the adopting company. What is a disruptive technology to one company may well be a sustaining technology to the next, even when the companies are by many standards quite similar.

The second argument made builds on a proposed distinction between the technology provider and the technology consumer roles and states that adopting certain technologies implies becoming a technology provider. It is illustrated how this adds an extra level of difficulty to technology adoption as one's business operations is extended to incorporate this new role. Hence, a technology shift may not only change the current business operations of a company, it may induce changes in what business the company actually conducts.

Keywords: technology shifts, innovation, securities trading

1 INTRODUCTION

The financial industry has been dependent on information technology (IT) for a long time (Garbade & Silber 1978) and still is (e.g. Evans & Wurster 1999). The importance of IT as a source for competitive advantage is well documented (McKenney & Copeland & Mason 1997). This is especially true for the transaction-intensive securities-trading branch of the industry. For instance, brokerage firms and exchanges interact in very intricate ways that are extremely technology dependent. It has been reported that securities trading firms spend about 20 percent of their total outlays on IT and trading desks as much as 50% of their revenue on IT (Dewan & Mendelson 1998).

The financial industry in general, and securities trading specifically, have been heavily affected by the Internet in terms of the world wide web, which has changed the basis of competition (Evans & Wurster 1999). In this paper the more specific example of the world wide web and its impact on the securities trading industry is discussed.

The rapid technology development causes significant challenges – what is state of the art today may be obsolete tomorrow. One important aspect of technology development is technology shifts, which will be discussed in this paper. The paper starts out by discussing the concept of technology shifts and how such shifts can affect market structures. The importance of the distinction between technology providers and technology consumers is then argued and illustrated using four brokerage firms. The specific example of the world wide web is then investigated before the paper ends with a discussion on the interdependence between technology shifts and business operations.

2 INNOVATIONS AND TECHNOLOGY SHIFTS

2.1 Different Views on Technology Shifts

A traditional distinction between different technology shifts is between radical and incremental shifts (e.g. Utterback 1994, Henderson 1993). Radical innovation means *"change that sweeps away much of a firm's existing investment in technical skills and knowledge, designs, production technique, plant, and equipment"* (Utterback 1994, p. 200). Henderson and Clark (1990) argue that the distinction between incremental and radical innovation is incomplete. Instead, they stress the importance of the degree of architectural innovation, which deals with reconfiguration of established systems, where the existing components are linked together in new ways, see Figure 1.

		Core Concepts	
		Reinforced	**Overturned**
Linkages between Core Concepts and Components	**Changed**	Architectural	Radical
	Unchanged	Incremental	Modular

Figure 1. A Framework for Defining Innovation (Henderson & Clark 1990)

Another approach to technology shifts, the concepts of sustaining and disruptive technologies, is introduced by Bower and Christensen (1995) and is discussed in greater detail by Christensen (1997). Sustaining technologies are characterized by improving *"the performance of established products,*

along the dimensions of performance that mainstream customers in major markets have historically valued" (Christensen 1997, p. xv). Thus, they tend to provide the customer with "more-of-the-same" regardless of how radical changes they may introduce. Disruptive technologies, on the other hand, have a different value proposition, offering new features that are compelling to a new group of customers. Often such technologies are weaker in other, traditionally valued, dimensions. Typically, products based disruptive technologies are "*cheaper, simpler, smaller and, frequently, more convenient to use*" (Christensen 1997, p. xv). A common trait for disruptive technologies is that the mainstream customers on a market often do not adopt them. Instead the technologies appeal to small special segments, or even completely new sets of customers, which were not attracted enough by the sustaining technology to bother to enter the market.

It is important to note that sustaining technologies can be either radical or incremental in nature. Thus, there is no direct mapping between sustaining and incremental technology shifts as one may be led to believe. The important difference between the sustaining and the disruptive technology lies in their value propositions, and not, as in the case with radical and incremental shifts, in how something is achieved.

Chandy and Tellis (1998) provide an even wider perspective on a product level as they identify the two dimensions technology and markets, see Figure 2. Technology, operationalized as "Newness of Technology", determines to what extent the technology used in the product differs from prior technologies. Market, operationalized as "Customer Need Fulfillment per Dollar", determines whether the new product fulfills key customer needs better than prior products, i.e. the customer or user is explicitly included in the discussion of the technology shift.

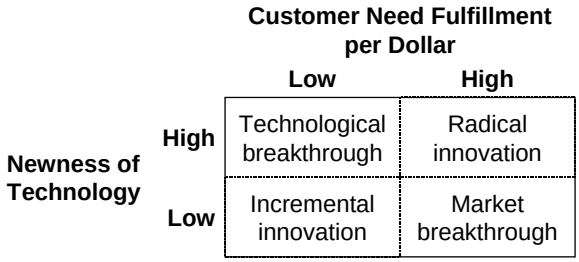

Figure 2. Types of Product Innovations (Chandy & Tellis 1998)

To sum up, there are different ways of characterizing technology shift. Where the incremental – radical distinction (Utterback 1994) focuses on the technology per se, the sustaining – disruptive distinction (Christensen 1997) discusses the value proposition of the technology. Chandy and Tellis (1998), finally, includes customer need fulfillment when discussing technology shifts. We will now turn to discussing technology shifts from a market impact perspective.

2.2 Market Impact of Technology Shifts

History has numerous examples (Clemons & Croson & Weber 1996, Cooper & Schendel 1976, Rosenbloom & Christensen 1998) of dominant companies losing their position when a new technology arrives. In every technology shift, two distinct perspectives can be discerned in a market, that of the inventor, or early adaptor, and that of established companies, the incumbent. In technology shifts that bring an end to the prevailing technology, established companies have shown a striking inability to survive. Christensen and Rosenbloom (1995) claim that most studies explain incumbents' problems in terms of the magnitude of the technological change and existing organizational dynamics. In their study, Christensen and Rosenbloom (1995) add the value network of the incumbents where value network refers to "*the context within which the firm identifies and responds to customers' needs,*

procures inputs and reacts to competitors" (Christensen & Rosenbloom 1995, p. 234). In fact, listening too much to existing customers and their needs is a key factor when it comes explaining why disruptive technologies are difficult to handle for incumbents (Christensen & Bower 1996).

The prevalent opinion is that *"established firms are likely to dominate incremental innovation, while entrants are likely to dominate radical innovation"* (Henderson 1993, p. 252). Channon (1998) argues that in the financial services industry, IT-induced change often has been "*pioneered by either new entrants or by maverick operators within the industries concerned*" (p. 197). Furthermore, he notes that "*strategic advantage has often been attained by first movers who have gained positions of competitive advantage whilst scarcely being observed by traditionalists*." (Channon 1998, p. 197). On the other hand, Pennings and Harianto (1992) argue that accumulation of technological experiences is conducive to innovation, after having studied the propensity of organizations in the financial services industry to adopt technological innovations. Their finding speaks in favor of established firms.

Rosenbloom and Christensen (1998) investigate this further by studying where existing companies usually go wrong. Their conclusion is that it is not primarily an inability to adopt new technology, but rather an inability to change business strategy. Companies comfortable in a value network with existing relations to suppliers and customers rather naturally run into problems when new technologies force them to question this network. Contrary to mainstream research they claim that the *"intrinsic technological difficulty or riskiness"* (Rosenbloom & Christensen 1998, p. 233) does not affect the existing company's ability to survive the shift.

Somewhat to their surprise Cooper and Schendel (1976) find that incumbents make substantial commitments to old technology, even when sales has already started to decline. They refer this back to the decision makers, as they note that not only the existing technology grows old, but also the skills and positions of influence. Adoption tends to be delayed because managers lack the background to comprehend new technologies (Morgan & Daniels 2001). Of course, that it is not optimal for incumbents to lag behind new entrants is not self evident (cf. Ghemawat 1991).

Day and Schoemaker (2000) contrast incremental innovations with emerging technologies. The latter denotes technologies that *"have the potential to create a new industry or transform an existing one"* (Day & Schoemaker 2000, p. 2) or more precisely technologies where *"(1) the knowledge base is expanding, (2) the application to existing markets is undergoing innovation, or (3) new markets are being tapped or created."* (Day & Schoemaker 2000, p. 2).

New technologies can also be a tool for affecting market structure. While being market-driven means taking market structure and behavior as given, driving markets mean shaping or affecting market structure and behavior (Jaworski & Kohli & Sahay 2000). There is an important distinction to be made between meeting existing demands and pursuing new business opportunities (cf. Slater & Narver 1998). Listening to existing customers and providing even better sustaining solutions is an example of being market-driven while disruptive technologies are associated with driving markets. Combining this with Christensen and Rosenbloom (1995) and Christensen and Bower (1996) would suggest that new entrants (being more likely to make use of disruptive technologies) are more likely to drive markets than incumbents, who are instead more likely to be market-driven, listening to their existing customer base.

2.3 Introducing Technology Providers and Technology Consumers

Technology shifts also relates to the concepts of innovation and adoption. Typically, a new technology will be considered an innovation to the company coming up with it while a company making use of the innovation is an adopter. However, the latter will however be an innovator in the business where the technology is deployed.

Robey (1986) describes three different types of innovations:

New products, meaning the development of new products offered to external customers.

Administrative innovations, including changes to an organization's structure or processes.

Technical innovations, involving changes to the organization's technology work process.

A distinction can be made between the first, new products, and the two latter, administrative and technical innovations. The first targets innovations provided by a company *for its customers*. The latter two target innovation aimed at internal use, which of course in the end hopefully will benefit the customer in terms of lower prices and higher quality.

Abernathy and Utterback (1978) provide another perspective by distinguishing between *Product Innovations* and *Process Innovations*. Thus, they emphasize the difference between the new product or technology per se, and how it can be used in some business process. In contrast to product innovation, process innovation brings with it issues such as implementation and organizational change. IT applications do not fall easily into either category. In a sense it is a Product Innovation, but its usage leads to Process Innovation.

Thus, a distinction can be made between acting as a *technology provider* and as a *technology consumer*, see Figure 3. "Acting as" are key words, as naturally a company can act both as a technology provider and a technology consumer. A similar approach is suggested by Balcer and Lippman (1984), who use the terms adoption (demand) and creation (supply). In Abernathy and Utterback's (1978) terminology, product innovation is typically done by a technology provider while process innovation is done by a technology consumer.

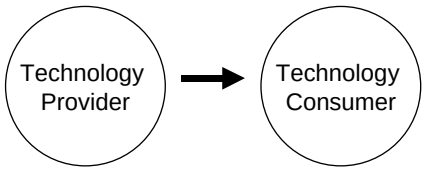

Figure 3. Technology Transfer between Provider and Consumer

The innovator – adopter, or provider – consumer, relationship is tied to a specific technology. The consumer will always be the adopter of the technology, but can also be an innovator in how the technology is deployed.

3 ILLUSTRATING THE TECHNOLOGY PROVIDER AND CONSUMER ROLES

To illustrate the technology provider and consumer roles, examples from four anonymous mini cases will be used. All case companies are brokerage firms and the main data-collection tool was interviews. In total forty interviews were carried out covering in each company the IT department, the business organization and top management. All interviews lasted between 45 minutes and two hours and 45 minutes and were semi-structured in nature (Rubin & Rubin 1995). As qualitative research interviews they were characterized by a limited degree of structure imposed by the interviewer, open questions and a starting point in real-life stories rather than abstractions and general opinions (King 1994). The complete case studies are reported in Mårtensson (2003).

Some main characteristics of the four anonymous case companies are presented in Table 1 below, where *Market segment* and *Employees* describe the companies as such, while *IT portfolio characteristics* and *Prominent applications* provide a very brief overview of their respective IT portfolios.

Company	***Lambda***	***Delta***	***Tau***	***Gamma***
Market segment	Institutions	Institutions	Retail	Retail
Employees (magnitude)	10	500	50	10000
IT portfolio characteristics	Very streamlined consisting primarily of proprietary EdbTrade application	Proprietary state-of-the-art solutions	Standard packages with proprietary solutions where absolutely necessary	Mix of old legacy back-office applications and modern standard package front-office applications
Prominent applications	Proprietary EdbTrade	Proprietary front-office application. Proprietary back-office application.	Corporate web site Standard package front-office application.	Standard package front-office applications Proprietary back-office applications Web site

Table 1. Some Overall Characteristics of the Case Companies

3.1 Lambda

Lambda was started as a green-field start-up in the mid-1990s. The business idea of being an electronic discount brokerage called for a different technical set-up than what was common in the industry at that time. By providing its customers with a computer terminal and a direct line into (the electronic virtual trading floor of) the stock exchange, Lambda brought a value proposition to its customers different than the usual one. Instead of offering analyses on what stocks to buy or sell and then taking care of the actual buying and selling, Lambda put a tool in the hands of their customers. Lambda conscientiously unbundled (cf. Clemons et al 1996) the standard brokerage offering consisting of a combination of analyses and order execution, by discarding analyses and focusing solely on order execution.

In many dimensions Lambda's service was worse than the prevailing standard since there was no personal communication with a broker. In other dimensions, such as trading floor feeling, Lambda brought a new value proposition to its customers. In very much the same way as disruptive technologies are discussed (Bower & Christensen 1995, Christensen 1997), Lambda's offering to its customers can be labeled a disruptive service. In Chandy and Tellis' (1998) terminology, Lambda provides a high *customer need fulfillment per dollar* in some areas, namely trade execution (but not in terms of analyses), and provides a high degree of *technology newness* compared to traditional brokerages, thus meeting the criteria of a radical innovation.

The choice to use new technology as a technology provider was clearly a business decision. The entrepreneurs starting Lambda even claim that without the electronic part of electronic discount brokerage, it would probably not have been interesting enough to start Lambda. Thus, a prerequisite for Lambda's existence is the identified business opportunity to become a new entrant providing a disruptive service to the customers of the brokerage community.

It can however be noted that even though the business opportunity was created by the technological development, i.e. it became possible to provide electronic discount brokerage services, what Lambda considers to be first mover advantages are not technical in nature. Instead they mention legal and organizational issues as well as user habits.

3.2 Delta

Delta is a well-established full-service brokerage firm targeting institutional investors. It acts as a technology provider in quite a limited fashion. The main example is the customer web site, where Delta tries to tie its customers closer. Instead of using existing clearinghouse style portals for research reports, Delta uses its own web site, which partly acts as a replica of some internal applications. The Java based analysis tool available on the web site is a simplified version of the analysis tools that the analysts use and allows customers to try their own scenarios. Thus, customers get partial access to the functionality of proprietary solutions. Instead of just providing analysts' research reports to the customer, Delta's IT solution is (partly) made available to the customer.

From a technology consumer perspective Delta claims to be among the first to get things working using new technology, even though others may be quicker to start experimenting. The research database used by the equity research department, and its way of distributing research via the Internet was an early adoption of Internet technology. Thus, Delta is able to move fast through the stages of knowledge creation and knowledge retention in order to apply their knowledge (cf. Iansiti 1998).

3.3 Tau

Tau is a low-cost do-it-yourself brokerage firm targeting the retail investor. Prior to the world wide web, Tau pursued the same business strategy using phones as the main communication channel to its customers.

Currently, Tau acts as a technology provider for its customers on the web. Tau's idea of providing a simple do-it-yourself way of trading stocks also means that their targeted market niche is not looking for the newest and hottest technology. Hence, the introduction of new technology must be adjusted to fit the needs and wants of their users (Dhebar 1996). Along these lines, the technology provided by Tau (e.g. its web site) is simple and straight forward, with as few bells and whistles as possible.

To Tau, IT is an explicit way of reducing costs. In line with this, the CEO does not intend to be the first to introduce new technology, even though he dreads being the last one to do so. Not being the first mover forces Tau to have short lead times in order to catch up somewhat with the early adopters. There are several reasons congruent with the active choice not to be the first mover. Some stem straight from the business strategy or even business vision of Tau. Since availability is deemed much more important than new functionality, it is natural to avoid technologies that are too young.

Of course, choosing to be an Internet brokerage business means choosing to rely on a somewhat unproven technology. Of course, given the competitive arena there are few alternatives to this strategy, especially for a discount broker like Tau.

3.4 Gamma

Gamma is a large full-service commercial bank where Gamma Markets manages the securities trading. Gamma Markets acts as a technology provider in terms of the web site providing securities trading to the retail customer. The new securities trading solution is offered to Internet bank users in a deliberate staged rollout process, where the solution is offered to one set of users at a time. First, the Internet bank users most likely to become users are selected. In this case, it is not the technical delivery that worries Gamma, since getting the technology itself to scale is less of a practical problem. The challenge lies in soft add-ons such as help desk services. Actually delivering the innovation can become problematic as was identified by Griliches (1957).

From a consumer perspective, Gamma has two organizational units covering the development of new technologies, *IT Strategic Control* and the *E-business* business area. One reason for this is cost control,

i.e. centralizing allows the organization to know how much is spent on projects related to new technologies. Another reason is to achieve critical mass in these efforts.

It is noteworthy that when Gamma has been at the leading technological edge (the development of the first version of web-based securities trading), the move was not triggered by any of those organizational units, but rather by some entrepreneurs at the line organization at Markets. Some people saw the business opportunity inherent in the new technology (in this case Internet technology in general, and web technology specifically).

This origin is interesting in comparison to Christensen's (1997) advice on coping with disruptive technologies, namely that they are best adopted by small, independent subsidiaries. At first glance, Markets is a small, fairly independent part of Gamma, at least from a business perspective. On the other hand, the development effort was carried out in close cooperation with the business at Markets, and in fact it was to this business it could be considered a disruptive alternative. So, the development effort was independent of the major IT department, but not independent of Market's core business.

4 THE WORLD WIDE WEB EXAMPLE

We will now turn specifically to the world wide web as an example and study how this new technology affected the four case companies.

Lambda offered an electronic linkage to the marketplace very early. Thus, it provided a disruptive service to its customers in comparison to the traditional brokerage. However, the world wide web turned Lambda into somewhat of an incumbent as similar solutions based on the public Internet and the world wide web have entered the marketplace. Lambda is targeting institutional customers who are presently willing to bear the costs of leased lines. The low-end segment of retail customers is however targeted by several brokerages using Internet solutions (e.g. Tau).

Delta incorporated the new technology into its existing business model where the service to existing institutional customers is enhanced by, for instance, electronic distribution of analysis reports. In this sense, Internet is only a new means to distributing information to the customer and has the character of a sustaining technology (cf. Christensen 1997). Concerning actual securities trading Delta does not deploy web-based solutions. Such solutions are disruptive to Delta's traditional existing service which incorporates personal interaction with brokers etc.

Tau is quite similar to Lambda in the sense that it is offering an unbundled version of the traditional brokerage service. It used to offer a phone-based solution, but switched to the Internet and the world wide web when appropriate, thus using it as a sustaining technology for its business strategy. Even as an Internet brokerage, its solution is towards the low-end since fewer add-on services, such as news feeds are offered. Other Internet brokerages have gone the other way. In line with Christensen's (1997) predictions, different dimensions of the product or service offered are used to compete until nothing but price remains. Many of Tau's competitors have chosen to add, for instance, news feeds in an effort to avoid competing on price alone. Thus, for Tau the world wide web really is not a disruptive technology. Rather it is a better and cheaper way of interacting with the customer than the original phone-based trading. The crucial distinction is between Tau's phone based trading, which was completely execution oriented, and traditional phone based trading, which includes analysis and personal service from the broker (as for Delta).

Gamma thrived early on based on a first-generation application developed by some entrepreneurs in the line organization. This is consistent with Christensen's (1997) argument that disruptive technologies are usually adopted by smaller companies (or independent organizational units of larger companies). The reason for this is that they are small enough to get excited by the initially very limited market for the technology (or in this case service). It is noteworthy that Gamma's formal organization was significantly slower in catching on to the new technology.

As is illustrated above, it is not feasible to categorize the world wide web as such as either a disruptive or a sustaining technology. Instead this varies with the technology's usage and how it relates to the company's existing business. The usage can be disruptive or sustaining in relation to prior activities and a company's business strategy as described in Table 2.

Company	***World Wide Web relative to existing business strategy***
Lambda	Sustaining in terms of technology-based interaction with customer. Disruptive concerning technology choice (public Internet vs. leased lines)
Delta	Disruptive to Delta's traditional analysis-based securities trading customer interaction. Sustaining to the research department and their report distribution.
Tau	Sustaining to Tau's traditional low-cost way of receiving order-flow over the phone.
Gamma	Disruptive to Gamma's traditional branch-office based customer interaction

Table 2. World wide web as disruptive and sustaining technology

Looking at the world wide web from a provider – consumer perspective provides a similar multi-faceted result. It is important to keep in mind that when a new technology (in this case in the form of the world wide web) causes companies to take on a new role as technology providers it does not imply that they provide the technology itself. Instead the technology enables developing new solutions (web-sites, thin trading applications etc) which the company provides to its customers.

The case companies' different approaches are compared in Table 3.

Company	***Disruptive / Sustaining***	***Technology Provider (TP)***	***Adoption Strategy for WWW***
Lambda	Disruptive	Was already TP	Decided not to adopt.
Delta	Disruptive to securities trading. Sustaining to report dissemination.	Was not TP	Adopted for report dissemination but not securities trading.
Tau	Sustaining	Was not TP	Adopted for securities trading.
Gamma	Disruptive	Was not TP	Adopted locally

Table 3. Different approaches to the world wide web

We can see that the world wide web caused at least Tau and Gamma to become technology providers in the sense that the securities trading changed character. Instead of communicating with their customers over phones or at branch offices (Gamma), the world wide web is used a the main means of communication.

Analyzing Table 3 it can be concluded that:

Lambda was already a technology provider but chose not to adopt the disruptive web technology.

Delta was not a technology provider and chose to adopt where sustaining but not where disruptive.

Tau was not a technology provider and chose to adopt the sustaining technology

Gamma was not a technology provider but chose to adopt the disruptive technology locally.

In general, when a new technology opens up new opportunities which requires a company to become a technology provider several different perspectives can be identified. The new opportunities can either be sustaining or disruptive related to the company's existing business. The company can also either already act as a technology provider or not. These perspectives are summarized in Figure 4 below.

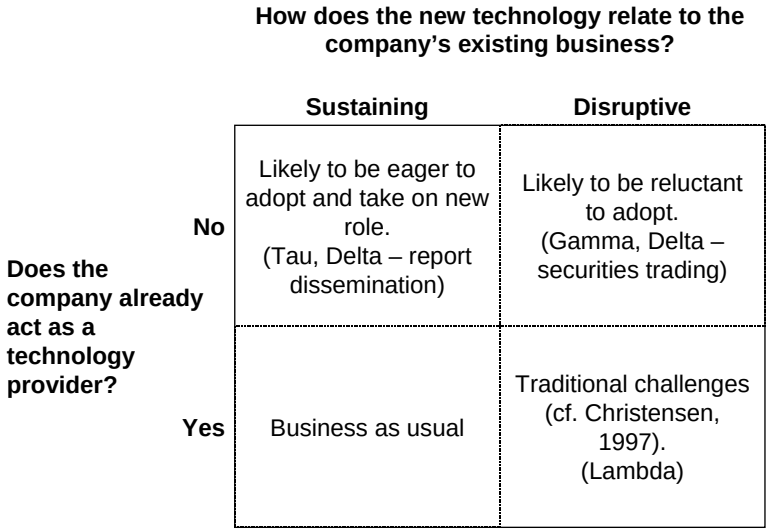

Figure 4. Different scenarios when adopting a technology implies becoming a technology provider

Traditionally, the literature on technology shifts discusses the lower half of Figure 4 (e.g. Christensen 1997, or if using incremental – radical e.g. Utterback 1994). A main contribution of this paper is the upper half. Some new technologies in fact makes technology non-providers to become technology providers. If the opportunities opened up by the new technology are sustaining to its current business (as for Tau) this migration is likely to be smoother since the company's business model and value network (Christensen & Rosenbloom 1995) can remain the same. If however the opportunities opened up are disruptive in nature in relation to the company's current business the challenge is twofold. Not only must traditional challenges with disruptive technologies (cf. Christensen 1997; Christensen & Bower, 1996) be managed, the company also faces the challenge of turning into a technology provider. This partly means changing business strategy (by incorporating technology providing services) which is inherently difficult.

It is noteworthy that becoming a technology provider brings with it implication not always considered at first. By providing e.g. an application to its customers the company in fact becomes a software provider, something that not necessarily lies within the natural area of expertise for a brokerage firm. In fact, it can be considered quite a leap in business strategy. This is indeed noted by Gamma when they fear future challenges in e.g. providing help-desk services.

5 CONCLUSIONS

One conclusion relates to the dichotomy sustaining vs. disruptive technologies. As has been shown above, this not necessarily a property of the technology itself, but instead depends on how it relates to the business of the specific company. In this regard, the interesting dichotomy is not so much "sustaining or disruptive" ("this technology is sustaining") as it is "sustains or disrupts" ("this technology sustains [our business strategy]"). It should be noted that the theory of disruptive technologies is based on technologies in general (cf. Christensen 1997), but in this paper it is applied to IT. Since IT is a very plastic type of technology, whose usage can vary significantly, it is maybe only natural that the distinction between the technology per se and its usage plays a more significant role than in the original theory.

Furthermore, the distinction between acting as a technology provider and as a technology consumer has been stressed. An interesting aspect of some technologies is that they may cause companies to

move from not being technology providers to actually provide technology to its customers. Doing this when the technology sustains the current business is likely to be quite attractive (e.g. Tau) since it will help the company to conduct its business in new, better ways. Doing it for a technology that disrupts the current business is likely to be less attractive. Not only do the traditional challenges with disruptive technologies come into play, the additional challenge of becoming a technology provider is added.

Thus, it is argued that there is really an interdependence between technology shifts and business operations. The character of a technology shift is more fruitfully determined in relation to some business operation instead of by judging the technology per se. Some important technology shift characteristics depend on the technology *usage* in some business. Thus, the business operations affect the technology shift, or rather its characterization. It has also been shown how a technology shift affects the business operations of a company, not only in the traditional way of changing how some activities are carried out, but more fundamentally in terms of what kind of business the company is actually in. Becoming a technology provider is conceptually a significant change.

A concluding remark is that the technology provider – consumer distinction makes it quite conceivable for two competing companies to frame themselves very differently. One company could very well frame itself as a "brokerage firm which uses IT", while another, emphasizing its technology provider role, could frame itself as an "outsourcing provider which happens to deliver securities trading services".

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