Product Development
– Effects on a Company's Network of Relationships

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Product development and the development of a network of relationships are both of great concern to many companies. This is confirmed by considerable research in both of these areas. For a company, product development and development of a network of relationships may be regarded as two connected processes.

This paper presents literature reviews describing product development and development of a network of relationships respectively as two processes that are important to companies. This is followed by a presentation of Nordic VLSI as the focal company of the thesis as well as the semiconductor industry of which it is a part. Nordic VLSI's development of a product for VingCard as one of its customers is presented to illustrate that the two processes can be viewed as connected.

1. Product Development

Product development can be understood as a process that starts with an idea and results in a new product (e.g., Saren, 1984). Alternatively, product development may be viewed as a conversion process, where companies' resources and R&D spending are combined, thus resulting in a new product (e.g., Cooper, 1982). This section looks into product development as an issue that is considered to be important and at the same time challenging for companies.

Product Development as Important

Product development is widely regarded as important for companies, among both academics and managers. Product development is not limited to a few high-tech companies. Rather, *"every company must carry on new product development"* (Kotler, 1997: 307). Other authors make similar statements (e.g., Dosi, 1988; Biemans; 1992; Utterback, 1994; Cooper, 1998), or even more dramatic ones, claiming that a company must "innovate or die" (Sheth & Ram, 1987). Actually, there is little disagreement among academics with respect to the importance of product development for companies (Van de Ven, 1986; referring to Schumpeter, 1942; Freeman, 1994). Further, the topic of product development has attracted increased attention among academics in recent years (e.g., Cooper, 1998; Roberts, 1999).

Recognition of the importance of product development among managers is indicated by numerous studies that rank "product development" along with "keeping up with new technology" and "product quality" among the top concerns of chief executives (e.g., Roussel et al., 1991). Harvard Business Review, as a highly respected journal with a management focus even dedicates a special issue to the theme *"The Innovative Enterprise – Turning Ideas into Profits"* .[1] This recognition of the importance of product development also surfaces in the companies' heavy spending on R&D (e.g., Cooper, 2001). According to a U.S. study[2], while R&D spending across all industry averages 4.4% of sales, particular industries, such as "electronic equipment" and "semiconductor-related devices" spend more than 10% (ibid.). As an illustration

[1] Harvard Business Review, Special Issue, August, 2002, Vol.79.
[2] Cooper (2001) refers to Industrial Research and Development Facts with the 1998 Industrial Scorecard, Industrial Research Institute, Washington D.E. 1999.

of the companies' view of the importance of product development, some industries even spend more on R&D than the entire profit for that industry (ibid.).

With product development as an important task for companies, it is natural to ask why this is so. First of all, it is important to keep in mind that to survive over time, companies have to sell products – goods and/or services. Product development further represents an investment in future sales. This aspect is also associated with the most cited argument for product development by the company: long-term profitability (e.g., Roussel et al., 1991; Webster, 1991). Other authors present similar arguments, such as growth (e.g., Penrose, 1959), prosperity and long-term success (Cooper, 2001), superior profits (Roberts, 1999), achievement of sustained competitive advantage (e.g., Barney, 1991), long-term well-being (Biemans, 1992), and the health of the company (Tushman & Moore, 1988; Cooper, 2001).

Customers and their changing needs and desires are also presented as an incentive for product development (e.g., Kotler, 1997). These changing needs and desires among customers have led to a widespread recognition of some kind of market life cycles along with corresponding product life cycles (e.g., Webster, 1991; Kotler, 1997). According to the principles of the product life cycle, new products tend to face low competition and to therefore generate higher profits, whereas products in their decline are assumed to be far less profitable, thus calling for renewal and development (ibid.). Competitors represent a vital ingredient in relation to the product life cycle, and are correspondingly presented as an argument for product development (ibid.). As an amendment to this, the often cited increase in the internationalization or globalization of markets is considered to increase competition (e.g., Tushman & Moore, 1988; Cooper, 1998).

Another aspect highlighting the importance of product development for companies is its great significance to the financial market, which is considered to have a strong influence on corporate behavior (e.g., Cooper, 2001). In this way, documentation of product development and investments in R&D becomes important for companies in order to attract investors. The overall technological progress in society is also indicated as a reason for the importance of product development for companies (e.g., Van de Ven, 1986; Dosi, 1988; Freeman, 1994). Companies can take advantage of this technological progress through their product development (e.g., Tushman & Moore, 1988; Cooper, 1998), e.g. through improvements in the quality and price of their products. At the same time that companies make use of this technological progress, they also contribute to it. Product development, or product innovation, thus influences more than the profitability of the individual companies. Economic progress and change at an industry level can be created (e.g., Dosi, 1988), and in this way create long-term economic growth in society (e.g., Freeman, 1994). In relation to this, product development, or product innovation, is often regarded as the best way to make an industry more profitable (e.g., Håkansson, 1987), which also indicates why governments frequently attempt to stimulate innovation within various business sectors and industries.

The growing importance of product development to companies seems to surface in the figures for new products as a percentage of their sales. A survey of 700 U.S. companies indicates that the importance of new products has increased, from accounting for 20 percent of all profits in the 1970s to more than 30 percent in the

1980s (Takeuchi & Nonaka, 1986). A similar study reports that new products accounted for 22 percent of profits in the period from 1976-81, whereas the proportion reached 32 percent in the 1990s (Cooper, 1998). This latter study views new products as the ones that the company has had on the market for five years or less (ibid.).

Product Development as Risky

While product development is important to companies, it is also risky. After all, the company sets out to do things it has never done before. Some of the difficulties related to product development stem from the company itself in the sense of corporate barriers (Sheth & Ram, 1987). It therefore becomes a challenge to overcome, or even eliminate, some of this internal resistance to innovation (e.g., Drucker, 1985). Further, many companies strive to increase efficiency and productivity, which often takes place at the expense of innovation and product development (e.g., Imai, Nonaka & Takeuchi, 1985; Tushman & Moore, 1988; March, 1991). There are also limitations within the company that are not motivated by resistance, such as lack of skills and human creativity (Utterback, 1994). Other difficulties are related to customers (Sheth & Ram, 1987). These may seem to be unpredictable, as they may sometimes encourage product development, and later show less enthusiasm for the very same product.

Other difficulties are related to the lack of a “best” way to develop products, as there is no mechanical application of rules that will ensure success (Roussel et al., 1991). This means that every company, at least to a certain degree, has to struggle with identifying a satisfactory approach. Technical uncertainties may affect product development, especially in the early stages: Will it work? As a consequence of all the difficulties related to product development, failures naturally occur. Several authors present failure rates on the basis of empirical studies (e.g., Webster, 1991; Crawford, 1997; Cooper, 2001). Such numbers and generalizations in themselves often mean little to the individual company, as it is important to be aware that there is strong variation in the failure rate among companies, among industries (Crawford, 1997), and among types of product development. This latter aspect follows naturally, as product improvements do not involve the same technical or commercial uncertainties as “new-to-the-world” products.

How Companies Attempt to Manage Product Development

The foregoing identification of difficulties related to product development raises the question of how companies can improve within this field. A major concern in this respect is to reduce new product failures (e.g., Moore, 1982; Cooper, 2001). As indicated earlier, there is no single “best” way to do develop products; every company and its context are unique (Roussel et al., 1991). This does not prevent the existence of a vast number of models for product development, which in their turn can be classified in different ways (e.g., Saren, 1984). Among the more widespread models are those which depict product development as a series of activities, e.g. exploration –

screening – business analysis – development – testing – commercialization;[3] as a departmental-stage model, e.g. R&D department – design department – engineering department – production department – marketing department (Saren, 1984) or as a decision-stage process.

A frequent criticism of such "basic" models is that their perspective on product development is too narrow. In response, models that combine elements from several of these basic models have been developed (see Twiss, 1986). One such model is the Stage-Gate™ New Product Process (Cooper, 1993, 1998, 2001). The models often promise an increase in the success rate for product development, and "a high-quality new product process" is even identified as the most important of nine constructs in total that have an impact on performance (Cooper & Kleinschmidt, 1995). Tough go/no-go decisions constitute an important part of a high-quality process (ibid.). These models for product development are claimed to provide more discipline and control in a process that is viewed as complex. These models also help to ensure that various tasks, such as market analysis, are conducted appropriately and perhaps even more importantly: at an early stage of the development process (e.g., Cooper, 1993).

These models are often supplemented by numerous key success factors, techniques or advices, such as "pre-technical product definition", "more pre-development work", "strong market orientation", "effective quality control procedures", "committing resources", "good internal and external communication" and "speed, but not at the expense of quality" (e.g., Rothwell, 1992; Cooper, 1993; Cooper & Kleinschmidt, 1995; Crawford, 1997). This last aspect in particular, speed, is frequently mentioned as increasingly important in relation to product development (e.g., Hamel & Prahalad, 1994; Imai et al., 1985). Some of these models introduce techniques to reduce development time by as much as 90 percent (Zangwill, 1993), e.g. through concurrent engineering.

A company seldom works on the development of only a single product. Rather, it is often involved in the development of a number of products that have reached different stages: some exist as ideas only, others are going through prototype testing, yet others have been on the market for a number of years. As a consequence, models for product development are often combined with some kind of portfolio management tools. The BCG-matrix, various risk-reward matrixes, and Porter's works represent the more widespread ones (see Drucker, 1985). Appropriate use of these portfolio management tools often promises a company increased success in relation to product development.

Another way for a company to improve its product development is to look more closely at its own organization. Product development involves changes that are likely to cause resistance, and it is therefore appropriate to ask how the organization can be made receptive to innovation (Drucker, 1985). This concerns how to *"create organizations that have the capability to operate in two time frames simultaneously"* (Tushman & Moore, 1988: xi), and thus find a balance between productivity and innovation as short- and long-term concerns respectively (e.g., March, 1991).

[3] See: *Management of New Products*, Booz, Allen & Hamilton management consultants, 1968, New York; or Biemans (1992) for a review.

One way to use the company as the point of departure in the search for ways to achieve successful product development is to look more closely into its resources. The development of these resources, also referred to as the company's "core competencies", may even take decades, suggesting that perseverance may be just as important as speed (Hamel & Prahalad, 1994). If the company's resources are regarded as the point of departure, it becomes important to utilize these in the development of new products (Penrose, 1959). The direction of product development should therefore not be haphazard, but closely related to the nature of the company's existing resources, thus contributing to an understanding of the growth of firms (ibid.).

How Companies Attempt to Evaluate the Success of Product Development

A feature of product development is the variety of ways in which companies attempt to measure it, e.g. its success rate. For a company, a traditional way to evaluate the effects of product development is to use measures such as time, cost and performance which can be measured immediately after the completion of the product development, while sales, payback period and break-even time represent long term measurements (e.g., Cooper, 1993). In relation to these, a PIR (Post-Implementation Review) may be conducted, approximately 6-18 months after the commercialization of the product (ibid.). The Stage-Gate™ New Product Process presented by Cooper (1993) incorporates these measures. As an illustration of its widespread use, this new product process has become widely accepted within companies throughout the world, which has made this book the most popular ever published on new products (Cooper, 1998).

Nordic VLSI and Product Development

The focal company in the thesis is Nordic VLSI. This company is located in Trondheim, Norway, and develops ASICs. Basically, an ASIC (Application-Specific Integrated Circuit) can be described as a customized data chip that is integrated into another product to enable this product to perform certain tasks. Looking at Nordic VLSI with the focus on product development reveals certain aspects of interest.

In 1993, Nordic VLSI contacted VingCard, then a maker of locking systems based on mechanical, recodeable punch-hole key cards, mainly for the hotel and cruise industries. VingCard became convinced that its next generation of locking systems should be recodeable, centrally operated and dependable. To achieve this, Nordic VLSI was assigned to develop an ASIC, while VingCard developed the connected parts of the locking system. The development of this ASIC was characterized by substantial trial and error. First, there were considerable time overruns. Second, there were considerable cost overruns in the terms of person-hours. This may have made Nordic VLSI regret that this ASIC was developed under a fixed-price agreement rather than on the basis of hourly rates, which have often been used for ASICs burdened with high

technical uncertainties. Third, the performance of the ASIC was originally not satisfactory, as an error was discovered after its approval.[4]

As indicated above, it is common to evaluate the success of product development according to certain short-term measures, such as time, cost and performance. Focusing on these measures implies that the product is viewed as the all-important effect of the development process. If the three common measures were applied to the development of this ASIC, this would immediately lead to the conclusion that it was unsuccessful for Nordic VLSI. After all, the ASIC was developed under a fixed-price agreement, and neither time, cost nor performance met the original estimates that formed the basis for the decision to develop it.

2. Development of a Network of Relationships

A relationship may be viewed as a resource that exists in the interface between two companies. As such, the relationship connects the two companies, and at the same time blurs the company boundaries. This section looks into the development of a network of relationships as a process that is considered to be important for companies.

Relationships and Networks as Concepts

As for product development, relationships between companies are held to be highly important in business (e.g., Håkansson, ed., 1982; Webster, 1991; Morgan & Hunt, 1994; Ring & Van de Ven, 1994). A relationship is not developed in isolation. Rather, relationships are connected – or interdependent (Cook & Emerson, 1978). Development of one relationship therefore always depends on the broader network structure. This has led to considerable research into business networks as well (e.g., Arndt, 1979; Miles & Snow, 1986; Thorelli, 1986; Håkansson, 1987; Jarillo, 1988; Powell, 1990; Håkansson & Johanson, 1992; Anderson et al., 1994; Håkansson & Snehota, 1995; Ford et al., 2003).

Relationships are referred to through the use of numerous concepts, such as collaboration, partnerships, partnering, coalitions (e.g., Ring & Van de Ven, 1994), horizontal and vertical alliances (e.g., Reve, 1992) or strategic alliances (e.g., Lorange & Roos, 1991; Teece, 1992). Taking a narrow view, a strategic alliance (SA) can be seen as a particular kind of relationship. At the same time, the concept of SA is widespread among companies, and it is frequently used to denote a number of different kinds of inter-firm cooperation. Much of the research conducted within the field of SA is fairly normative, and addresses how strategic alliances should be developed and managed (e.g., Lorange et al, 1992; Pekar & Allio, 1994; Spekmann et al., 1996). The concept of SA is widespread within research traditions such as resource-based theory and knowledge management (e.g., Hamel & Prahalad, 1994; Quelin, 1997).

Relationship marketing (RM) represents another application of the concept of relationships (e.g., Gummesson, 1987; Grönroos, 1990; Payne, ed., 1995). RM is

[4] This part of the case is presented in more detail in section 4.3.

also reported to be widespread among companies (Sharma & Sheth, 1997) . RM contrasts with "traditional" marketing in the sense that it is cross-functional and involves a number of departments rather than regarding the marketing department as all-important (Payne, 1995).

Even though considerable research into relationships has been conducted, it has not resulted in consensus on what a relationship is (e.g., Dubois & Håkansson, 2002). A relationship can be viewed as one of three basic types of governance forms, where market and hierarchy are the other two (e.g., Blois, 1972; Williamson, 1975). This view can be expanded to a number of other governance forms on a continuum from the market at one end to a hierarchy at the other (e.g., Webster, 1991). With such a point of departure, the relationship becomes a medium for achieving certain advantages in relation to a transaction. According to this view, a relationship is often said to be entered in a search for competitive advantage (Hogan, 2001), and is even presented as one of three ways to understand how companies sustain profits or quasi rents (Rumelt et al., 1991). But a relationship may also be viewed as a valuable resource in itself, an investment in the same way as e.g. an expensive machine (e.g., Johanson & Mattsson, 1985; Håkansson & Snehota, 1995). In this way, a single relationship becomes something more than simply a medium for transactions. A company's network of relationships becomes a resource constellation which it may consider to be highly valuable for a number of purposes.

Increased Interest in Relationships and Networks

The interest of academics in relationships and networks is observed to have grown in recent decades (e.g., Håkansson & Snehota, 1995; Möller & Wilson, 1995), and has resulted in considerable research. Numerous articles on relationships, networks and SA have been published in academic journals. Special issues of these journals have even been dedicated to these concepts. These include two special issues of *Academy of Management Journal* published in the 1990s, where the topic of the first one was collaboration among organizations and that of the second one was strategic alliances and networks.[5] *Strategic Management Journal* published a special edition on "Strategic Networks", which included topics such as learning in relationships, formation of R&D networks, startup networks for innovative performance, alliance formation, supplier networks, and capabilities available in networks.[6] In addition, this edition refers to an enormous body of literature in this field (Gulati et al., 2000). *Industrial Marketing Management* published the special issues *"Business Relationships and Network"* in 1999, *"Business Marketing: Perspectives from the Market-as-Network Approach"* in 2000 and *"Strategizing in Networks"* in 2003.[7]

Some authors suggest that this increased interest in relationships is due to a shift in the way in which companies operate. To an increasing extent, transactions between companies are said to occur in "internal" markets within long-term relation-

[5] See Ring (1996).
[6] *Strategic Management Journal*, Special Edition: Strategic Networks, Vol.21, March 2000, pp.199-428.
[7] *Industrial Marketing Management*, Special Issue: Business Relationships and Networks, Vol.28, No.5, 1999, pp.413-564, *Industrial Marketing Management*, Special Issue: Business Marketing: Perspectives from the Market-as-Networks Approach, Vol.29, No.4, 2000, pp.285-386, and *Industrial Marketing Management*, Special Issue, Strategizing in Industrial Networks, Vol.32, No.5, pp.355-440.

ships (Arndt, 1979). It is said that companies are becoming more specialized, in contrast to the classic, vertically integrated company, thus requiring relationships to tie them together (e.g., Achrol, 1997). This calls for companies that view organizational boundaries as flexible, and are willing to adapt to a dynamic network form (e.g., Miles & Snow, 1986). Companies enter relationships at a much faster pace than they did only a few decades ago (Ring & Van de Ven, 1994). Strategic alliances between companies are reported to be increasing (e.g., Niedlerkofler, 1991), and in 1994 it was stated that global strategic alliances had reached record numbers in the preceding year (Ring, 1996; referring to Knecht, 1994). The following extract from an article in Business Week, *The 21st Century Corporation*,[8] published in 2000, describes a shift in the way that companies operate:

> *"Companies will focus on what they do best and farm out the rest to a network of partners. (…) In the near future, companies will call on outside contractors to assemble teams of designers, prototype producers, manufacturers, and distributors to get the job done. (…) It's management by Web. That means not just Web as in Internet but the web-like shape of successful organizations in the future. If there are a pair of images that symbolize the vast changes at work, they are the pyramid and the web. (…) The 21st century company, in contrast, is far more likely to look like a web: a flat, intricately woven form that links partners, employees, external contractors, suppliers, and customers in various collaborations. The players will grow more and more interdependent. Fewer companies will try to master all the disciplines necessary to produce and market their goods but will instead outsource skills – from research and development to manufacturing – to outsiders who can perform those functions with greater efficiency. Managing this intricate network of partners, spin-off enterprises, contractors, and freelancers will be as important as managing internal operations. Indeed, it will be hard to tell the difference. All of these constituents will be directly linked in ways that will make it nearly impossible for outsiders to know where an individual firm begins and where it ends. (…) The boundaries of the firm will be not only fluid or blurred, but in some cases hard to define. (…) It's more about bits, less about atoms. The most profitable enterprises will manage bits, or information, instead of focusing solely on managing atoms (the corporation's physical assets)."*

Other authors prefer to explain this increased interest in relationships by questioning the traditional approach to marketing within the mainstream marketing literature, such as the marketing mix model (e.g., Håkansson, ed., 1982). The marketing mix model implies a large number of buyers and sellers, and it focuses on the single discrete purchase. Empirical studies of industrial markets, on the other hand, indicate the existence of relationships (ibid.). Some authors, particularly within RM, point out that the traditional approach to marketing has been questioned to the extent that they refer to this incorporation of relationships as "New Marketing", and even claim that a paradigm shift is taking place (Gummesson, 1987; Payne, 1995). Others stop at pointing out that a "major shift" is occurring within the field of marketing (e.g., Morgan

[8] Business Week, European Edition, *The 21st Century Corporation*, August 21-28, 2000, pp.46-47.

& Hunt, 1994). From this point of departure, one may conclude that the increased interest in relationships among academics does not necessarily stem from the companies' increased interest in relationships. Rather, relationships may very well have been important for companies all the time, although they have not been the focus of mainstream research in fields such as marketing. With this approach, relationships become not so much a discovery, but a rediscovery, of an approach widely applied by companies (Payne, 1995; Ford et al., 1998).

It is important to keep in mind that the increased interest among academics in relationships and networks may derive from both the two explanations, namely a change in how companies operate as well as a questioning of the traditional approach to marketing as presented within the mainstream marketing literature.

Nordic VLSI and Development of a Network of Relationships

Revisiting Nordic VLSI, emphasizing the network of relationships this time, reveals new aspects. Nordic VLSI and VingCard cooperated extensively during the development of the ASIC. First of all, VingCard as a first-time user of the ASIC required assistance in the development of the product specifications that were traditionally developed by Nordic VLSI's customers. Nordic VLSI therefore needed to gain substantial insight into the connected technologies developed by VingCard in order to handle their interface to the ASIC appropriately. After all, VingCard had at that stage already spent considerable time on the development of the software in the locking system. Following this cooperation, the two companies made important adaptations. Before the assignment of the development of this ASIC, Nordic VLSI had already signaled that it would assist VingCard, creating expectations that were important to the company's decision to develop this new generation of locking systems. Before its first contact with Nordic VLSI, VingCard had made inquiries to some large, global companies regarding development and manufacturing of an ASIC. These companies required VingCard to develop parts of the ASIC itself, thus attempting to avoid handling the parts of the development that required insight into VingCard's technologies. VingCard regarded the technical uncertainties associated with this solution as too high. Nordic VLSI and VingCard, on the other hand, projected as symmetric parties with respect to company size and knowledge of the ASIC and the connected technologies respectively. As the development of the ASIC came to last several years, the relationship became characterized by high continuity. Following the development of this ASIC, VingCard claimed that on the basis of its new generation of locking systems it had transformed lock making from a craft into a high-tech industry.

Nordic VLSI was engaged not only to develop the ASIC, but also to manage its manufacturing. As Nordic VLSI did not manufacture ASICs itself, it had to contract a semiconductor manufacturer to undertake this. This was actually the first time Nordic VLSI, rather than its customers, managed the coordination with a semiconductor manufacturer. Nordic VLSI established a relationship with Alcatel Microelectronics as the semiconductor manufacturer. First of all, Alcatel Microelectronics provided detailed information about its manufacturing processes to Nordic VLSI. Following this, these two companies cooperated in managing a number of challenges.

The illustration above shows the development of a network of relationships taking place concurrently with the development of the ASIC. Cooperation and sharing of knowledge were important aspects of Nordic VLSI's relationship with VingCard. Alcatel Microelectronics shared knowledge about manufacturing of ASICs with Nordic VLSI, as the latter company held little experience within this field.

3. Development of Products and of Relationships as Connected Processes

A company may view product development as an isolated process. But a company may also view it as a process that is connected to the development of its network of relationships. This does not only concern whether the company chooses to view these processes as connected, and if so, to what extent. The company chooses, or at least influences, the extent to which these processes become connected.

This section first reviews the extent to which development of products and of relationships as connected processes has received attention among academics. This is followed by a discussion of advantages and disadvantages which may result for a company that attempts to connect these processes.

Research Conducted within this Field

Compared to the research on development of products and of relationships respectively, the connecting of the two processes is not widespread among academics. Rather, academics focusing on product development are criticized for applying an overly narrow perspective (e.g., Håkansson, 1987), which may prevent a company from making appropriate use of its network of relationships for product development (Tidd, 1995). This is not very surprising, as it is possible to imagine a company that develops a product on the basis of its general interpretation of a "market" before contacting potential customers. Such descriptions of the product development process were not uncommon in the early models.

Even though research connecting product development and development of relationships is not widespread, the importance of cooperation with other companies in relation to product development has been addressed. Customers are found to be of great importance in product development (e.g., von Hippel, 1988). In relation to this, some customers can be identified as "lead-users", and provide valuable information during the process of product development. Similarly, suppliers have been identified as important for a company's product development (e.g., Teece, 1992; Gadde & Håkansson, 1993). Some authors refer to the importance of a company's network of relationships in relation to product development (e.g., Håkansson, 1987; 1989; Freeman, 1991). Strategic alliances are further identified as frequently playing an important role in product development (e.g., Teece, 1992; Lei & Slocum, 1992). Other studies point out how large companies, such as Canon and Sony, make use of their networks of relationships in their product development (Harryson, 1997), or how Silicon Valley companies undertook large parts of their product development by utilizing the flexibility offered by their network (Hobday, 1994).

Advantages for Companies in Relation to Connecting the two Processes

To further explore the connections between development of products and of relationships, it seems appropriate to elaborate on some of the advantages related to developing relationships when conducting product development. From an organizational point of view it is often difficult for a company to develop products single-handedly, as this involves questioning and rebuilding existing perspectives – "double-loop learning" (Nonaka & Takeuchi, 1995; referring to Argyris & Schön, 1978). This is supported by Teece (1992), who claims that experience in one particular technology may represent an obstacle to change, i.e. a company's core capabilities are also – simultaneously – its core rigidities (Leonard-Barton, 1995: 30). Development processes deviate from a company's ongoing activities, and are accordingly difficult to handle. On the other hand, involving other organizations may widen a company's perspectives and thus reduce these obstacles. Håkansson (1989: 120) suggests this by claiming that *"relationships tend to open the way towards a variety of new solutions"* in relation to development of products, and therefore provide a basis for change.

Other authors point out that the development of products, due to their complexity, often requires the forming of relationships upstream and downstream, laterally and horizontally (Teece, 1992). According to Gadde & Håkansson (2001), the rapid technological progress within different fields often makes it impossible for the single company to handle all development in-house. This is particularly true of highly complex products that are affected by a number of different technologies (ibid.). Relationships therefore become advantageous due to the need to involve other companies in order to develop the product. Hence, for many companies the ability to keep up with technological progress has led to a focus on reducing the proportion of the knowledge required to develop their products (Teece et al., 1997), for instance by making use of components developed externally. This trend towards some kind of "specialization" is also indicated by Gadde & Håkansson (1993), who claim that the importance of suppliers in product development work has gradually grown. Outsourcing of the development of various parts of the products tends to follow this, basically motivated by the benefits of utilizing technical fields within which other companies have specialized (Gadde & Håkansson, 2001).

In accordance with the argument concerning specialization, the development of products often requires access to complementary technologies through relationships (see Ford et al., 1998). Product development may thus require coordination and mobilization of resources organized outside the company (Håkansson, 1987). Complementarity also implies that the success of a product does not rest upon its superiority as such. Rather, the product needs to become useful through combining it with other technologies (Håkansson, 1993), which inevitably suggests the importance of relationships. Rosenberg (1976) points out that a given invention cannot fulfill anything like its potential unless other existing technologies or inventions are taken into consideration. This combining embraces processes of interaction, where adaptations are often undertaken by several companies. As a consequence, relationships become important for reasons including the need to induce changes in other parts of the network (Håkansson & Lundgren, 1995).

So far, some products have been identified as compound. Accordingly, these products may be influenced by the technological progress in a number of different fields. A company may find itself in a situation where new technology that seems important for the development of its products comes from areas far outside its field of experience (Dosi, 1988; Ford & Saren, 1996). With lack of knowledge of previous technologies, it is always difficult for the individual company to enter this field (Penrose, 1959). One way of overcoming these difficulties is by developing relationships with companies that are familiar with these technologies (Teece, 1992). Dosi (1988: 279) in particular indicates such cooperation by using terms as "co-development activities" and "R&D joint ventures" as appropriate ways of organizing the development of products when *"the sources of know-how lie external to the firm and cannot easily be acquired"*.

Some of the advantages of developing relationships during product development relate specifically to the idea or invention aspect of the development of the product, for instance the "lead user" may contribute valuable knowledge about how the product should be developed (von Hippel, 1988). According to this author, "lead users" are particularly important when the product is technically advanced and a high need uncertainty exists. The author points out that recognition of the importance of the "lead user" contrasts with the traditional view of the manufacturing company as responsible for the entire development of the product. Håkansson (1987; see also Ford et al., 1998) supports this view by highlighting the importance of the customer in knowledge development in relation to product ideas as one reason for companies to cooperate. Håkansson's argument differs somewhat from von Hippel's. Whereas von Hippel emphasizes the "lead user" as the source of innovation, Håkansson emphasizes the importance of the interaction that takes place within the relationship, which means that the parties jointly participate in this invention: see figure 1.

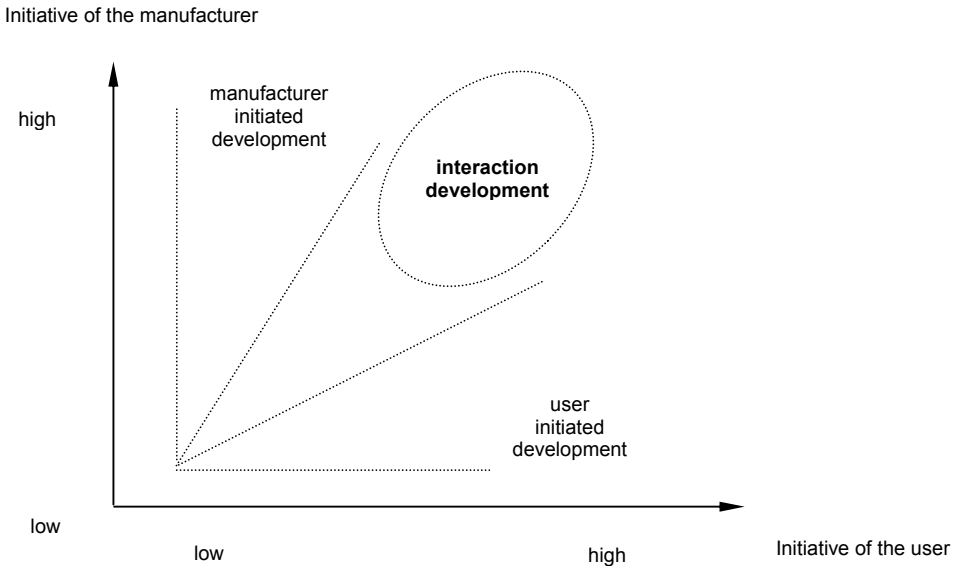

Figure 1 : The initiator of product development
(Adapted from Håkansson, 1987: 86)

Håkansson (1987) also points out that this relationship should not just involve a single customer. Rather, this author presents arguments for why a network of relationships may be involved in this invention as a precursor for the development of the product. Consequently, Håkansson (1987) describes these relationships as idea generators that require interaction and testing in order to verify whether a certain product will be accepted by the network. This is also discussed by Håkansson & Snehota (1995), who suggest that the ideas for product development often originate within relationships because this is where the use of a resource is confronted with how it is produced. Powell et al. (1996) support these arguments by noting that the locus of innovation is sometimes found in networks rather than in individual firms, in particular in situations with complex products and sources of expertise that are widely dispersed among companies.

Other advantages of developing relationships during the course of product development relate specifically to the actual development of the product. Access to complementary resources (Teece, 1986) has already been mentioned, and Steele (1989) points out that these resources for development of a product are obtainable not only at lower cost, but also in less time.

Disadvantages for Companies in Connecting the two Processes

On the other hand, developing relationships during product development does not only carry advantages. Development of relationships is a cumbersome and resource-demanding process (Håkansson & Snehota, 1998). The relationships themselves may represent burdens in many respects, as they involve a loss of control and tend to exclude others (ibid.). Relationships may not simply reveal a variety of new issues to be considered in the development of a product, but they may also represent an obstacle to change due to technical, economic or social dependencies (Håkansson, 1987). In addition, relationships may prevent a company from developing knowledge of important aspects of its products, such as their marketing potential (ibid.).

Nordic VLSI and Development of Products and of Relationships as Connected Processes

Nordic VLSI has so far been discussed in relation either to product development or to the development of a network of relationships. By revisiting Nordic VLSI, this time emphasizing the development of products and of relationships as two connected processes, new aspects emerge. Both VingCard as the customer and Alcatel Microelectronics as the supplier formed relationships with Nordic VLSI as they participated in the development of the ASIC. This indicates that the company's network of relationships is important for the product development, and at the same time that product development is important for the development of this network of relationships. Looking simultaneously at the two development processes therefore reveals new aspects, e.g. how these interact and influence each other.

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