Purchasing's development role : the internal and external integration of purchasing in technological development processes : intermediate report I

Eindhoven
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Purchasing's Development Role

The internal and external integration of purchasing in technological development processes

Intermediate report I

door:
J.Y.F. Wynstra

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The Internal and External Integration of Purchasing in Technological Development Processes

Intermediate Report I

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Contents

List of tables and figures

Preface

This paper is a research memorandum on the first phase of the (PhD) research project 'Internal and External Integration of Purchasing in Technological Development Processes'. Rather than being a final report on a completed project, it is an exploration of the topic at hand, illustrating some of the foundations of our research, and discussing how we will proceed. The empirical part consists of small, explorative case studies at some 20 Dutch and Swedish companies.

Supervisors of this project are professor dr Arjan van Weele, Eindhoven University of Technology - Graduate School of Industrial Engineering, and dr Björn Axelsson, Uppsala University - department of Business Studies. The responsible researcher, drs Finn Wynstra, is affiliated with both institutes.
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Eindhoven / Uppsala, july 1995

Executive Summary

Introduction

Two closely related trends -- the firm's increased dependence on its environment, especially in terms of technology, and the more strategic status of purchasing -- have led to an increased attention for the role of purchasing in technological innovation, especially in technical cooperation with suppliers (see Lamming, 1993; Hines, 1994; Bonaccorsi and Lipparini, 1994 ; Atuahene-Gima, 1995). However, the research still seems underdeveloped.

First, most of the research has focused on purchasing's involvement in new product development projects (see Burt and Soukup, 1985; O'Neal, 1993; Dowlatshahi, 1992; Mendez and Pearson, 1994). Other important issues related to technological development where purchasing can play a role as well, for example, discussions regarding the technical core competences of the firm, are relatively neglected (*cf.* Bonaccorsi, 1992). Consequently, a clear overview of all the appropriate tasks and responsibilities of purchasing in technical development issues is still lacking (*cf.* Williams and Smith, 1990; Atuahene-Gima, 1995). Secondly, most of the research in the field has been limited to large-scale assembly industries, like the automotive industry (Lamming, 1993; Hines, 1994), or the electronics industry (Mendez and Pearson, 1994; Nishiguchi, 1994). Consequently, we know very little about purchasing's involvement in technical innovation in industries with small series production, process - or unit production. This can be considered a shortcoming, as research has shown that these different types of production imply different priorities for the purchasing function (Håkansson, *ed.*, 1982).

In this report, we develop a framework for describing the different tasks that are associated with purchasing's involvement in technological development. In doing that, we do not only consider the contributions purchasing can make to new product development projects, but also more long-term directed activities, resulting in a framework that captures the role of purchasing in technological development across a wide variety of issues.

Before examining this framework , which together with a survey of the existing literature is the main result of the research so far, we want to briefly discuss the design of our research, so that the reader is able understand what the empirical part of our project will involve.

The Design of the Research

In the first year, around 20 interviews have been done to get a better idea of the current state of purchasing's involvement in technological innovation in six selected industries, and of the problems that occur (see chapter 4). The six industries are: the food-packaging industry, the telecommunications industry, the truck industry, the chemicals industry, utility construction, and electrical power generation. Based on these explorative interviews, and on an extensive literature review, we present a framework in which we specified a number of tasks we think form the potential 'role' of purchasing in technological development .

The second phase in the research has been to translate a Scandinavian questionnaire, which is currently being used by a group of ± 20 Swedish and Norwegian researchers to analyze industrial firms. The questionnaire contains questions on the focal firm's five most important supplier- and customer relations, and technological development. It is supplemented with questions focusing on the purchasing strategies, - organizations and - processes of the buying parties, where we will draw extensively on the data gathered from our explorative case studies. The available database gives us the possibility to provide a wealth of relevant empirical data, also on companies outside the industries we have selected. This could, amongst others, help us to find out if we have selected industries that are special in any relevant aspect. The second advantage of carrying out the interviews with the standard questionnaire, is that it provides an excellent way of getting to understand the situation of the company. The questionnaire contains all kinds of questions regarding basic information, necessary whenever one is conducting a case-study on that particular company. Since we want to work with the same companies in the future as we are interviewing now, this is very beneficial.

Within each of the six selected industries, we aim to interview one pair of companies both in Sweden and in the Netherlands, each pair consisting of a customer and one of their suppliers. The information will also enable us to study the horizontal interdependencies and the vertical interdepencies between the various relations. What we want to do next is to take one of the companies of each pair , and study their way of handling technological cooperation with suppliers - especially from purchasing's point of view - more closely. The aim is to make a diagnosis of the current role of purchasing and suppliers in innovation processes for each particular firm, compare that with a more or less 'ideal' situation, and make suggestions for improvements.

Purchasing's Development Role

Purchasing's increasing importance as a source of competitive strength for the individual firm has amongst others been discussed by distinguishing three different roles; a *rationalization* role, a *structure* or *network* role, and a *development* role (Axelsson & Håkansson, 1984).

The *rationalization role* concerns purchasing's possibilities to contribute to the firm's competitive strength by acting to minimize the total costs of inputs, logistics, and production. This is the most traditional role of purchasing. Purchasing's *structure or network role* relates to reducing the degree of supply risk, through manipulating the number of potential suppliers, and influencing the standardization of their product offerings. Purchasing's *development role* implies systematically matching the firm's technological development with the development of the suppliers and the supplier network. It involves, for instance, participating in discussions on the appropriate scope of in-house technical development respectively development in co-operation with suppliers, and generating suppliers' interest in developing products that the firm needs and wants. Additionally, it consists of carrying out development projects in co-operation with suppliers, together with other internal functions (Axelsson and Laage-Hellman, 1991).

The Four Areas of Purchasing's Development Role

In our view, there are four different areas where purchasing has a development role to fulfill: long-term technology management, managing the supplier network, handling individual supplier relationships, and, finally, supporting new product development projects.

Technology Management

As technological development progresses, products consist of a growing number of cosely intertwined technologies, like micro electronics, or telecommunications. At the same time, knowledge within specific technology areas is growing as well, leading to even more narrow specialisms. The technologies that are relevant for a company are getting bigger in number and more fragmented at the same time, while the company controls a decreasing part of it. This implies a growing role for technologies that are controlled by others -- 'external technologies' (Ford, 1988) -- and an increased need for coordination and co-operation in the field of technological development. Since suppliers are an extremely important category of cooperation partners in this context, purchasing has the task of acting as a key contributor to the firm's technology strategy. In the area of technology management, purchasing can play a role (along with other functions) in the *develop-or-buy* question: what kind of technical competences does the customer company want to control itself, and what does it leave to suppliers?

Thomas (1995) argues that the value of a given technology to the purchasing firm can be assessed and described in terms of the availability of the technology, its stability and the level of dependence. The availability of the technology defines the range of companies from which it can be obtained, while the stability relates to its stage of development or maturity (*cf.* Utterback and Abernathy, 1975). The level of dependence defines the reliance of the purchasing firm on the technology for its competitive position (*cf.* Pralahad and Hamel, 1990).

The most appropriate activity for the purchasing function in this context, is the monitoring of supply markets in order to determine the availability of the given technologies, or equivalent/alternative technologies. This is a basic activity within the purchasing function that is instrumental to build up technological competence in general, and an understanding of the technological capabilities of suppliers in particular (Axelsson and Laage-Hellman, 1991, p. 83). This knowledge about alternative technologies, and the capabilities of suppliers -- crucial for becoming involved in technological development processes -- can be collected by different departments or persons. In the case of two chemical companies, we discovered that at one company, purchasing was barely involved in development projects, because it had limited technical expertise regarding the supply market. At the other company, purchasers were supposed to supply the manufacturing divisions with information on technical capabilities of suppliers. This 'centralized locus of control with respect to the flow and exchange of technical information' (Williams and Smith, 1990) was the department's strong argument for becoming involved in issues of technological innovation.

Managing the Supplier Network

Based on empirical research, it has become clear that relationships between companies cannot be considered in isolation as relationships often influence one another (e.g. Håkansson and Snehota, 1995; Anderson *et al.*, 1994; Snow *et al.*, 1992). When managing (or studying) collaborative relationships with suppliers, these interdependencies have to be taken into account as well. As a result, a company not only has to pay attention to single development relationships with different suppliers, but it also has to consider its handling of the total supplier structure.

In the context of managing the supplier network, there are two main tasks that have to be performed: coordinating the different suppliers' complementary strengths, and having suppliers handle their relationships with their own suppliers in a way that is beneficial to the purchasing firm. The first activity implies *horizontal* coordination, and the second one *vertical* coordination. Here, we see the clear overlap between the development role of purchasing, and its network role.

The first task -- the coordination of the complementary strengths of different first tier suppliers -- can be aimed at short-term goals, for example, the development of a new product, or at long-terms goals, like the matching of different specializations in the supplier network. In both cases, the efforts of different suppliers need to be coordinated in time and in content, in order to attain the maximum benefits (Håkansson and Eriksson, 1993). In the case of a beer brewery, this became evident when it tried to develop a packaging solution for canned beer in six-packs. The new solution had to be cheaper than the usual packaging method where 24 cans are stowed on a tray, with plastic rings connecting every two cans. This meant that the cost of the six-pack carton should equal the cost of the plastic rings and the corrugated board tray. Working closely together with the paper suppliers, this turned out to be impossible. Then the can supplier was involved, and asked to make a price concession, arguing that selling in six-packs was expected to increase total sales, and thus also the brewery's purchases of cans. Convincing the can supplier, the whole project turned out to be feasible .

The second task involves efforts to have suppliers handle the relationships with their own suppliers in a way that is beneficial to the buying firm. This is part of what is commonly called 'supply chain management' (*cf.* Womack *et al.*, 1990; Lamming, 1993). To 'manage' technological development processes, it is not sufficient to look at one 'stage' of buyer-supplier relations only; it is necessary to pay attention to interdependencies with other stages in the supply chain as well (Håkansson *ed.*, 1987 and 1989) . In some industries, like the electronics and auto industries, coordination between the innovative efforts of so-called first- and second-tier suppliers seems to be widely practised (Kamath and Liker, 1994; Hines, 1994). In our research up till now we found, however, little evidence for an active role of the purchasing company in this context. Most of this coordination activities seem either to not exist at all, or to be left to the responsibility of the first-tier suppliers. In some cases, the purchasing company even carries out the technological cooperation with the second-tier supplier himself, more or less excluding the first-tier supplier from the process.

For both tasks, it is possible to distinguish between two levels: one where the division of labour between the first- and second-tier, or between the various first-tier suppliers, is given, and one where it can be changed.

In the latter case, the purchasing company might, for instance, want to decrease the degree of vertical integration -- in terms of technical competences -- of a supplier, for example, to achieve a more favourable cost structure or to become less dependent of that particular supplier (notice the overlap between the development - and the other purchasing roles here).

Handling Individual Supplier Relationships

During the last decade, there has been an increasing interest in the development of cooperative supplier relationships (Burt, 1989; Carlisle and Parker, 1989; Helper, 1991; Lamming, 1993; Hines, 1994). One of the motives behind the pervasive trend of reducing the number of suppliers, and developing closer relationships with the remaining suppliers is to benefit from their technological knowledge (Burt and Soukup, 1985; Womack *et al.*, 1990; Gadde and Håkansson, 1993), which can have a large impact on the competitive strength of companies (Clark, 1989). Technological cooperation with suppliers is widespread (Nishiguchi, 1993; Helper, 1991; Håkansson; 1989), and can take various forms: from mutual exchange of technological information, shared tests and trials, and joint design, to joint project groups, and long-term collaboration.

Handling these relationships is the responsibility of the purchasing function, and one of the most important aspects of handling relationships is the actual pattern of contacts between the two organizations in terms of the departments involved. These patterns can differ widely: for example, all the contacts between the various departments can be totally controlled, or only coordinated by the purchasing department, or they can be 'stratified' -- the corresponding functional departments of the two companies interact with each other directly (Cunningham and Homse, 1986; *cf.* Bergman and Johanson, 1978). It is possible to point out four basic tasks in organizing single development relationships:

- select the right partner-suppliers;
- organize the relationship;
- exploit the technological capabilities of the supplier, and
- generate the supplier's interest in developing (parts of) products the buying firm needs or wants.

The first task of handling a collaborative development relationship -- selecting the counterpart -- can be more or less deliberate, but if it is deliberate there are two main criteria: commercial and technical relevance (or leverage). Research has shown that technological cooperation usually takes place in relations that involve large business volumes, and that the causal relation runs from volume to cooperation (Håkansson, 1989). In that case, the choice of a cooperation partner seems to be determined by the overall character of existing supplier relationships. The selection can also take place the other way around: Håkansson and Eriksson (1993) mention the example of Volvo, which in cutting its number of major suppliers used their potential in technical development during the next ten years as the main selection criterion. In this case, the choice of suppliers with which to develop an overall relationship was based on their suitability as a 'cooperation partner'.

The other main criterion in the selection of collaboration partners is their importance in terms of technology. If the technology possesed by the supplier is crucial for the performance of the purchasing firm's product, close cooperation with that supplier is necessary and/or beneficial (Bergman and Johanson, 1978). A particular technology can also be of importance because of the potential interactive and multi-competence effects (Håkansson, 1989).

In this context, Axelsson (1987) emphasizes that the choice of suppliers should not be static; attention should be given to technological areas that may be of interest in the future. The selection of cooperation partners should therefore be based on the company's long-term technological strategy, and its expectations on future technological developments. In that respect, this selection should be closely related to the company's develop-or-buy decisions: as Bonaccorsi (1992) points out, the structural level of the supply network, in terms of vertical integration and disintegration, is affected by the management of individual supplier relationships.

The second task concerns organizing the collaborative relationship, which involves creating the right conditions for a 'productive' relationship to develop. Referring to the 'interaction model' regarding business relationships (*e.g.* Ford, 1990), one critical aspect of these conditions is *atmosphere*: long-term relationships seem to result in and benefit from a balanced power-dependence relationship, a mixture of high cooperation and high conflict, a high level of closeness and mutually shared expectations (Håkansson, 1982). Organizing a collaborative relationship would therefore seem to involve creating these kinds of conditions. This cannot be achieved overnight; "The atmosphere is a product of the relationship ..." (*op.cit.*, p. 21), and the development of a relationship is a lengthy process. Closely related to this is another key element in organizing a productive collaboration: establishing the exchange of information. This is a crucial task, without which the next two tasks - exploitation of the capabilities of the supplier, and getting the supplier interested in certain developments - cannot be carried out (Axelsson, 1987).
The third activity, exploiting the technological competences of suppliers implies mutual adaption of the suppliers' and the firm's capabilities; if not, the capabilities are too far apart to produce possible benefits.

The final activity is the task of getting suppliers interested in developing (parts of) products that the buying firm needs or wants. To get a supplier interested is equivalent to mobilize his resources; for adapting to the buying company's needs and wants, the supplier has to consume some of his resources. One possibility for the buying company to mobilize these resources is to become attractive for the supplier, based on business volume involved, its image, possible new product ideas, access to production technologies, etc. (see Håkansson and Eriksson, 1993). Getting suppliers to develop the 'right things' also takes timing. Timing is important because the resources that companies control are generally limited; it also serves to have all contributions fit together at the same time, to create the maximum effects. However, being focused on product development projects at the customer, most of the available research implies that the timing of supplier involvement is determined by the buyer side. But, in some cases it could be more appropriate that the timing of this involvement is determined by the supplier side, for example, when a supplier introduces a new production technology that is of interest to the customer company. There can be practical problems implementing this 're-scheduling': the large investments in development projects and their tight time-tables make it difficult to benefit from (and, therefore, let take place) information exchange not in phase with these projects (see Kamath and Liker, 1994) . In the truck industry, we came across a small supplier that was delivering sub-assemblies to two major competing customers. These competitors were each involving the supplier in their product development programmes that usually took place following one another. The supplier had pointed out to them that it could be very beneficial in terms of available resources to combine the projects it carried out for the two, but the customers were reluctant to change their project 'rhythm'.

Supporting New Product Development Projects

Most of the research on purchasing's role in technological development, has been limited to the area of the new product development projects (*e.g.* Burt and Soukup, 1985; Dowlatshahi, 1992; O'Neal, 1993; Mendez and Pearson, 1994). Purchasing's involvement in product development is motivated by three major goals: shorter time-to-market, reduced costs (or improved efficiency), and improved quality.

Reduced time-to-market gives the firm two main options: it can earn higher revenues through early market introduction (*cf.* Robinson and Fornell, 1985; Robinson, 1988; Schonberger, 1986), or the firm can start the development project later than its competitors. In the latter case, the firm can acquire more accurate market information, and still introduce the new product at the same time as its competitors, but better suited to the market needs (Wheelwright and Clark, 1992). Concurrent engineering - sometimes referred to as simultaneous engineering, or parallel engineering - concentrates on the simultaneous and cross-functional consideration of product development activities, with the aim of reducing time-to-market (Winner *et al.*, 1988; Takeuchi and Nonaka, 1986). Limiting the concurrent engineering approach only to internal functions implies that, especially in the area of input material, the problems of the sequential engineering approach still remain (Burt and Soukup, 1985; *cf.* O'Neal 1993).

The involvement of suppliers and the purchasing function in product development can lead to a higher quality of the purchased item, and therefore also of the final product, because they will be more knowledgable about the production processes involved and the part itself, and because the supplier will better be able to develop a product that meets the expectations of the customer. Actually, the exchange of ideas between users and producers regarding potential innovations is by many researchers considered to be one of the key success factors of innovations (*e.g.* Von Hippel, 1988; Foxall, 1989).

Involving suppliers in product development projects can have important cost reduction effects as well. First, by cooperating in technological development, companies share development costs, which implies *lower costs per company.* Second, the division of tasks between the co-operating partners leads to *lower total development costs*, because the companies specialize in what they do best. In addition to immediate development cost reductions, technological cooperation can also result in lower costs of the final product .
In our view, purchasing has six main tasks in the product development process:

- providing information on sourcing options, and assisting in the development of specifications;
- suggesting alternatives;
- determining and timing supplier involvement;
- deciding on the degree of competition among suppliers at the time of involvement;
- coordinate the design of protoypes by suppliers, and
- ensuring the availability of items that need to be purchased.

One way to structure these tasks is to describe them according to the different stages in the product development process: concept development, product planning, product/process engineering, and pilot production / ramp-up (Wheelwright and Clark, 1992). It is not implied that these phases follow each other in a sequential order, with the next phase beginning when the previous one has been completed. As has been argued, the 'new new product development process', as advocated by the simultaneous engineering approach, has stages that overlap each other. This means that the listed activities can take place simultaneously as well.

Concept Development / Product Planning

We argue that the purchasing function needs to be involved in the development process from the very beginning, although its contribution in concept development may be limited. Still, some of the decisions even in this phase -- product architecture and conceptual design - could benefit from the information that purchasing can provide. Purchasing can provide engineers with information on new components that are available in the market, or suggest potentially interesting suppliers. Purchasing could function as a kind of 'window' for engineers on the technological capabilities of suppliers. Erens and Van Stekelenborg (1993) refer to this function as 'enlarging the solution-space'. Later, in the product planning phase, purchasing could assist engineers in developing specifications. Preferably, these specifications should be functional, rather than technical. Engineers tend to write quite narrow specifications, often leading to 'sole supply' situations (Van Weele, 1994; Dowlatshahi, 1992). In some cases, even suppliers could be involved already in this stage of the development process, but this will be mostly limited to informal information exchange.

Product/Process Engineering

In this phase, purchasing has as its first task suggesting alternative solutions. It can inform designers and engineers about various suppliers' abilities to meet the functional specifications, giving information about costs, performance, market availability, quality and reliability of particular components (Burt and Soukup, 1985, p. 96). A way of investigating possible alternatives is by means of Value Analysis, targeted to maintain or improve functional and performance output of a new product, while reducing the cost input (*e.g.* Nishiguchi, 1994). Purchasing can also point out to designers other parts that have more common or commercially available specifications: part standardization can reduce costs, the number of suppliers needed, and the time and cost of designing and producing the final product (Wheelwright and Clark, 1992; Kamath and Liker, 1994). This is also the phase where, in general, it is useful to have suppliers involved in the development process (Burt and Soukup,1985; Dowlatshahi, 1992): suppliers often have specific technological knowledge, and based on that they can often suggest alternative solutions that might be cheaper, or technically better than the design solutions the designers of the buying firm have devised. There are two main decisions that need to be taken with regards to supplier involvement: who is involved when, and whether there will be some form of competition between them or not (Bonaccorsi, 1992).

Determining and timing supplier involvement (who and when) is a clear manifestation of *timing* and *priorotizing*. The Dutch manufacturer of copy machines Océ-Van der Grinten is a good example of a company that uses a formal tool to select its cooperation partners, and determine the moment of their involvement in development projects. Océ classifies each purchased product in the well-known purchasing portfolio or Kraljic-matrix (Kraljic, 1983; Van Weele, 1994), which is then used to make a distinction between the different supplier categories and the moment of their involvement in the product development process. To their relationships with suppliers of strategic products, Océ applies 'co-development', which implies that the supplier will be involved in the product development process from the very start (concept stage). Early Supplier Involvement, applied to suppliers of leverage- and bottleneck items, means that the supplier will be involved at the stage of product engineering.

The logic behind this is that those parts of the copying machines that are the most expensive and most important for the machine's functioning are developed first, which requires that suppliers of those parts are involved first. Kamath and Liker (1994) provide evidence from Japan, where similar differences in the level and timing of involvement in product development exist between different types of suppliers.

Regarding the level of competition between the suppliers, there is a continuum with, at the ends, two basic options: (1) there is open competition, and the probability to be selected is the same, (2) there is one selected supplier (Bonaccorsi and Lipparini, 1994). If the buying company wants to have as much freedom as possible, and deeply believes in the incentive benefit of competition, it is likely to choose the first option if available. On the other hand, if it believes that its expression of commitment that is associated with the third option will stimulate the supplier most, and it does not find the resulting dependence troublesome, it will prefer that option. These 'beliefs' are closely related to the company's general purchasing policy in terms of single - or multi-sourcing. This was evident in the case of several truck manufacturers we studied: those that traditionally had a policy of dual sourcing, were reluctant to select just one supplier early in a development project (see also Bonaccorsi, 1992). The actual choice of one of these options depends on various other factors, like the number of available suppliers in the network, their relative technological capabilities, and the resources that the purchasing company is able (and willing) to spend on supplier involvement.

The final activity in the product/process engineering phase is the coordination of the design of prototypes by suppliers. Having the right prototypes at the right time is extremely important for a successful development project (Wheelwright and Clark, 1992), and good performance of suppliers in this context is often crucial (Kamath and Liker, 1994). This involves mobilizing the development resources of suppliers, and timing between their schedules and those of the buying company.

Pilot-Production / Ramp-up

In the last phase of the product development process, purchasing's main task is to ensure the timely availability of the final full-scale produced goods (Burt and Soukup, 1985). This involves mobilizing the production resources of suppliers, and timing between their schedules and those of the buying company. When the configuration of a product is going to be changed in this phase, purchasing should assist in the evaluation of the effects of engineering changes on purchased parts. One way to prepare for these engineering chances is to develop contingency plans for different manufacturing options in case the most favoured option proves unattainable. Again, suppliers can provide useful inputs in this stage of the development process. They are the ones that know their production processes best, and should be able to point to the possible problems and solutions regarding full-scale production. They should also provide information regarding, for example, the availability, and lead times of various components (Dowlatshahi, 1992).

Having defined the four main areas where purchasing can perform its development role, it is clear that these areas are closely related, and overlap partially. For example, while in the area of technology management the division of labour between the suppliers and the purchasing firm is the central issue, this division is taken as given in considering the three other areas of purchasing's development role.

However, as Bonaccorsi (1992) points out, these areas are interrelated: especially the structural level of the supply network, in terms of vertical integration and disintegration, is affected by the management of individual supplier relationships. Similarly, management of the supplier network is affected by the organization of an individual supplier relationship and vice versa (Axelsson and Håkansson, 1984; Anderson *et al.*, 1994).

In the beginning, we identified two flaws of most of the current research on the involvement of purchasing in technological development: it is mainly limited to product development, and to the experiences in large-scale assembly industries. We have tried to develop a more systematic and broader view of purchasing's role in technological development by explicitly considering other levels or areas of involvement. Further empirical research should be done on how exactly these activities are being carried out, by whom, when and under what circumstances. This research should also explicitly consider the influence of production technology on these matters. The broad and systematic framework of development activities that has been developed here can serve as an important starting point for that research.

Chapter 1 Introduction

1.1 The Increasingly Dependent Firm

The modern firm is operating in an environment which is characterized by fast technological development, increased internationalization and often high demands on cost efficiency. To cope with these conditions, it is necessary for every firm to actively co-operate with firms in its environment.
As technological development progresses, and technology becomes more and more complex, and divided into numerous specializations, it becomes increasingly difficult for organizations to posses all the knowledge and competences necessary to develop, produce and sell products on their own. Companies are focusing on what they think they do best, and put the rest of their activities in the hands of others (Pralahad and Hamel, 1990). This trend is reinforced by shortening product life cycles and increased development costs. At the same time, organizations have increasingly focused on innovation as a means of building and sustaining competitive advantages (*cf.* Bolwijn en Kumpe, 1988). Competitors and customers force organizations to innovate, and at an increasing speed. Therefore, to create competitive advantage, companies need innovations; and to realize potential innovations, and to realize them quickly, organizations need to make use of the dependencies between them (Håkansson *ed.*, 1987).
These developments can be observed in, for example, the increasing technological co-operation between manufacturers, subcontractors and their suppliers in, for instance, the automotive, electronics and computer industry (Nishiguchi, 1994). It has lead to a situation where the firm is to a high degree dependent on its environment, and has increasingly become an integrated part of a bigger, and more international network (Axelsson and Laage-Hellman, 1991, p. 9).

Parallel to these changes, important developments have been going on for some years now within firms' purchasing departments. Purchasing has successively acquired more tasks and powers. From having been a mainly administrative unit earlier on, rooted in the financial and stock-handling operations in the firm, it has more and more become a commercial and strategic function (Van Weele, 1992 and Dobler *et al.*, 1990). From being responsible for the price of purchased materials from given suppliers, purchasing has in many cases gone through responsibility for price, ordering decisions, and volumes, to a strategic responsibility for supplier handling, supplier selection, and the creation of supplier structures. Purchasing can nowadays often be described as 'managing the external resources of the firm'. This development ties in with the increase of purchasing's share in companies' production value. Already a decade ago, this share was typically higher than 50 percent and many industries nowadays show shares of 60-70 percent (Van Weele, 1994, p. 12).

These two closely related trends - the firm's increased dependence on its environment, especially in terms of technology, and the more strategic status of purchasing - intersect at one point:

the role of purchasing in technological innovation, and especially in technical cooperation with suppliers. This role can, for example, consist of being involved in the product development process in order to give advice on costs of purchased parts, or of informing development engineers about the technical competences of particular suppliers. Purchasing's involvement in technical innovation has attracted considerable attention during the last decade (Burt and Soukup, 1985; Axelsson, 1987; Dowlatshahi, 1992; O'Neal, 1993; Mendez and Pearson, 1994; Atuahene-Gima, 1995), but the research is still underdeveloped in three respects.

First, most of the research has focused on purchasing's involvement in new product development projects. Other important issues related to technological development where purchasing can play a role as well, for example, discussions regarding the technical core competences of the firm, or innovations in the production process, are relatively neglected. The focus on product development projects at the customer also implies that the timing of purchasing's involvement is determined by the buyer side. In some cases, however, it could be more appropriate that the timing of purchasing's involvement in technical innovation is determined by the supplier side, for example, when a supplier introduces a new production technology that is of interest to the customer company.

Secondly, most of the research in the field has been limited to the automotive industry (Lamming, 1993; Hines, 1994), the electronics industry (Mendez and Pearson, 1994, p. 8; Nishiguchi, 1994), or R&D intensive industries in general (Stuart, 1991; Atuahene-Gima, 1995). Consequently, we know very little about purchasing's involvement in technical innovation in industries with small series-, or unit production. Thirdly, a clear overview what the tasks and responsibilities of purchasing exactly could (or should) be is still lacking (*cf.* Williams and Smith, 1990; Atuahene-Gima, 1995). This is partly due to the limitations we have mentioned under the two previous points.

The research underlying this report aims to fill these three gaps. It is not limited to purchasing's involvement in product development projects, neither to the automotive- and electronics industry, and it tries to develop a more explicit overview of the tasks involved. This report on the first part of the research-project has an explorative character. Therefore, it does not present extensive empirical results, although we have done some explorative case studies (see chapter 4). It is mainly concerned with a discussion of the theoretical background, and the development of a frame of reference regarding the activities that purchasing could carry out in the context of technological innovations. Further research will focus at the actual activities that are carried out: by whom, when, how, and under what conditions. We will also investigate whether and how the performance of these activities can be improved (see chapter 6). In this chapter, we first take a closer look at terminology - what do we mean by 'purchasing'? After that, the different tasks (or roles) of purchasing, both at a general level and within the specific area of technological development, will be discussed. Finally, the structure of this paper is presented.

1.2 What is Purchasing?

Van Weele (1994, p. 9) defines purchasing as: *'obtaining from external sources all goods and services which are necessary for running, maintaining and managing the company's primary and support activities at the most favourable conditions.'* Primary activities are directed at the physical transformaton and handling of the final products; support activities enable and support the primary activities (Porter, 1985, pp. 39-40).

Scheuing (1989, p.4) describes purchasing as 'the acquisition of needed goods and services at optimum cost from competent, reliable sources'. And, 'It consists of both the act of and functional responsibility for securing necessary inputs from outside sources.' (*op.cit.*, p. 5). Scheuing also uses the term 'to procure' to illustrate that these inputs do not have to be bought; they can be leased or traded as well (*op.cit.*,p. 4). The field of purchasing has seen a lot of new terms being introduced in the last decades; strategic sourcing, supply management, procurement, to name just a few. Van Weele (1994, p. 9) provides a useful overview (see figure 1.1).

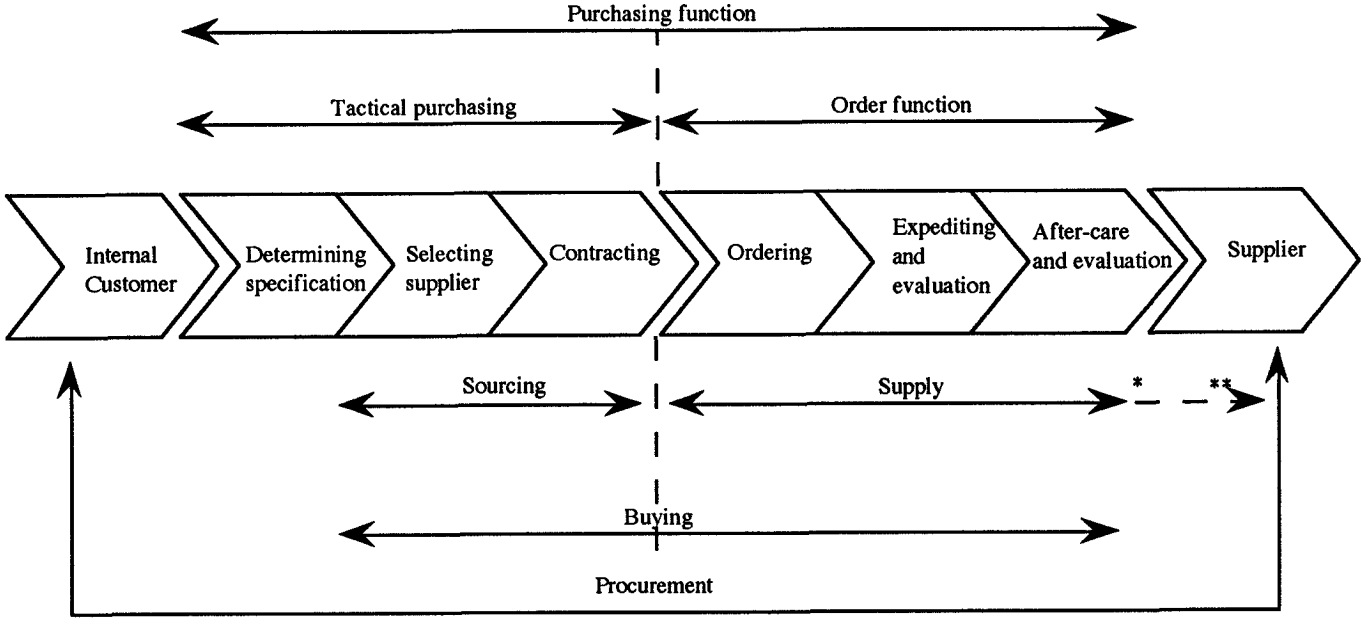

Figure 1.1: Purchasing process model and some related concepts; * = USA, ** = UK. From: Van Weele, 1994.

According to figure 1.1, *tactical purchasing* and *order function* refer to the first three and the last three steps of the purchasing process respectively. Ordering relates to the placing of orders against previously arranged conditions. Tactical purchasing comprises all activities that are necessary to arrange the supply conditions. The activities that are brought under the heading of *sourcing* usually relate to finding and selecting suppliers. In the USA, *supply* covers the internal provision of goods.

In the UK and the rest of Europe, it seems to have a broader meaning to include receiving and storing deliveries. *Buying* usually refers to those purchasing activities for which the specifications are already set. *Procurement* encompasses -- in addition to the purchasing function -- stores, transportation, inspection of incoming goods, and quality control and assurance.

This way of defining purchasing (or ther related terms) places emphasis on the activities involved, rather than the people performing those activities - it perceives purchasing as a *function*. The distinction between the purchasing function and the purchasing department is widely used (*cf.* Axelsson and Laage-Hellman, 1991, p. 10). The purchasing manager coordinates the six activities mentioned in figure 1.1, but this does not necessarily imply that these activities should be carried out by his department; "Therefore, the scope of the purchasing function is usually much broader than that of the purchasing department." (Van Weele, 1994, p.10). For example, management might be involved in make-or-buy decisions, and engineering is probably having contacts with suppliers regarding the design of new products: these activities are also part of the purchasing function. The overall purchasing process cuts through the entire organization. Even straight buying often takes place without the intervention of the purchasing department (*op.cit.*, pp. 28-30). For the rest of this paper we referto purchasing *as a function*, because we are primarily interested in *activities*, rather than in the people carrying out those activities (see chapter 5). We have chosen the word *purchasing* instead of procurement, simply because it is most widely used term. In carrying out the purchasing activities mentioned above, some objectives or goals have to be met: in other words, some 'roles' have to performed.

1.3 The Roles of Purchasing

Purchasing's increasing importance as a source of competitive strength for the individual firm has amongst others been discussed by distinguishing three different roles; a *rationalization* role, a *development* role, and a *structure* or *network* role (Axelsson & Håkansson, 1984).

The *rationalization role* concerns purchasing's possibilities to contribute to the firm's competitive strength by acting to minimize total costs of production, logistics, prices of inputs, etc. More specifically this role comprises the following tasks (Axelsson and Laage-Hellman, 1991, pp. 11-13):

1. **Reduce direct material costs** (price in relation to volume, freight, insurances, etc.).

Examples of measures to achieve this:

- choose products/suppliers that are cheap
- reduce prices by concentrating purchases to fewer supliers
- reduce prices through coordination of common materials requirements for different business units
- reduce prices by skillful negotiating
- adapt one's own product in order to reduce the supplier's production costs (price)

2. **Reduce the indirect** (i.e. internal) **material costs** by:

- improving logistics, for example, by just-in-time deliveries
- reducing the need for inspection/arrival-control
- reducing the costs of credits (interest)
- minimizing operational costs purchasing, for example, by computerized order and invoice handling

3. **Reduce internal production costs** by minimizing:

- reject rates of incoming materials, for example, by improving product specifications
- downtime/production-stops, through improved supplier delivery performance
- machining/assembling time, for example, through adaption of the supplier's product or adaption of one's own product/production process to the supplier's product
- one's own development/construction costs, for example, by letting suppliers take responsibility for development of components or sub-systems

Purchasing's *development role* concerns systematically matching the firm's technological development with the development of suppliers and the supplier-network. This role comprises the following tasks:

1. To ensure that the **technical competences of suppliers are exploited** in the firm's R&D, i.e. to assure that the product development is adapted to externally accessible technology.
2. To generate **suppliers' interest in developing products that the firm needs and wants.**
3. To carry out **development projects in co-operation with suppliers**, together with other internal functions.
4. To **participate in discussions on the appropriate scope of in-house technical development** respectively development in co-operation with suppliers, or by purchasing technology from suppliers.

Purchasing's *structure or network role*, finally, relates to reducing the degree of supply risk.
In this respect, it is not only important to look at relations with direct, first tier suppliers, but also to take into consideration the indirect, second tier suppliers. Put differently, this role deals with:

1. Measures to increase, maintain or decrease the **number of possible suppliers.**
2. Measures to influence the **standardization of the product offerings of the firm's own suppliers,** either to become more standardized or more unique.
3. Activities to **identify, screen and control changes regarding the development of the supplier-structure.**

As is illustrated in figure 1.2, the three roles are connected to each other, and partially overlapping. The rationalization role can, for example, in the short run be favoured by a strategy that creates an unfavourable structure in the long run. Considering costs, it can be beneficial to concentrate all purchases of a particular item at one supplier.

When doing that, one should be aware that the customer does not become too dependent on that supplier, otherwise purchasing has neglected its structure role. Similarly, an important element of the development role can be that purchasing participates in the design-phase of new product development projects. By choosing a design, construction methods, and, consequently, components and suppliers, the rationalization role can be affected in an important way. Suppliers that are excellent partners for technological cooperation, may be, for example, less suitable as a long-term source of supply because of unfavourable cost structures.

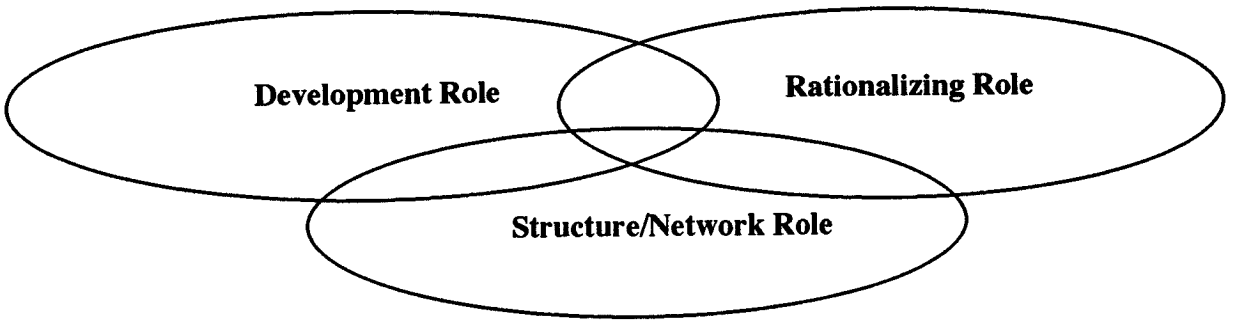

Figure 1.2: Purchasing's three roles: partially overlapping.

The concept of the development role of purchasing captures quite accurately what we want to analyze: the possible taks of the purchasing function in technological development processes.
Focusing on this role, it is important, however, to keep in mind that the development role cannot be considered in isolation from the two other roles.
In the next section, we take a closer look at purchasing's development tasks.

1.4 Purchasing's Development Tasks

The tasks, mentioned in the previous section, involved in carrying out the development role clearly have two aspects. One aspect is related to purchasing's external tasks; dealing with suppliers and supply markets. The other is related to purchasing's internal tasks; dealing with internal departments and -customers. This duality is always present in purchasing activities, as it is a kind of cross-boundary link, spanning across the 'border' between customer and supplier. And it is in its function of serving as that sort of link that purchasing's prime tasks (and most important problems[1]) originate: managing the external resources of the firm.

[1] Note, for example, the often observed phenomenom of purchasers 'switching sides': their loyalty shifts from their employer to the supplier(s) they are working with.

Purchasing is on the one hand faced with (mostly) external suppliers, that have certain characteristics in terms of resources, competences, and skills. On the other hand, purchasing is facing internal customers who, based on their own characteristics, have particular demands regarding the 'inputs' they require. At the interface of these two areas of internal demands and external opportunities, purchasing has its operating field[2]. And it is at this interface that purchasing can acquire a role in technological development processes.

One area of technological development is product innovation (in the next chapter we will look in more detail at the different kinds of technological development). In table 1.1, we have listed some of purchasing's possible tasks and contributions in the area of product innovation.

Table 1.1: Examples of purchasing's possible activities in the field of product innovation

Internal	External
• be involved in the product development process at an early stage to : - introduce a commercial perspective - inform engineers about suppliers' competences - have engineers set up functional - instead of detailed technical specifications • provide information about technological developments in supply markets	• generate suppliers' interest in developing products that the buying firm wants • urge suppliers to become or stay innovative • inform suppliers about the technical competences the buying company is looking for • coordinate the efforts of different suppliers

From these examples, it will be clear that there is a wide variety of activities that can be carried out. Apart from the distinction external vs. internal activities, we can also introduce the distinction strategic vs. operational. Strategic, long-term directed activities would relate to issues like developing an innovative supplier base, shifting major areas of technological knowledge towards suppliers, and developing guidlines for purchasing's involvement in technological innovation processes. Operational, more short-term directed activities would relate to issues like participating in cross-functional teams, the early involvement of particular suppliers in product development projects, and vendor rating on the basis of relevant R&D activities.

Purchasing's development tasks will be discussed in more detail in chapter 5.

[2] Putting it this way, it gives the impression that the customer is always making the demands, and that the supplier is the more dependent party. The reverse, however, can apply as well, for example, when a relatively small buyer is faced with a very dominant and powerfull supplier.

1.5 The Structure of this Paper

In this chapter, we have set the stage for the issue that we are investigating in the next chapters; the internal and external integration of purchasing in technological development processes. We have argued that there are two important developments, being the increasing dependency of individual firms on their environment in terms of technology and production on one hand, and the (consequent) growing strategic importance of the *purchasing function* on the other hand.

These developments together lead to increased attention for purchasing issues in matters related to technological development. Furthermore, we have argued that the development role of purchasing consists of two sides; an internal - and an external side. Additionally, there are operational and strategic aspects to this development role. These distinctions seem usefull when describing and analysing purchasing's development role in a structured manner.

In the next chapters, we investigate this role more closely, based on literature study and some empirical research, in order to develop a more precise description of it. The next two chapters are mainly based on a literature study. In chapter 2, a specific framework for studying industrial markets, the network approach, is presented. We have chosen this approach as a theoretical basis, based on reasons that are explained in more detail in that chapter. The chapter also deals with the perspective of this approach on technological development. In chapter 3, technological cooperation and its various aspects are being discussed. After discussing the rationale behind technological cooperation, we take a look at one specific type of cooperation: between customers and suppliers in industrial markets. Chapter 4 describes a series of explorative case studies, consisting of some 28 interviews with purchasing managers at 22 Dutch - and Swedish companies. These explorative case studies have served to identify the main areas of interest, and to further specify our research questions. They have also enabled us to describe in more detail the kind of activities that would embody the participation of the purchasing function in technological development. These activities are discussed in chapter 5.

Finally, chapter 6 presents the design of the next phases of this research project.

Chapter 2 The Network Approach and its perspective on Technological Development

2.1 Introduction

The network approach has its origins in large empirical studies into relationships in industrial markets, which challenged some of the assumptions of established industrial marketing theory and research (Henders, 1992, p. 24). The group of founding researchers, the International Marketing and Purchasing (IMP) group, challenged (Håkansson *ed.* 1982, p. 1):

- the concentration of the industrial buyer behaviour literature on a narrow analysis of a single discrete purchase,
- the view of industrial marketing as the manipulation of the marketing mix variables in order to achieve a response from a generalized, and by implication passive market,
- the view which implies an atomistic structure in industrial markets, and
- the separation which has occured in analyzing either the process of industrial purchsing or of industrial marketing.

Instead, the IMP group emphasized:

- the importance of the relationship which exists between buyers and sellers in industrial markets,
- the interaction between individual buying and selling firms where either firm may be taking the more active part in the transaction,
- the stability of industrial market structures, where those present as buyers or sellers know each other well and are aware of any movements in either the buying or selling market, and
- the similarity of tasks of buyers and sellers in industrial markets.

These empirically based observations have driven the IMP group to develop a conceptual framework to analyze these phenomena (Håkansson *ed.*, 1982; Turnbull and Valla, 1986; Ford, 1990).

The first step was the formulation of a dyadic relationship model - the so-called interaction model.

In this model, a relationship is seen as the result of an interaction process between two active parties.

A long-term relationship is built up by short-term exchange episodes. In turn, this long-term relationship governs, and ultimately forms the basis for the short-term exchanges. The interaction model is represented in figure 2.1 (next page).

The second step was to include the 'embedded' character of relationships, i.e. their connectedness to other relationships. The approach that resulted from that, has come to be known as the 'network approach' (see also Henders, 1992, p. 24).

2.2 The Network Approach

In the network approach, relationships are not just an affair between two actors, but they are affected by the interests of several actors (Håkansson, 1994, p. 256; Anderson *et al*, 1994). Håkansson and Johanson (1992) provide a useful overview of the network model. The model's basic variables are *actors, activities* and *resources*. They are connected to each other in the overall structure of networks. The basic structure of the model is represented in figure 2.2 (page 13). Actors are those who perform activities and/or control resources. In activities, actors use resources to change other resources. Resources are means, used by actors in performing activities. These circular definitions relate three networks to each other; a network of actors, a network of activities and a network of resources.

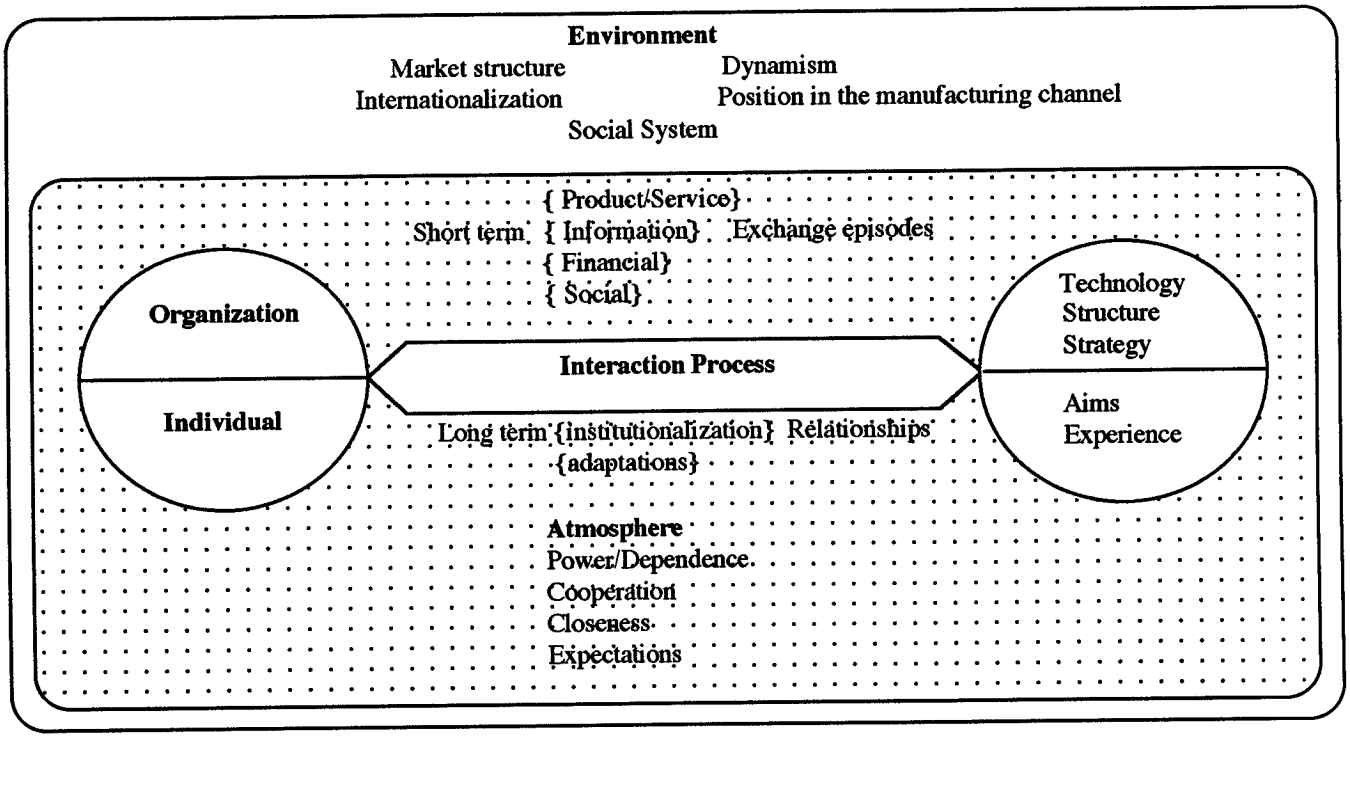

Figure 2.1: The Interaction Model

Source: Håkansson *ed.* (1982)

Actors

There are actors on several levels; individuals, group, parts of firms, firms and groups of firms. Independent of their level, they have five features. First, they determine which activities they perform, in what way, and which resources are to be utilized. Second, they develop relationships with each other through exchange processes. These relationships provide also access to other actors' resources.

Third, the control over resources forms the basis for actors' activities. Ownership constitutes direct control, relationships constitute indirect control. An important characteristic of industrial networks is the different views actors have of the extent of control over a certain resource by certain actors. Fourth, actors are goal oriented. The general goal of all actors is to increase their control over the network. This control is instrumental in achieving other goals. The efforts to increase control affects the control of other actors; sometimes negatively, sometimes positively. Thus, in a network, there are conflicting and common interests. Fifth, actors have differential knowledge about activities, resources and other actors in the network. They have different experiences, and they know different parts of the network.

Activities

There are two kinds of activities, *transformation activities* and *transfer activities*. Transformation activities are always controlled by one actor, and change resources in some way. Transfer activities transfer direct control over a resource from one actor to another. Single activities are linked together in repetitive activity cycles of transformation- and transfer activities. Such cycles are never controlled by a single actor. Activity cycles are -- more or less tightly -- coupled into transaction chains. Most single activities are part of several activity cycles and - chains.

Resources

Resources are used in transformation - and transfer activities. Resources are heterogeneous, meaning that their value varies depending on which other resources they are combined with. They have an unlimited number of attributes, which makes it impossible to decide definitely how they can be combined. Their use and value is dependent on the activity cycles they are utilised in, and on the functions they have in the network. Axelsson and Håkansson (1979) distinguish five resource areas; raw material, manpower, technological, marketing, and financial resources.

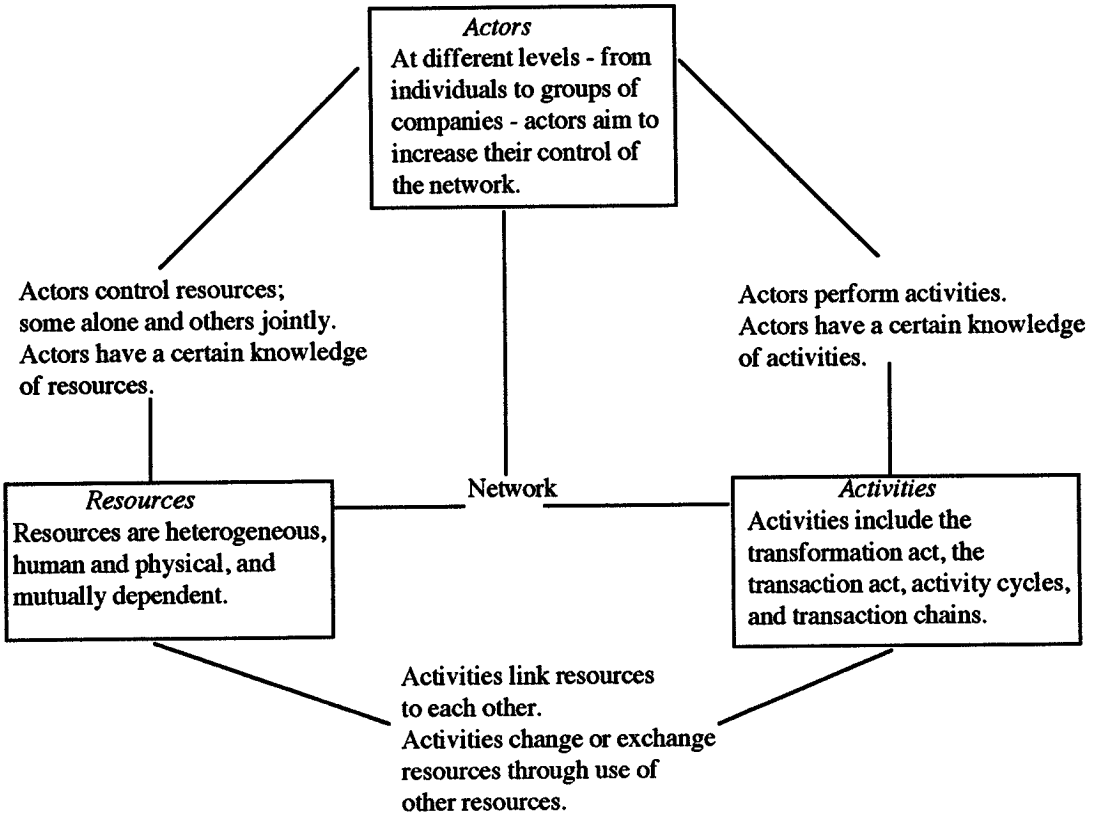

Figure 2.2: The basic Network Model

Source: Håkansson *ed.*, 1987.

Each of these three classes of variables form a network through the relations of their respective elements. The three networks are also closely related to each other. They are bound together by forces, in which terms the total network can be analyzed. These forces are:

- functional interdependence: actors, activities and resources together form a functional system,
- power structure: through control over resources and activities, actors develop power relations,
- knowledge structure: actors use knowledge and experience in designing activities and using resources,
- intertemporal dependence: the history of the network determines its current form, and sets boundaries to change, as change has to be 'accepted'.

Additionally, a network can be tightly or loosely structured; in a tightly structured network, actors have well-defined roles which are known to all. This level of structuralization is both a result and a conditioning factor of changes in the network.

Relationships

The key element in the network approach is formed by the *relationships* between actors. Basically, these relationships have the same characteristics as defined in the (precursory) interaction model, but some features have been introduced to enable more detailed analysis of these relationships (Håkansson and Snehota, 1995, chapter 2). Relationships are said to consist of three elements; *actor bonds, resource ties* and *activity links.* Hammarkvist *et al.* (1982) distinguishes five categories of bonds: technological, time, knowledge, social, and economical/juridical bonds. These bonds indicate to what extent and in what areas actors are oriented towards each other, and/or have mutual interests. Examples of bonds are ownership connections, or extensive social contacts.Ties between resources occur when actors make adaptions in the resources they control, in order to achieve a better 'fit' with the resources of other actors they have relationships with. These resource ties are quite important, because of the heterogeneity of resources. Examples of resource ties are the coordinated use of raw materials, or dedicated manpower[3]. Activity links refer to the connections between transfer- and/or transformation activities in activity cycles. Examples of activity links are a production activity that relies on the transfer of a special input, or the sales of complementary goods.

The network model is voluntaristic; actors can act, but the possibilities are determined by the relations between the three basic variables. However, these relations form also the means for changes. The network model therefore, " .. suggests mechanisms whereby stability and change in industrial systems not only co-exist but are actually dependent one upon the other." (Håkansson and Johanson, 1992, p. 34). After this brief introduction of the network approach, we discuss its perspective on technological development.

2.3 Innovation and Technological Development

Before presenting the network perspective on technological development, we first discuss the concepts of innovation and technological development, and introduce some perspectives on the origins or sources of innovations.

What is innovation? - What is technological development?

Zaltman, Duncan, and Holbeck (1973, pp. 7-9) argue that the term 'innovation' refers to one of the following three concepts: the process of developing the new item, the process of adopting the new item, and finally, the new item itself. These concepts are closely related to each other, be it that they look at innovation from different viewpoints.

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[3] The concept of resource ties bears some relation with Williamson's notion of asset specificity (1985).

The first view is the perspective of the developing unit, the second is the perspective of the adopting unit. These can be different units, but also one and the same, as in the case of a firm developing a production machine for internal use (Biemans, 1992, pp. 7-8). There has been extensive discussion with regard to the term 'new'. Some researchers have argued that it is not necessarily objectively 'new', but that it refers to being new to the unit of adoption (Rogers and Shoemaker, 1971, p. 19). This view has been questioned by others, who stress that innovation only takes place when the organization is among the first to adopt an innovation. Biemans (1992, pp. 8-9) points out that as time goes by, and the diffusion process progresses, "the innovation loses its uniqueness, and becomes just one of the many products offered by the manufacturer, and just one of the many options available to potential adopters." Seeing the new item as an innovation is, however, not the same as saying 'innovation is invention'. Invention is usually the result of research activities, while innovation relates to a commercial product: 'Innovation = invention + exploitation' (Roberts, 1988, p. 13).

We follow Biemans (1992), and opt for a definition in line with the third view of innovation given above: '*any newly developed idea, practice or material artefact that is perceived to be new by the early units of adoption within the relevant environment*' (p. 9). We focus on process- and product innovations, i.e. new practices and new material artefacts. This is because we are interested in *technological* innovation; in that area, we assume, purchasing can make a valuable contribution.

Technological innovation is sometimes also referred to as technological *development*, a term that is widely used, but a clear definition seems to be lacking (Håkansson *ed.*, 1987 and 1989). In general, it would seem to refer to a stream of innovations in time. In that sense, it clearly is a concept that is defined at a macro- or meso level. Technological development -- or technical change (Dosi *et al*, 1988) -- is often referred to as taking place within a certain industry, or a certain (technical) area. Sometimes however, the term '*a* technological development' is used as well, meaning a more specific process. Used in that context, the term seems to be equivalent to 'innovation'. Alternatively, technological development can be said to consist of episodes of innovation.

We will use both terms, innovation and technological development, since we will be looking both at long term development processes, and at specific innovation projects or -episodes. Regarding the long term development, one could, for example, look at a company's supplier structure and the way it is trying to develop that structure to promote technological change. Regarding specific innovations, one could, for instance, analyze the process and organization of particular projects and the role purchasing has. These different aspects are discussed in more detail in chapter 5.

The Sources of Innovations

For a long time, the development of knowledge has been seen as the act of a lonely innovator, inspired by the flash of genius. Operating on its own, the lonely innovator made inventions and innovations, and was thereby the generator of technological development.

This idea has also influenced the view on technological innovations at the level of the company: product development has been seen as an internal issue. The company should be focused at developing the right products, using a systematic development process, and then the products should be introduced to the market (Håkansson, 1987, p.3). Von Hippel was one of the first (1976; 1978; 1982)[4] to challenge this traditional view on innovation:

> *"It has long been assumed that product innovations are typically developed by product manufacturers. ..... However, it now appears that this basic assumption is often wrong."*
> (von Hippel, 1988, p. 3).

According to von Hippel's findings, innovations are not always developed by product manufacturers, but they can also be developed by suppliers, or by users of innovations. He introduces the concept *'functional source of innovation'* to categorize firms in terms of the functional relationship through which they derive benefit from an innovation (1988, p. 3). Suppliers benefit from supplying components or materials necessary to build or use an innovation. Users benefit from using the innovation, and manufacturers benefit from manufacturing the innovation. The functional source of innovation is a useful concept because of two reasons. First, this source differs significantly between categories of innovation. Von Hippel's research indicates that, for example, innovation in scientific instruments, and semiconductor processes is largely dominated by users. In the area of engineering plastics and plastics additives, innovations are mainly developed by manufacturers, and in the use of industrial gases and thermoplastics, suppliers play an important role as innovator. Second, the concept of functional source of innovation opens up a possible explanation for this variance as well. An analysis of the temporary profits expected by potential innovators can by itself allow to predict the functional source of innovation reasonably often.

Focusing at manufacturers and users, von Hippel presented two paradigms describing the idea generation stage of the innovation process. The *Manufacturer-Active Paradigm* (MAP) refers to a process where the customer is quite passive, and where the manufacturer analyzes needs, develops and tests this idea. This paradigm applies to consumer products mostly. The *Customer-Active Paradigm* (CAP) refers to a process where the potential manufacturer is quite passive, and where the customer is active in selecting a supplier, and making the request for a particular innovation (von Hippel, 1978, p. 40). The relevance of the Customer Active Paradigm for industrial products is supported by a number of studies. One of them is Utterback (1974), which concluded that three out of four succesful industrial products were developed in response to a perceived user need. Additionally, the most important factors influencing the success of innovations fall into the category of marketing (uniqueness of the product, benefits to the user, etc.) (Biemans, 1988, p. 24). This too stresses the role of the customer in product innovation.

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[4] Von Hippel's writings and those of the IMP Group (see paragraph 2.1) originate from almost the same period, but von Hippel's ideas on technological development are probably the most well-known.

The MAP and CAP concepts could be compared to technology-push and demand-pull effects respectively. One of the cornerstones of theories on technical change is formed by the work of Joseph Schumpeter (f.e. 1910; 1942). His view on innovation can be termed 'technology push' (*cf.* Lamming, 1993, p. 72). The 'demand-pull' perspective originates mainly from the work of Jacob Schmookler (1966).

Von Hippel's Customer Active Paradigm (CAP) has been criticized by some researchers for still being too much focused on an active role of the manufacturer: "Even in the CAP, it is the manufacturer, not the user, who is responsible for product innovation and who benefits from its wider marketing and economic diffusion as a product ." (Foxall, 1989, p. 96). Foxall and Tierny (1984) argue that CAP describes customer-led invention/innovation, but that it ignores the possibility of customer-initiated entrepreneurship (p. 13). This entrepreneurship involves actively seeking out markets and marketing arrangements for its internally generated innovations. Foxall (1989) uses the term 'user-initiated innovation' (or *reverse innovation*) to encompass situations where the user invents and applies a novel device, and is "entrepreneurially alert to the possibility of gaining maximally from its wider diffusion as product innovation." (p.97).

In general, there is a growing realization that neither the MAP nor the (revised) CAP solely represent reality. Lamming (1993, p. 67) argues that neither the demand-pull type of concept (CAP) nor the technology-push concept (MAP) is sufficient to explain the nature of technical change. Models that combine both driving forces - 'interactive' models - have been introduced, amongst others by Rothwell and Zegveld (1985). The network approach has also adopted an 'interactive' perspective of innovation.

Innovation and Technological Development in the Network Approach

According to the view of the network approach, technological development processes take place in the form of exchange between different actors. Innovations, therefore, should not be seen as the product of only one actor but as the result of an interplay between two or more actors; as a product of a 'network' of actors (Håkansson *ed.*, 1987, p. 3). Innovation relies on three main processes: *knowledge development, resource mobilization,* and *resource coordination.*

Knowledge development, and consequently innovation, is promoted by bringing together different knowledge 'bodies' for two reasons. One is that new knowledge often emerges at the interface of new knowledge areas. Ideas developed for other situations by one actor can be useful to other actors. This happens especially when the actors concerned are a buyer and a seller. This effect is called the *interactive* effect. The other effect is related to the fact that new products are often using several technologies. By bringing together competences in several areas, exchange situations can produce certain *multi-competence* effects.

Actors have to adapt in order to make use of an invention and turn it into an innovation. They have to learn to use it and to combine it with other resources and products. The innovation process therefore involves adaptations, learning, and socialization (acceptance).

These processes require resources, which have to be mobilized. As actors increasingly specialize in the area of production, they also have to specialize their development resources. The resulting specialized development resources increasingly need to be coordinated.

Summarizing, innovations are based on three elements; knowledge development, resource mobilization, and resource coordination. These activities can not be performed by one single actor, but only through exchange between actors. In the network perspective therefore, technological development is almost synonimous with technological cooperation. At the same time, however, technological development cannot be regarded as an isolated phenomenon (Håkansson, 1989, p. 29). At the level of the individual company, technological development can be related to three processes; the company's behaviour towards other units in the network, the company's handling and developing of its resource base, and corporate development as a whole.

Behaviour towards other units

Relationships with other actors in the network often contain elements of technical coordination and collaboration. This cooperation with other units has a positive influence on innovation and technological development in three ways; it creates new knowledge, it creates possibilities for coordinating resources, and it enables actors to mobilize resources. Co-operation has some disadvantages as well. One is the possible loss of control over some resources that are involved in the cooperation[5]. The other disadvantage is related to costs. Every collaboration carries costs, and this sets a limit to the total number of cooperation projects.

Regarding technical cooperation with other actors, several questions arise. The first regards the division of resources between internal development projects, and collaborative projects with others.
The second question concerns the choice of cooperation partners, and the order in which they should be given preference. The third and final question deals with the content and form of the individual development relationships.

Handling and developing the resource base

The company's technological development is largely determined by its collection of resources and relationships. Ideas for technical development usually originate in two ways; either from practice, based on experience, or from theoretically generated knowledge. The relative importance of these two sources depends partly on the kind of technology involved (compare von Hippel's findings regarding the appropriateness of the MAP and CAP respectively). This will in turn determine to a large extent which parties are interesting for the company to cooperate with.

[5] However, the possibilities for control do not only depend on ownership connections. In some cases it could be easier to 'control' an external unit compared with an internal unit, for example, a small, dependent external supplier versus a large, self-supporting subsidiary.

If research based technological development is dominant, then research units will be very active in technical cooperation. If experiential development is dominant, then technical cooperation will mainly take place between producers and users. Besides this technological field, we find the spatial environment that influences the company's technological behaviour towards external parties as well.

Considering the handling and development of a company's resource base, we can distinguish three questions. The first concerns the relative importance of experiential and theory-related knowledge. The second is related to the importance of different types of units to the company's technical development. The third question focuses on the extent to which the immediate environment of the company is used to develop the company's resource base with respect to technological development.

Corporate development

Overall corporate development patterns usually show a mix both of tranquil periods of gradual change and development, and of more dramatic changes. These two basic types of change - step-by-step and leap-wise - can be related to technological development. Leap-wise change occurs in the form of major investment or radical new products. Step-by-step change often occurs in the form of minor product improvements, some complementary investments, or making better use of machines.

This raises two questions. The first concerns the connection between the company's collaborative projects with other parties and the two kinds of change. The second focuses on the possible differences between the various parties in this respect. One possible hypothesis, for example, would be that cooperation with customers leads to step-by-step change.
In our research, we are mainly interested in technological development in relation to the company's behaviour towards other units.

2.4 Summary

This chapter presented a brief overview of technological development as it is perceived in the network approach. In short, technological development is seen as the result of complex interaction processes, not only between users and producers of potential innovations, but between all sorts of actors. Technological development in a network setting involves knowledge development, resource coordination, and resource mobilization. At the level of the individual company, technological development is intertwined with technical cooperation with other actors, with the development of the company's resource base, and corporate development in general.

In the rest of the paper, the focus is on (the relation between) technological development and technical cooperation.

In the light of the three functions that need to be performed during and/or by technological development – knowledge development, resource coordination and - mobilization -- technological cooperation implicates emphasis on three issues. The first regards the division of resources between internal development projects and collaborative projects with others. The second issue regards the choice of cooperation partners, and the order in which they should be given preference, and the third touches on the content and form of the individual development relationships[6].

These issues will return in chapter 4, where we deal with purchasing's involvement in technological development. In the next chapter, we first discuss, in more detail, technological cooperation between suppliers and customers .

[6] These issues remind of Rothwell and Zegveld's description of innovation as 'a complex net of communication paths, both intra-organizational and extra-organizational, linking together the various in-house functions, and linking the firm to the broader scientific and technological community and the marketplace', (1985, p. 50).

Chapter 3 Technological Cooperation between Suppliers and Customers

In the first chapter, we observed two trends that have lead to an increasing relevance of our research topic -- the role of purchasing in technological innovation --: the increase in technological cooperation between firms, and the growing importance of the purchasing function. After having presented our interpretation of technological development in the previous chapter, this chapter is devoted to technological cooperation. We limit the discussion to cooperation between suppliers and customers, as a logical consequence of the focus on the role of the purchasing function in innovation. First, some of the reasons and needs for technological cooperation are discussed. The characteristics and key issues in technological cooperation between customers and suppliers are analyzed. Finally, this and the previous chapter on theory are summarized in the form of a frame of reference.

3.1 The Reasons

There is a wide variety of factors that explain and give rise to the need for cooperation. Here, we will only discuss two groups of factors that seem the most important: technical factors, and economical factors.

Technical factors: Complexity and Differentiation

In section 1.1, we have already discussed some of the developments that have lead to an increased need for technological cooperation from a technical point of view. The most important development in that respect has been technological progress in general, and the increasing complexity that is associated with it. Products consist of a growing number of closely intertwined technologies, like in the field of micro electronics, and telecommunications. At the same time, knowledge within specific technology areas has been growing as well, leading to even smaller 'specialisms'. This implies that it is becoming more difficult for individual companies to posses all the relevant knowledge and competence.

The development towards technological differentiation is reinforced by the trend towards specialization, and concentration on a set of 'core competences' (Pralahad and Hamel, 1990; Quinn and Hilmer, 1994). Companies focus on areas they are strong in, and which they consider to be of strategic importance, leaving other areas for similarly focused companies.

In short, the technologies that are relevant for a company are getting bigger in number and more fragmented at the same time, while the company controls[7] a decreasing part of it. This implies a growing need for coordination and co-operation in the field of technological development. The technical rationale is complemented by, and closely connected with, an economic rationale[8].

Economic factors: Quality, Cost, Time

Business behaviour is primarily motivated by economic goals, profit being one of the most important. Technological cooperation is expected to have a positive impact on profit via three factors: quality, cost, and time (O'Neal, 1993, pp. 4-5).

Co-operation of different, specialized companies can lead to a higher quality of the final product, both because the partners will be more knowledgable about the processes they apply when making their part of the product, and because they are more knowledgable about the part itself. Apart from this technical aspects of quality, there is a marketing aspect of quality, which relates to the 'right quality' - the customer gets (at least) the quality it expects. It will be clear that technological co-operation between customers and suppliers leads to higher quality also in this respect: co-operation involves communication of needs and wants, and in that way the supplier will better be able to develop a product that meets the expectations of the customer. Actually, the entire success of an innovation depends on the communication or cooperation between the producer and the customer of a specific innovation. The confrontation of user- and producer perspectives regarding potential innovations is by many researchers considered to be one of the key success factors of innovations (see section 2.3).

Technological cooperation can have important cost reduction effects as well. First, by cooperating in technological development, companies share development costs, which implies *lower costs per company.* This aspect of sharing costs is supposedly becoming more important, as total development costs for new products are said to rise[9]. Second, the division of tasks between the co-operating partners leads to *lower total development costs*, because the companies specialize in what they do best. In addition to immediate development cost reductions, technological cooperation can also result in *lower costs of the final product.* It is well documented that the design of a product determines the final production costs to a large extent. Some data even indicate that design determines 80 % of total production costs (Whitney, 1988; O'Neal, 1993; Dowlatshahi, 1992). In order to attain the maximum possible cost reductions, cooperation partners -- in our case, suppliers -- need to be involved in an early stage of the product development process.

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7 At least, by means of ownership. As we have seen in the previous chapter, relationships are a means of control too.

8 It could even be traced back to economic reasons, if one assumes that the primary reason for firms not to have all necessary competences in-house is an economic one (as it probably is). While, in this way, the technical rationale for cooperation may ultimately be based on economic motives, there are also more direct economic motives involved.

9 While this might be true in absolute figures, it remains to be seen whether development costs for a product in relation to the company's sales of that product have increased as well.

When suppliers are only involved at a very late stage, the specifications have already been set, and there is no longer room to change specifications which could lead to cost reductions for the final product (see figure 3.1). In the later stages of product development, the costs of using new information for an engineering change are prohibitive.

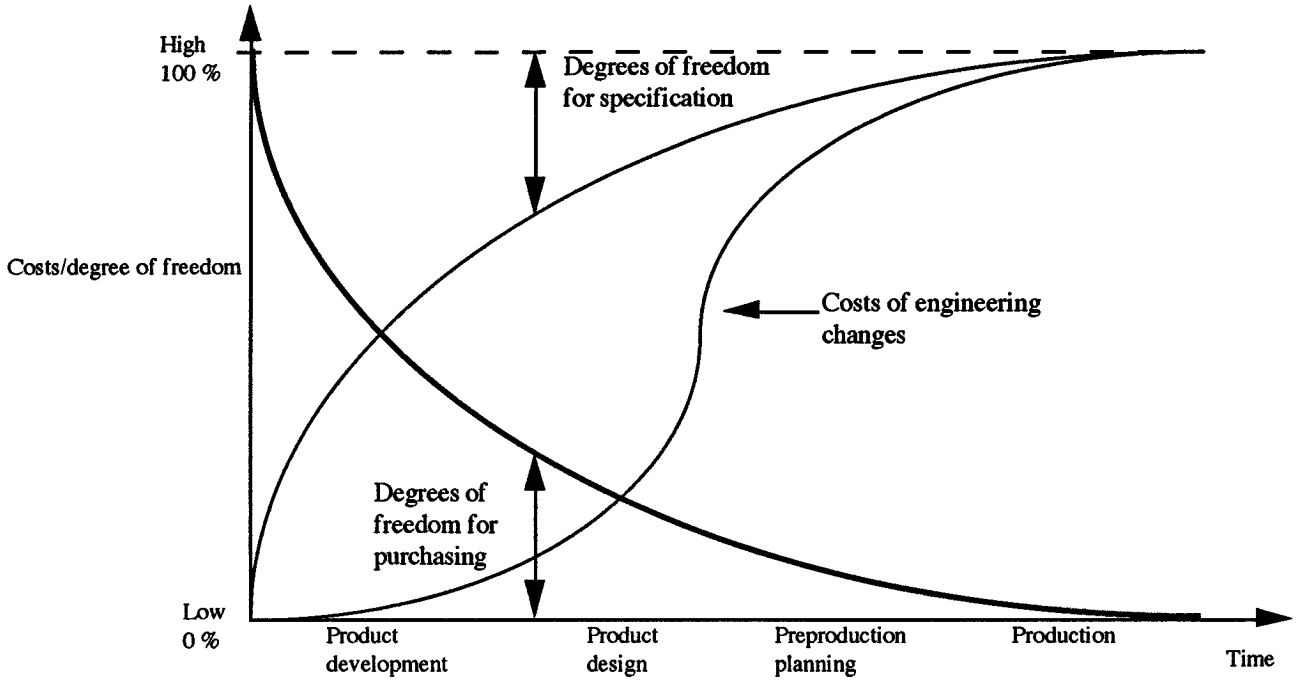

Figure 3.1: Room for achieving cost reductions through product design

From: Van Weele, 1994, p. 146.

Technological cooperation can also be used to reduce time-to-market. Stalk and Hout (1990) introduced the term 'time-based competition'. According to them, "Most important of all is the time required to develop and introduce new (automobile) designs to the market." (p. 29). Introducing a new product earlier than competitors, gives the firm two main benefits. First, it can start to earn revenues at an earlier stage, with the additional benefit of being able to 'skim' the market, and ask premium prices - at least until its competitors enter the market. Second, it is usually able to take a larger market share because of the early introduction, which leads to increased revenues as well. In the electronics market, a rule of thumb states that the first two manufacturers that introduce a new product get as much as a 80 percent marketshare (Business Week, 1990). Data from the PIMS (Profit Impact on Marketing Strategy) project indicates that pioneers obtain marketshares of around 30 %, well above the marketshares of followers and late entrants (*cf.* Robinson and Fornell, 1985; Robinson, 1988).

A McKinsey report states that a half year delay in product introduction leads to reduction of profits by one-third (Business Week, 1990; House and Price, 1991).

The importance of time-to-market is enhanced by shortening product life cycles. As products last shorter at the market place, being late with product introduction carries a higher penalty. It is difficult, however, to present clear evidence of the supposed trend towards shorter product life cycles[10]. We therefore restrict ourselves to stating that if shorter life cycles do indeed occur, time-to-market is of even more importance.

There are also disadvantages of being the first to introduce a new product. The first innovator often incurs considerable expenses in 'creating and educating' the market. These costs are made partly to the benefit of companies that introduce their new product later. The benefits of shorter time-to-market and of being the first will only be interesting, if the market is 'prepared' for the new product, and the costs of 'opening up' the market are not too high. Moreover, the desire to be the first to introduce a new product should not weigh more heavily than the development process itself. Overhastened introductions of products that have not been fully thought through and tested can lead to failures, with potentially disastrous effects for the company.

The engineering process that is specifically designed to reduce time-to-market, is called *concurrent engineering* (Winner *et al.*, 1988). Concurrent engineering - sometimes referred to as simultaneous engineering, or parallel engineering - implies the simultaneous consideration of all product development activities. It is the opposite of so-called sequential engineering, where in every next stage of the development processs, each department will mainly consider its own interests. Simplistically stated: subsequent product concepts are, as it were, being 'thrown over the wall' (O'Neal, 1993). Takeuchi and Nonaka (1986) compare the old approach to a 'relay race, with one group of functional specialists passing the baton to the next group'. The new, simultaneous engineering process is a 'holistic, or rugby approach - where a team tries to go the distance as a unit, passing the ball back and forth' (p. 137). Carrying out development activities in parallel, with each development phase partially overlapping with the next and the previous phase, aims to substantially reduce development lead times. Business Week (1990) estimates that the adoption of concurrent engineering leads to a 30 to 70 percent reduction of development time, quoting examples from AT&T, NCR , and Deere & Co. In research related to our project, Schrijver (1995) reports a 30 percent reduction in development lead time following the implementation of concurrent engineering principles. In addition to reduced development time, concurrent engineering can also have positive effects on development - and product costs, see Womack *et al.* (1990, pp.104-137) and Clark *et al.* (1987).

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[10] Most of the problem is related to what we define as a product. Is a computer with a 386 processor a different product than his successor with a 486 processor? If not, is a computer then a product in itself - and, in that case, do we really experience shorter life cycles?

While the concurrent engineering approach is primarily meant as an instrument to let internal functions and departments cooperate earlier and better by using cross-functional development teams, it involves, ideally, closer cooperation with external players as well, especially suppliers. As O'Neal argues, "two additional representatives from outside the organization need to be added to the CE team. These are the external user (customer), and the key materials suppliers." (1993, p. 5). The reason to involve suppliers in this process of simultaneous engineering as well is basically the same as for the involvement of the internal functions. As products *contain* purchased parts, increasing both in number and in importance, suppliers are more and more affected by, and capable of exerting influence on the design of the final product. Limiting the concurrent engineering approach to internal parties implies that the same old problems of the sequential engineering approach will remain: "..the most vulnerable aspect of the product development system in many companies is their failure to use the full creative capabilities of potential suppliers." (Burt and Soukup, 1985, p. 95).

There are many examples of companies, adopting the simulataneous engineering approach together with early supplier involvement, the Xerox company being one of the pioneers. Other examples include Motorola, Honda, Canon, Epson, NEC, Brother, 3M, Hewlett-Packard and IBM. In the case of Ford, about 70 % of its purchasing value goes to suppliers that concurrently engineer components (O'Neal, 1993; Business Week, 1990). One way to involve suppliers in product development projects, is co-location of engineers. Nishiguchi (1993) states that already in 1958, 'resident engineers' were seen at Toyota (p.71). Since then, it has been a normal practice, for example, in the aircraft industry (Roundhill, 1991).

In this section, we indicated some of the reasons for technological cooperation between buying and supplying companies. At the one hand there are technical factors, being the increased differentiation and specialization in technical knowledge. At the other hand, there are economic factors, being the motive of profit, attainable through quality improvement, cost- and leadtime reductions.

We will now turn to some of the characteristics of technological cooperation between suppliers and customers, and the key issues involved.

3.2 Technological Cooperation

During the last decade, there has been an increasing interest in the development of cooperative supplier relationships (Burt, 1989; Carlisle and Parker, 1989; Womack *et al.*, 1990; Lamming, 1993; Hines, 1994; Gadde and Håkansson, 1993). One of the reasons to develop closer relationships with suppliers has been to benefit from their technological knowledge (Burt and Soukup, 1985; Womack *et al.*, 1990; Lamming, 1993). The use of suppliers' technological capabilities can have a large impact on the competitive strength of companies (Clark, 1989, p. 1256, quoted in Lamming, 1993, pp. 126-127).

In this section, we will discuss technological cooperation with suppliers in more detail.

First, we will take a brief look at some of the characteristics of this cooperation. Following that, attention will be given to some key issues.

3.2.1 Characteristics

Within the network approach of studying industrial markets, considerable research has been done on the nature of technological cooperation. Håkansson (1989) describes the results of a cross-sectional study of more than hundred small and medium sized Swedish manufacturing companies, which were investigated with regard to their cooperation with external parties in technical development. One category of external parties was formed by suppliers. Technological cooperation with suppliers was widespread; around 75 % of the investigated companies had important co-operation relationships with suppliers. More than half had development relationships with at least 3 suppliers. Around 70 % of the companies had development relationships with customers, which of course involves - viewed from the other side - co-operation with suppliers as well (*op.cit.*, pp. 75-82). In the case of Japan, Nishiguchi (1993) reports that "by 1987, approximately 60 % of subcontractors in the electronic, machinery, transportation equipment and precision machinery industries were found to involved in the joint design of components which they sold to their customers" (p.66).

Technological cooperation with suppliers has some specific characteristics (Håkansson, 1989, pp. 75-82, 108-119; see also Håkansson and Eriksson, 1993, pp.12-15). First, the cooperative relationships had a long duration. The weighted average of development relationships with suppliers was 13 years.
Second, most of the relationships -- around 80 % -- had a non-formal character.
Third, there was a close connection between the importance of relationships in terms of volume and the propensity for technical collaboration. Half of the suppliers with which there was cooperation accounted each for more than 5 percent of the total volume of purchases. The evidence showed that volume comes first, and collaboration follows.
Fourth, relationships were used for cooperation in several projects. This was expressed in future expectations regarding the relationships. Fifth, most cooperation took place with suppliers that are located in the same region or country. Sixth, the cooperative relationships involve a wide and lively range of personal contacts.
Seventh and last, the relationships are not just cooperative and friendly, but they also involve conflicting interests and tensions. The strength of well developed relationships is that they can turn these conflicts into something constructive. This notion is present in the whole network approach, and is represented in figure 3.2.

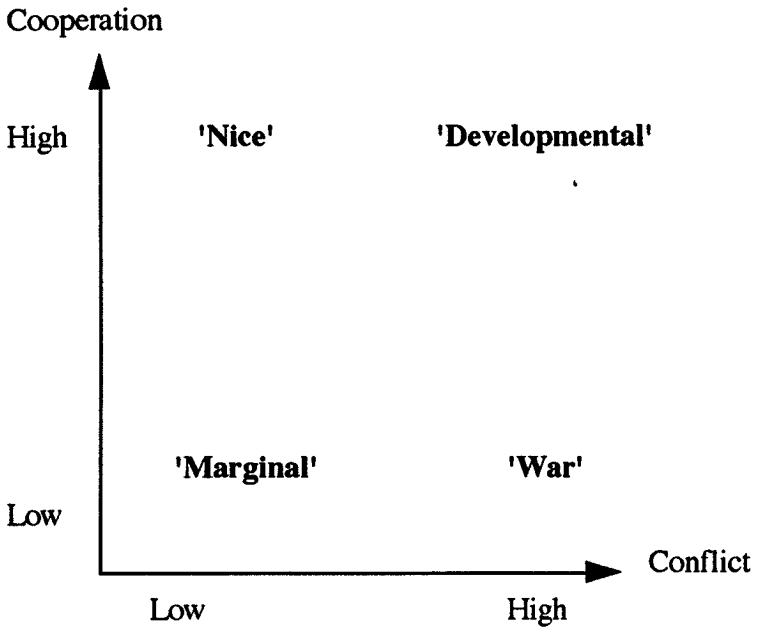

Figure 3.2: Relationships' differing content
Source: Gadde and Håkansson, 1993.

Apart from these common attributes, technological cooperation with suppliers also showed some variations. First of all, the collaborations varied in content. Most common were mutual exchange of technological information, shared tests and trials, and particular projects paid by the other partner. At a higher level, and less often, the company and its cooperating supplier established a joint project group, and carried out long-term collaboration.

Second, the cooperation took place with different types of suppliers. The suppliers of raw or processed materials were most often chosen as a collaborative partner. Continuously bought items like materials and components are more likely to undergo minor innovations, while major innovations mainly relate to less frequently bought items, like production equipment. Consequently, most cooperation projects appear to be concerned with continual adjustments. This confirms the results of other research (Håkansson *ed.*, 1982; Turnbull and Valla, 1985).

3.2.2 Key Issues

Based on the empirical studies reported in Håkansson (1989), and two additional case studies, Håkansson and Eriksson (1993) present four key issues in dealing with technological cooperation with suppliers, or, as the title suggests, in 'getting innovations out of suppliers'. These are *prioritizing, synchronizing, timing,* and *mobilizing.*

Prioritizing involves the choice of the actual collaboration partners. Companies have limited resources to handle their relationships. A collaborative relationship needs resources to function, which means that companies have to set their priorities. The data from Håkansson (1989) mentioned earlier show that one of the factors that determine these priorities, is the volume of business involved.

Synchronizing involves the coordination and adaption of activities and resources within the network that the company is part of. To create productivity and innovations, it is necessary that the company synchronizes its activities and resources with those of its counterparts. This issue has been mentioned in section 2.3, under the name 'resource coordination'. The need for synchronizing grows with increasing specialization.

Timing is a special kind of synchronizing, which involves the temporal coordination and adaption of activities and resources. Timing takes place at three levels; within the single company, within a single relationship, and between different relationships. Timing is becoming increasingly important due to the growing emphasis placed on time-to-market and time in general as a means of competition (see section 3.1).

Mobilizing involves the mobilization of resources and other actors to achieve acceptance for a certain innovation (see section 2.3). The mobilization may involve suppliers themselves and their resources, or their other relationships ('networking').

These four main issues can be related to the three issues that were distinghuished for technological cooperation in general (in section 2.4, see 3.3). Axelsson (1987) stresses that in dealing with these issues, the company should "not only focus on the relationship with a certain supplier and the current exchange with him, but at the same time survey the whole network" (p. 156). In addition to paying attention to the current and direct network it is part of, a company should also consider the more indirect and potential networks the company can relate to. The choice of suppliers, for example, should not be static.

After this discussion of the characteristics and key issues of technological cooperation with suppliers, the chapter is concluded by an overview in the form of a frame of reference.

3.3 Frame of reference

In this and the previous chapter, we have described technological innovation and - cooperation. We argue that innovation does not take place by one single actor, nor solely by pairs of users and producers. Instead, we argue, innovation takes place within a network of actors which all have direct and direct relationships with each other, relationships that influence the innovation process. Technological development draws on three related processes: knowledge development through interactive and multi-competence effects, resource mobilization and - coordination.

At the level of the individual company, technological development is composed of three processes; cooperation with external units, development of the internal resource base, and overall corporate development.

Focusing at the cooperation with external units, especially suppliers, we analyzed specific characteristics, and the key issues involved: prioritizing, synchronizing, timing, and mobilizing. These issues relate to the three processes related to technological cooperation as discussed in section 2.3.
The choice and coordination between internal and collaborative development involves the issues of synchronizing and timing. The selection of cooperation partners and the order in which they should be given preference is the same as prioritizing, and decisions regarding the content and form of the individual development relationships are aimed at synchronizing, timing and mobilizing (of resources and actors).

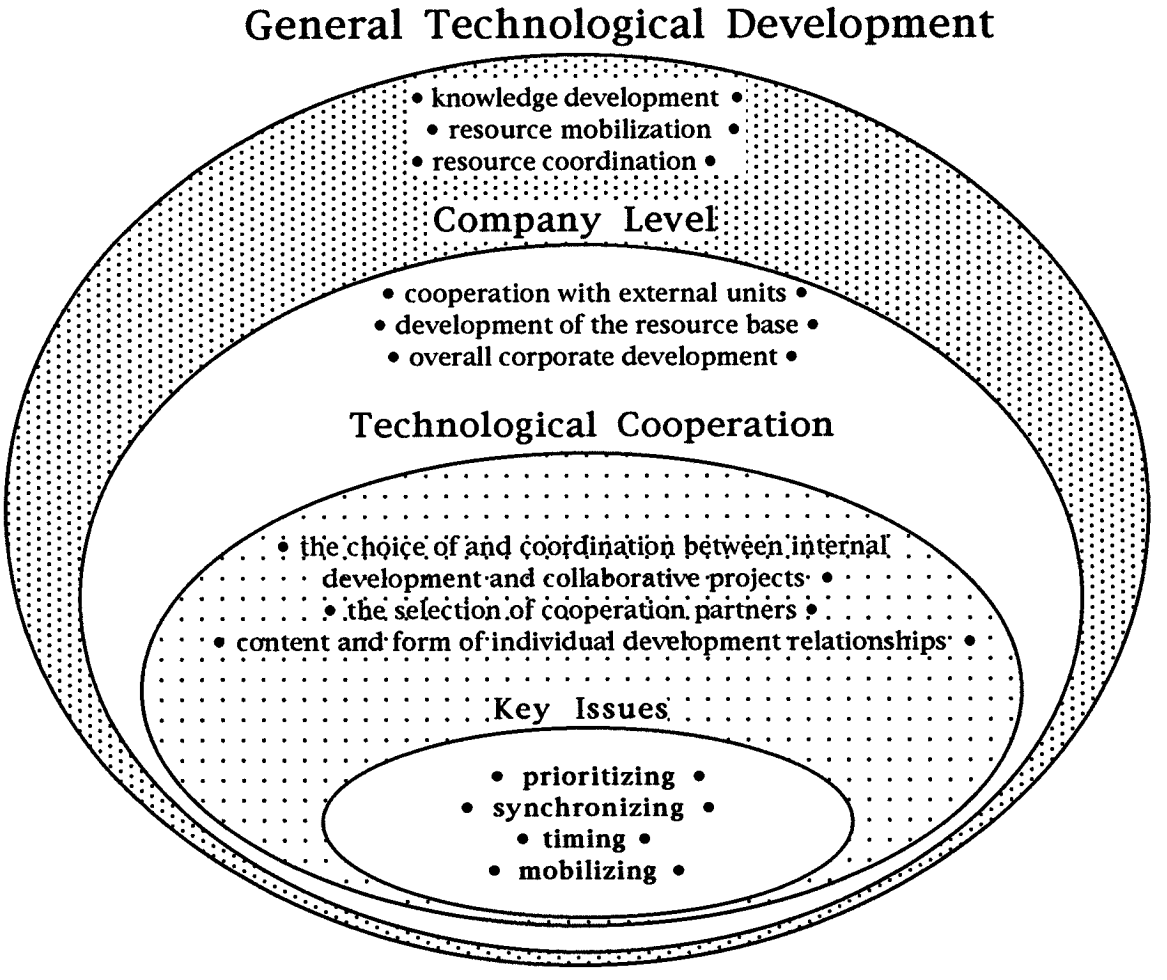

Figure 3.3: Frame of reference

Figure 3.3 presents some kind of frame of reference, incorporating the theoretical concepts we use to analyze technological development, and technological cooperation with suppliers. The four issues in the center form the basis for the tasks the purchasing function has in carrying out its development role. In our research, we will focus at these issues, both at a strategic and operational level. This research is introduced in the following chapter.

Chapter 4 Explorative Empirical Investigations

In the first chapter it was stated that purchasing's involvement in technical innovation has attracted considerable attention during the last decade, but that the research is still underdeveloped in three respects. First, most of the research has focused on purchasing's involvement in new product development projects. Secondly, most of the research has been limited to industries with large-series - or mass production like the automotive -, and electronics industry. Thirdly, a clear overview what the tasks and responsibilities of purchasing exactly could (or should) be is still lacking.

In this chapter, we discuss the empirical research we will carry out to fill these three gaps, putting the most emphasis on the selection of the industries that are studied. The first step of the research project, an explorative series of case-studies, that is reported on here, has been carried out to give an insight into the relevant issues and problems, and to specify the research questions (*cf.* Van Aken, 1994).

4.1 Six Industries, Two Countries - Background and Selection Criteria

The research project contains three major rounds of empirical research; an explorative series of case studies, in-depth interviews using a standard questionnaire regarding the companies' supplier- and customer relations, and an additional round of in-depth interviews that focus more on the development processes. These three rounds of interviews will be completed with a study on the implementation of the developed organizational instruments in (at least) two companies (see chapter 6). The research will mainly be carried out within six selected industrial production chains, but some empirical data from other companies and industries will be used for support and illustration, mainly to describe 'best practices'. The six selected production chains are:

1. packaging for foodstuffs
2. truck industry
3. telecommunications
4. chemical industry
5. construction industry
6. electrical power generation

These chains are studied in two countries; the Netherlands and Sweden.

They have been selected to reflect a variety in the kind of suppliers and customers, in the technologies employed, and in the general competitive environment. Table 4.1 gives a short presentation of the six production chains.

Within every chain, three 'links' or levels of companies will be studied; one or two focal companies, their suppliers and their customers. By doing that, we are able to look at purchasing's contribution to technological innovation not only from the perspective of the customer, but also from the perspective of the supplier. This is especially interesting since, as mentioned earlier, one of the flaws in the research available so far, is the exclusive focus on this contribution of purchasing seen from the customer side. Looking at it from the supplier side can contribute to a better insight into purchasing's development role[11]. Additionally, analyzing three different levels of actors can provide interesting information regarding the (potential) inkerlinkages between different cooperative relationships. Such interlinkages are very relevant for our problem (see sections 3.2.2, and 5.3).

However, the research is focused at the customer company, as our primary interest lies with a function internal to the firm: purchasing, and its development role within that company[12]. It is therefore crucial to choose the focal companies correctly. One of the criteria is, naturally, that they have to be involved in technological development with suppliers. Another, related, criterium is that they need to have identifiable and relatively large customers. Otherwise, it is unlikely that technological cooperation will take place between the focal company and its customers (see section 3.2.1). Since we are primarily interested in the organization of this cooperation (and the role of purchasing), and not whether it takes place or not, this would not be instrumental for our research.

Table 4.1 Overview Production Chains' Characteristics

Production Chain	*Focal Company*	*Products Purchased*	*Final Products (of the chain)*	*Production Technology*
packaging for foodstuffs	beverages producer	(packaging) materials	consumer goods	process / large batches
truck industry	main-supplier	components, subassemblies	finished product/ capital good	large series
telecommunications	telecommunications equipment supplier	components, sub-assemblies	services, finished products	large series
chemical industry	engineering plastics manufacturer	raw materials additives	components	process production
construction	supplier of construction material	raw materials, components	projects (unstandardized)	unit production/ project installation
power generation	turbine producer	components sub-assemblies	installations (standardized)	unit production/ project installation

As has been said before, these industries have been selected to reflect a variety in the kind of suppliers and customers, in the general competitive environment, and in the technologies employed. Research has shown that firms with unit production technology, mass production technology, and process-production technology respectively, have different purchasing strategies and different characteristic problems (Håkansson *ed.*, 1982).

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11 Some suppliers are actively using 'Early Supplier Involvement' in product development as part of their marketing strategy (Ferro *et al.*, 1995; Derikx *et al.*, 1995).

12 Or, at the 'border' of that company: see section 1.4.

As this, presumably, has an influence on the development role of purchasing as well, we decided to include companies with these three different production technologies in our research. Furthermore, we have been careful to not only select industries that have been well studied in the areas of 'new, strategic purchasing' and its relation to technological development, such as the auto industry (Lamming, 1993; Hines, 1994; Kamath and Liker, 1994) or the electronics industry (Nishiguchi,1994)[13].

One could say that we have included two sectors that are more well-known in that respect, being the truck- and telecommunication industry. The reasons why these two have been selected are that they are considered to undergo rapid technological change (especially the telecommunications industry), and to have a purchasing function that is rather well developed. The truck industry seems interesting because it presents an example of an industry that is in technological respect quite close to the well-researched car industry (also using the same suppliers in many cases), but also very different in terms of sales volume and the variety of parts it buys. It is interesting to have the telecommunication industry included in the research, because the product the most important customers of the focal company (*i.e.* telecom operators) are offering is essentially a range of services. We believe this has some influence on the technological cooperation between the telecommunication equipment supplier and the telecom operator. The truck- and the telecommunication industry are examples of series production industries.

As examples of unit-production industry, we have chosen two industries that mainly differ in the extent of standardization of the final product. The turbine industry build turbines in unit-production, but mainly according to standard models. The construction industry builds in unit-production as well (at least in the area of utility- and infrastructure construction), but with a very low degree of standardization. This difference is expected to have an effect on the form and content of technological development and -cooperation.

As examples of process-production industries, we have taken the foodstuff packaging - and chemical industry. The first is actually a kind of mixture of process- and mass-production industry. The focal companies in this industry are producers of beer, beverages and other liquid foodstuffs. The chemical industry is a 'traditional' mass-production industry. It is interesting, as it is an industry where purchasing traditionally is not a very strong function. While technological cooperation with suppliers and customers does take place, the involvement of purchasing seems limited.

Summarizing, we have two mass-production-, two unit-production, and two process-production industries. This variety, and the differences we have referred to within these 'pairs', are hopefully sufficient to build a research project on that aims to fill the identified gaps, and to present ways to involve the purchasing function in technological developments, contingent on company- and industry-specific conditions.

We have also taken the decision to make an explicit comparison between Swedish and Dutch companies. On the one hand, this decision was based on the mere fact that we are able to collect empirical data in these two countries.

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[13] Data from these industries could however be used to illustrate 'best practices'.

Rather than studying some industries in Sweden, and some others in the Netherlands, we decided to structure our research in such a way that, besides inter-industry / intra-country comparisons, intra-industry comparisons are possible. This adds an extra dimension to the research. In that way it becomes possible to compare individual companies within the same industries, and, for example, to check for cultural factors. It also provides the possibility to systematically include technological cooperation between, for instance, Dutch companies and Swedish suppliers, or vice versa. The cultural factors are not our primary interest: otherwise we would have choosen countries that differ more than Sweden and the Netherlands.

4.2 First Impressions

The first series of explorative case studies has been completed during june 1994 - january 1995. It consisted of 28 interviews, mainly with purchasing managers, at 22 different companies. Twelve of these companies were located in Sweden, the other 10 in the Netherlands. In most cases, it concerns the focal companies in the industries under study. In some cases however, it concerns customers or suppliers. In the following sections, the six industries are discusses in more detail, and some of the preliminary findings are presented. Appendix A contains a list of the companies that were interviewed.

4.2.1 The Industry for Foodstuff Packaging

Focal Company	*Products Purchased*	*Final Products*	*Production Technology*
food producer	(packaging) materials	consumer goods	process/large batches

Suppliers	*Focal Company*	*Customers*
	Sweden	
SCA Emballage, Tetra Pak	Pripps	ICA, Konsum
	Netherlands	
Tetra Pak, PKL, Veglaplast, VGL	Riedel, Heineken	Ahold, Schuitema

The industry for foodstuff packaging provides an interesting case to study technological cooperation. Due to environmental concerns, there are quite some innovations in packaging: in the type of material, the amount of material, and in printing techniques. The Swedish brewing company Pripps, for example, is very active in the development of new packaging methods, in cooperation with its suppliers:

> Pripp's most important technological co-operation with suppliers has taken place with regard to trays of corrugated board (SCA), and cartons for six-packs (Frövi). Specifications for corrugated board are functional, not technical: the tray should comply with 'transport' requirements (be able to take the weight of 24 cans), and should be suitable to be dealt with by packaging machines at certain speeds.
> Within that functional requirements, SCA is free to come up with new ideas and solutions. The basic aim is to reduce the required amount of all packaging materials. Pripps used to have only one type of tray, both for 33 cl and 50 cl cans. The planning and production departments were of course quite happy with that. But you can save a lot of material costs, if you make the 24 / 33 tray lighter, as has been done recently. Important developments take place in the field of 6-packs, and those affect the trays as well.

One aspect is the amount of decoration; if you have decorated cans, and then decorated cartons, do you need a decorated tray as well? In Europe, many competitors are selling on undecorated trays. A second issue is that the tray that has 4 six-packs on it, does not have to be as strong as the normal 24-can tray. A third issue has been the thickness of the six-pack carton. Usually, the carton would have a folding systems which requires a certain thickness. Pripps and Frövi have now developed a thinner version, which is glued together. Additionally, this type requires also a smaller piece of carton than the other type. A fourth development is that there are plans to pack six-packs directly onto a pallet, so without any trays at all. Estimates are that six-packs will account for more than 80 % of all sales of cans, and then it is of interest to reduce the amount of packaging material used for that kind of packaging. The goal is to let the six-pack 'method' not be more expensive than the usual tray method. That means that the cost of the six-pack carton should equal the cost of the plastic hycon rings (connecting every two cans) and the tray. This turned out to be impossible. Then the can supplier (PLM) was involved, and asked to make a price concession, as sales in six-packs are expected to increase total sales, and thus also purchases of cans. With this construction, the whole project seems to be possible.
(Source: author's interview with Åke Carlsson, purchasing manager Pripps Bryggerier)

The suppliers of packaging materials themselves are beginning to adopt a more active approach to technological cooperation with their customers as well (*cf.* Ferro *et al.*, 1995). An interesting aspect in this industry, is that the customers - retail channels - are quite powerful, and have a great influence on technological developments. The experiences of the Dutch company Riedel provide some examples of this influence.

Recently, Riedel has adopted two innovations in packaging. One is the small round carton container - the size of a small soft drink can. This so-called Cartocan was introduced by a Finnish company, and Riedel has the worldwide premiere outside Finland. The expectation is that it will have a much more positive image than the small brick shaped packages, with the associated possibility of a higher price. Another innovation concerns the introduction of a reclosable package. Both PKL and Tetra Pak had a solution, of which the PKL option was the most consumer friendly. The sales outlets - the retail channel - however, had objections; the PKL cartons could not be stacked, because the small piece of plastic was too high. Therefore, Riedel has chosen to adopt the Tetra version, although it is less consumer friendly.
(Source: author's interview with P. Preenen, deputy director Riedel Drankenindustrie)

Based on our interviews, we have the impression that, within the foodstuff packaging sector, there:

- is a considerable amount of technological development driven primarily by environmental concerns;
- are important connections between the relations of the various actors;
- is close cooperation between suppliers and users of packaging material; and there
- is a well-developed purchasing function (both at the food producing companies and the retail chains).

This leads us to expect that in this sector, purchasing plays a considerable role in technological development.

4.2.2 The Truck Industry

Focal Company	*Products Purchased*	*Final Products*	*Production Technology*
main-supplier	components, subassemblies	finished product/ capital good	small series

Suppliers	*Focal Company*	*Customers*
	Sweden	
Texas Instruments, ÖW	Valeo Engine Cooling	Scania CV, Volvo Trucks
	Netherlands	
....	Polynorm, Inalfa, Giessen	DAF Trucks

The truck industry has a very high degree of internationalization: not only do companies compete worldwide, they also produce worldwide. Scania, for example, has extensive production in South-America, and Volvo Trucks has plants in a.o. Poland, and the US. Competition in the various segments is quite fierce, which puts a continuous pressure on costs. One way to achieve cost reductions is aiming for benefits of scale, as has been witnessed by the concentration processes that have taken place. Another way is by standardizing the trucks which are offered, by using standard modules, something especially Scania is very strong in. Other companies opt for a focus on certain segments, like for example DAF Trucks. Technological development in the industry is driven by environmental demands from the authorities, and efficiency demands from the customers, of which transport companies and fleet owners are the most important. Fuel economy, durability, emission- and noise levels are important parameters. Attention is also increasingly being paid to the comfort and safety of the driver.

The truck industry is an industry where, just like in the automobile industry, the purchasing function has been recognized as a strategic funtion already for some time, and considerable cooperation takes place between the truck producers and their suppliers. The difference with the auto industry is that the assembly companies in the truck industry are usually much smaller. This means that their position vis-a-vis suppliers that operate in both industries is rather weak if we look at it in terms of volume. DAF Trucks, for example, has relatively little bargaining power when dealing with Robert Bosch (injection systems) or ZF (transmissions). The situation is slighty different for Scania, which is much larger than DAF Trucks, but in general, truck assemblers are far less powerfull than auto assemblers. Other things equal, this implies that the suppliers in this industry are in a stronger position than the suppliers in the car industry. In the area of technological cooperation, this could mean that the customers are less dominating than usually is the case in the car industry.

The technological interdependencies between the final product and (some of) the components and sub-assemblies are quite strong. Therefore, the development efforts of the suppliers of the various components need to be well coordinated. Another interesting feature of this series-production industry is that product innovations regarding the truck often require process-adaptions or -innovations. The focal companies deliver a product that needs to be incorporated in a final product - the truck.

Joint supplier-customer development projects are quite common, and the companies we interviewed, especially DAF Trucks, are giving more and more attention to the organization of such projects. Summarizing, in the truck industry there seems to be:

- a considerable amount of technological development,
- close technological cooperation between truck assemblers and their suppliers, and
- a well developed purchasing function at the truck assemblers.

4.2.3 The Telecommunication Industry

Focal Company	*Products Purchased*	*Final Products*	*Production Technology*
telecommunications equipment supplier	components, sub- assemblies	services, finished products	large series / project installation

Suppliers	*Focal Company*	*Customers*
	Sweden	
Texas Instruments, GEC Plessey	Ericsson Radio Systems	Telia
	Netherlands	
.....	Philips, Nedap	PTT Telecom

The telecommunication industry is a sector with rapid technological change. The equipment producers seem to be the most important drivers in that process. The case of PTT Telecom can serve as an illustration:

> While in the 1970's, one could speak of a technology push behind most of the innovations, innovations nowadays are increasingly being initiated by the customer market. When a business unit comes up with an idea for a new kind of service, this is usually on the basis of a similar service developed somewhere else.
> But, the idea is only investigated when it is already clear whether and how the new service can be realized technically. Before, Telecom used to have a large R&D department, and a great deal of effort went into 'inventing'. Nowadays, there is no financial room for such kinds of innovations.
> Thus, PTT Telecom now only embarks on innovations for which the technology is already available. Video on demand, or the GSM network, are clear examples of innovations that have been demanded by the customers, and that demand little new technology. Suppliers like Alcatel or AT&T have wide experience in the field of telecommunications, and often provide PTT Telecom with interesting information regarding customer demands. Specifications given to suppliers are increasingly functional; this is due to the fact that innovations are more and more 'pulled' by the market.
> (Source: author's interview with G. Brouwer, purchasing director PTT Telecom)

The equipment producers, companies like Ericsson, are working closely with their suppliers - and customers - to provide new products and new technologies.

> Ericsson does not use a formal tool (e.g. the Kraljic matrix) to select the suppliers whom to work with according to Early Supplier Involvement procedures. General criteria however relate to the economical and technical importance of the goods that are delivered by the supplier. The suppliers that Ericsson works with in R&D projects are encouraged to direct their own R&D efforts in the direction Ericsson prefers them to. This is based on the technologies and functions Ericsson wants to offer to its final customers. By focusing their efforts in the direction of Ericsson's wishes and putting less emphasis on other technologies, suppliers can save resources and be more effective.

Suppliers are generally positive about this more intensive way of working. Ericsson tries to have its suppliers work with their suppliers in the same way. They are willing to do so, but often lack the resources.
(Source: author's interview with J. Tufvesson, Vice-President Procurement, LM Ericsson Telefonaktiebolag.)

The liberalization of telecommunications markets and the associated internationalization in both the operator- and hardware markets lead to an increased complexity in the relations between the actors involved. Companies that were only telecoms customers before, are now becoming involved in the operator business as well (f.e. public utilities companies, electronics firms). Competition is increasing, as many (European) countries are getting second - and even third operators. These changes in the environment are having substantial effects on the relationships between customers and suppliers in the telecom market.

Suppliers of hardware are no longer facing only one customer in a particular national market, but they can have two or three - with possibly very different demands. These customers however operate in an increasing number of markets, and therefore have an increasing number of suppliers to choose from. This implies that in terms of technological development, there are more, possibly conflicting demands, and that in the area of technological cooperation, there are more alternative partners to choose from. Traditional national supplier / national operator 'development-pairs', like in the case of Ericsson - Telia in Sweden, will increasingly face or be replaced by other combinations of actors that cooperate in technological development.

Summarizing, within the telecommunications industry there seems to be:

- a considerable amount of technological development, in a rapidly changing environment,
- close cooperation between equipment producers and their suppliers, and
- a well-developed purchasing function, both at the equipment producers and the telecoms operators.

4.2.4 The Chemical Industry

Focal Company	*Products Purchased*	*Products Delivered*	*Production Technology*
chemicals manufacturer	raw materials additives	engineering plastics	process production

Suppliers	*Focal Company*	*Customers*
	Sweden	
BasF, Exon	Akzo Nobel	Perstorp
	Netherlands	
.....	DSM	plastic parts producer

The chemical industry is characterized by a high degree of internationalization. There is a limited number of major producers, which all are global players. Some of these buy their raw materials from other (petro-) chemical companies, others posses or manufacture their own raw materials.

The upstream levels in the industry are dominated by a relatively small number of competitors, while at the level of the customers of the chemical companies, there is a huge number of companies. This means that the chemicals producers have a wide variety of customers they can choose from, while the choice of chemicals suppliers (in many segments) is relatively limited. This will also affect the cooperation patterns.

The chemical industry is also an extremely capital-intensive industry, implying that a large part of the purchases in this sector relate to investment goods. Consequently, it seems that product innovations in this sector are very closely connected with process innovations. This will affect the type of suppliers that chemicals producers have technical cooperation with.

To be able to study technological cooperation in more detail, we have chosen to focus on the production of engineering plastics, plastics that are used quite heavily by the car industry. There is considerable technical development in this area, caused, for instance, by new demands on recyclability and weight-reduction. The development of this plastics takes place in close cooperation with customers. DSM Polymers, for example, has developed new plastics for car bumpers in close cooperation with PSA and Renault. An interesting aspect of this kind of cooperation is that it combines more than just two companies from the supply chain, as the plastics component manufacturer is usually involved as well. This manufacturer will use the plastics material to make the components the automotive customer needs. The reason that a chemical company does not want to work only with the component manufacturer seems to be twofold: it tries to influence the automotive customers to demand specifically that plastics producer's products to be used by the component suppliers ('market-pull'), and it speeds up the development process.

An important difference between this process production industry and the other sectors, is that at some of the chemical companies studied up til now, the purchasing department does not seem to have a very important role in technological cooperation. Development- and production engineers seem to handle most of the contacts with suppliers that involve technological matters. Perhaps this is due to the high capital intensity mentioned before.

Summarizing, in the chemical industry there seems to be:

- a situation of small numbers in the upstream levels of the supply chain, leading to a situation where a chemicals producer will usually have a large group of (potential) development partners at the customer side;
- close technological cooperation between chemical producers and some of their customers; and
- a relatively weak purchasing department at the chemical producers.

In this industry, it is likely that we will find that other departments than purchasing are carrying out the development role of the purchasing *function.*

4.2.5 The Construction Industry

Focal Company	*Products Purchased*	*Final Products*	*Production Technology*
supplier of construction material	raw materials, components	projects (unstandardized)	project installation

Suppliers	*Focal Company*	*Customers*
	Sweden	
.....	Gyproc, Atlas-Copco	Siab, NCC, Skanska
	Netherlands	
.....	Braat, Jongeneel	Kon. Volker Stevin, HBG

In the construction industry, technological development does not seem to be going as fast as in most of the other sectors. Additionally, the purchasing function is just starting to become an important function. Cooperation with suppliers has been taking place mainly within the field of logistics and materials handling (see also Asplund and Danielson, 1991; Holgersson and Wootz, 1991):

> To tackle the logistics issue, attention was first focused at changing the way of thinking within the purchasing organization. The emphasis on price had to replaced with an emphasis on costs. This was difficult, since most of the indicators and measurements the purchasers worked with were still oriented towards price. .....
> Standard catalogue items (drilling machines, screws, nails) were the first group of items to deal with. They were always bought ad hoc, with the fashionable luxury of having them delivered on very short notice. The range of products was enormous, and there was no coordination whatsoever. This was all very expensive for Siab. An effort has been made to reduce the range of products; bottom up, because when the central department would have dictated a certain assortment, this would have been badly received by the people at the workfloor. Agreements have been signed with distributors to have pre-scheduled routes of delivery, so that every site is supplied at a specific time. Currently, Siab is also trying to get these 'first tier' suppliers to work with their own suppliers in similar ways as well. Similar projects have been carried out in the fields of gypsum board, household appliances, and steel reinforcing. It all deals with the activity-chain: which activity can be performed best by which actor? The focus is on the costs and effectiveness of the whole chain, from the production of building materials to the delivery of the construction project to the final customer.
> From the purchasing point of view, the construction industry is following the general trend towards buying in functions/assemblies. In the case of gypsum board, the supplier now delivers pre-cut packages of boards instead of standard units which then have to be cut by Siab. In the case of household appliances, Electrolux now does all the installation instead of Siab. In the case of steel reinforcements for concrete, the distributor company Tibnor is now carrying out a lot of 'production': fitting the steel into the shape and size Siab needs. The steel supplier, Fundia, has concentrated its manufacuring operations, which makes it more difficult for them to plan and transport all kinds of customized reinforcements.
> (Source: author's interview with M. Öberg, purchasing director Siab)

Because of the relative small amount of product innovation (as discovered so far), it might be useful to look at construction- and delivery procedures instead, and to focus on innovation in that respect (process innovations). In our series of explorative case interviews, we have not been talking to a supplier of construction material, i.e. the focal company in this chain. It remains to be seen whether they cooperate with their (sub-)suppliers. The fact that technological development does not seem to be going very fast may to some extent be due to the structure and practices of the industry. The construction industry, both in Sweden and the Netherlands, consists of a small number of major companies and a large number of smaller companies. Compared with other industries, there is very little internationalization. Only recently, major construction firms have started to operate abroad regarding housing- and office construction.

In general, the industry is not known for its fierce competition. Particularly in the Netherlands, long standing practices guarantee that construction projects are granted in turns to each company. This rotation system keeps companies from cutting prices. During the last few years, these practices have attracted increasing attention from national - and European authorities, and some of them have been forbidden. Still however, the industry is far from fully competitive. This lack of competitive pressure may have been one of the reasons that technological development traditionally has not been very strong, and only recently seems to be picking up.

Still, the construction industry remains an interesting case, because:

- the unit-production process places special demands on the purchasing function, which influence the conditions for technological cooperation, and
- it is an example of an industry where the purchasing function is improving its status and postion.

Perhaps, the construction industry can serve as an example where the development role of purchasing is gaining importance.

4.2.6 The Turbine Industry

Focal Company	*Products Purchased*	*Final Products*	*Production Technology*
turbine producer	components sub-assemblies	installations (standardized)	unit production/ project installations

Suppliers	*Focal Company*	*Customers*
	Sweden	
....	ABB Stal	ABB Generation, Vattenfall
	Netherlands	
....	Thomassen International, ABB	SEP, ...

This industry is especially interesting because the focal companies' customers are public utilities (or big industrial companies). Just as in telecommunications, the turbine industry in Sweden has been dominated by strong 'development-pair': Asea (now ABB) and Vattenfall, the national electricity company. These pairs seem to flourish especially in those industries where public authorities are major customers.

The industry has seen interesting technological developments, like in the field of combined-cycle - or co-generation. Those developments have been, at least partly, driven by strong (environmental) demands from customers and other stakeholders than the turbine producers themselves. This indicates that there is substantial technological cooperation in this sector.

In this industry, the interviews have not yet provided many data regarding technological cooperation and purchasing's involvement. It is still unclear which actors undertake most development efforts, and which departments are involved. Further interviews are needed to asses the special characteristics of the turbine industry.

4.3 Further Research

Of the six industries that have been selected, the foodstuff packaging sector and the truck industry seem the most interesting at the moment. The next round of in-depth interviews, will start after we have completed the standardized questionnaire (see chapter 6).

After the first interviews , the questionnaire will be revised and complemented if necessary, and used for the remaining interviews. Within each sector, we will study the focal company through interviews with 2 or 3 purchasing- and marketing managers. This information will be supplemented with interviews at one or two suppliers and customers within the chain.

In the final chapter, we discuss in more detail how the research will proceed. First, in chapter 5, we develop a framework for the activities that compose purchasing's development role.

Chapter 5 Technological Development and the Purchasing function

In this chapter, we focus on the exact topic of our research; purchasing's involvement in technological development. More explicitly, the possible role and contributions of the purchasing function in product - and process innovation processes. As an introduction, in section 1.4, we have discussed some examples of this role, distinguishing external - and internal aspects. In chapter 2, the network approach was presented, being the basis for our theoretical framework, and we looked at different perspectives on innovation. In chapter 3, technological cooperation with suppliers was discussed in more detail: the technical and economic reasons, and the key issues involved.

In the current chapter, we elaborate on the four key issues of prioritizing, synchronizing, timing, and mobilizing, by focusing on what kinds of activities the purchasing function could carry out in tackling those issues. We illustrate these (potential) activities with practical examples. In doing that, we try to make a distinction between internal and external activities, as has been done in chapter 1. Furthermore, we discuss these activities at different levels and in different contexts. Apart from the available literature, we will build our arguments on the findings from our explorative case studies (and related research) that have been presented in chapter 4.

5.1 Purchasing's Involvement in Innovation

Earlier, we have described purchasing's development role or task as '*systematically matching the firm's development with the development of the suppliers and the supplier-network*'. This description refers mainly to two of the key issues that we have identified in the third chapter, namely synchronizing and timing. Naturally, to be able to match the firm's development with that of suppliers, purchasing needs to select certain suppliers to work with (prioritizing), because resources are limited, and it needs to try make suppliers adapt to and accept particular innovations (mobilizing).

To create some logical order in the tasks and key issues that we have discussed, it seems useful to distinguish four levels at which purchasing can make a contribution to technological cooperation with suppliers;

- a general strategic level,
- the level of overall supplier structures,
- the level of the individual supplier, and finally,
- the level of the individual development project.

At each level, the four key issues are present. By distinguishing four levels within purchasing's development role, we try to overcome the first shortcoming of most of the research in the field: the exclusive focus on purchasing's involvement in new product development projects (*cf.* O'Neal, 1993; Dowlatshahi, 1992; Burt and Soukup, 1985; see section 1.1).

The rest of this chapter is devoted to a structured overview of all the possible tasks of purchasing in technical development, which we feel is still lacking (the third shortcoming of most of the available research). In the following sections, we take a closer look at the activities at these different levels. Apart from the available literature, our argument rests on the findings from our explorative case studies (see the previous chapter).

5.2 Strategy and Organization

The formulation of a strategic plan usually is at the basis of any development role purchasing might have. This plan will, in broad terms, have to define what this development role implies, what tasks are associated with it, and the way(s) to perform those tasks. In terms of goals/aims and means, there are in our view four basic questions at the strategic level that need to be answered by the buying company:

1. What kind of technical competences do we want to **control ourselves**, and what do we **leave to suppliers**? (*develop-or-buy* question)
2. What are the **basic principles and objectives** for purchasing's involvement in issues of technological development ?
3. What kind of **organizational lay out** do we want to use for that?
4. What kind of **'tools'** are we going to use in the process?

1. Develop-or-buy

The first question is a major one, with implications for the whole company. Basically, it involves the analysis of the company's core competences (Pralahad and Hamel, 1990). This is an issue that will and cannot be decided by purchasing alone. Moreover, it seems unlikely that purchasing has had a strong voice in these matters up till now. With the increased strategic role of purchasing (Van Weele, 1994; Axelsson and Laage-Hellman, 1991), purchasing's contribution in this discussion could become more substantial.

In our further research, the develop-or-buy question will not be one of the primary interests. In most cases, we assume that the company has reached some kind of decision in this matter. Another reason to not go into this issue too deep, is that it is such a basic and strategic question, that discussing it will lead us far away from our focus on purchasing.

Nonetheless, in some cases we pay attention to it, as increased technological collaboration with suppliers can have implications for this develop-or-buy issue, as is demonstrated by the following example from Ericsson Radio Communications.

> There is a shift of competence between Ericsson Radio Communications and its suppliers. As technological development progresses, electronical components can perform an increasing variety of tasks.
> This means that nowadays the supplier, which used to make a component that only had a minor function within a larger sub-assembly, has to know more about the interfaces with and functions of the other components in the final product. This means that some of Ericsson's previously private knowledge, will now become knowledge that is shared with the supplier. At the same time, Ericsson is increasing its knowledge about the supplier's production and products, in order to use their competences optimally. Consequently, while the total knowledge of supplier and Ericsson together is increased by technological development, the amount of knowledge that is shared between the two increases as well. Ericsson tries to make sure however, that the supplier is not knowledgable about Ericsson's core competences: this could threaten Ericsson's position, and decrease Ericsson's importance to the supplier.
> (Source: author's interview with J. Tufvesson, Vice-President Procurement, LM Ericsson Telefonaktiebolag.)

2. Basic principles and objectives

The second question--what are the basic principles and objectives for purchasing's development role--regards the formulation of a strategic plan. This plan will to a large extent be determined by the overall purchasing strategy, and its role and status within the organization. This, in turn, is influenced by many factors, such as the kind of industry the firm is in, and the kind of production process it uses (*cf.* Håkansson *ed.*, 1982, pp. 316-323). In the previous section we have argued that, talking about purchasing's development role at a strategic level, it is possible to make a distinction between internal -- product development -- aspects, and external -- supplier management -- aspects. When formulating basic principles and objectives for purchasing's development role, it is therefore necessary to include these not only in the general purchasing strategy, but also in the overall development strategy. In other words, it is not sufficient to write in a supplier management statement that suppliers should be involved in product development in an early stage (ESI): this has to be complemented by a development strategy that actively involves these suppliers through some kind of simultaneous - or concurrent engineering approach.

The principles and objectives that need to be formulated can be related to different levels; the total supplier base, individual relations suppliers, or development projects. Again, we use Ericsson to give an example of such principles.

> The early involvement of purchasing is crucial, as the decisions in the early phases of the development trajectory will have a profound impact on all further decisions. The first decisions will set the boundaries; later on, decisions have just to abide these boundaries. If purchasing does not want to be confronted with a largely given set of parameters to work with, it should be involved in the product development process in an early stage. Besides this early participation, it is crucial to have a cross-functional collaboration in the development process to ensure that the views of all relevant disciplines are taken into consideration.
> To make this work, it is necessary to have a decentralized organization with local power. People should be able to sit together in the same room or corridor, and should have the authority to make decisions themselves - otherwise the teamwork process will be a hollow concept. At the same time however, to ensure that the same principles and policies are adopted throughout the organization, it is crucial to have a strong central control of the general way of working. This is also important for showing 'one face' to suppliers.
> These four points - strong central control, early participation, cross-functional collaboration, decentralized organization - are complemented by a fifth point: colloboration and coordination within the whole of Ericsson. According to Tufvesson, this is crucial to prevent the 'swinging of the pendulum'.

> If there is no company-wide coordination in these matters to balance central control of policies and decentralized power, there will always be change from one extreme - total centralization- to the other - total decentralization. Together, these five points are the basic principles for purchasing's involvement in product development projects.
> (Source: author's interview with J. Tufvesson, Vice-President Procurement, LM Ericsson Telefonaktiebolag.)

This touches on our third question, the organizational lay-out.

3. Organizational lay out

The design of the purchasing organization is quite important with respect to its possible involvement at the more operational levels like, for example, product development projects. One of the important parameters of the purchasing organization is the degree of centralization. In general, a decentralized organization seems better suited to become involved in these projects (see the example of Ericsson).
But, Axelsson and Håkansson (1984) state:

> 'For bigger, long term projects in collaboration with suppliers it seems that a strong decentralization of the purchasing function is *unsuitable*; one ends up at a too low hierarchical level, both opposed to internal units and to suppliers." (p.22, own translation).

The case studies in Axelsson and Laage-Hellman (1991) show the importance of organizational lay-out as an influential factor for purchasing's role in product - and process development. Related to the issue of decentralization, Parkkinen (1995) stresses, based on observations at Ericsson Radio Systems, the importance of locating purchasers and developers closely to each other (p. 30).

4. Tools

The last question concerns the design and selection of 'tools' that support purchasing's development role. There is a wide range of possible tools; from the organization of regular meetings of purchasers and engineers, computer information systems (see Erens and Van Stekelenborg, 1993), and vendor rating schemes paying attention to 'innovativeness', to particular engineering approaches (SE/CE), residential engineering projects, and the formulation of functional - instead of technical specifications.

While the design and (to some extent) choice of these tools is a strategic issue, the actual use of these tools takes place at the operational levels: dealing with supplier structures, single suppliers, and individual projects. We will deal with these tools when discussing these more operational tasks. To illustrate the design of supporting tools, we will take a look at the Dutch copy-machine manufacturer Océ - Van der Grinten.

Océ - Van der Grinten is mainly an assembly firm, with extensive R&D facilities. It is working very close with suppliers, especially in the product development process. In choosing the kind of suppliers to work with in this development process, Océ has been using the Kraljic matrix (Kraljic, 1983). This matrix distinguishes purchased items according to their economical - and technical importance and - risk. Kraljic then proposed different purchasing strategies for these four different categories of items. Océ has used the same classification to make a distinction between suppliers and their involvement in the product development process (see fig. 5.1).
Co-development goes one step further than ESI, and implies that the supplier will be involved in the product development process from the very start.

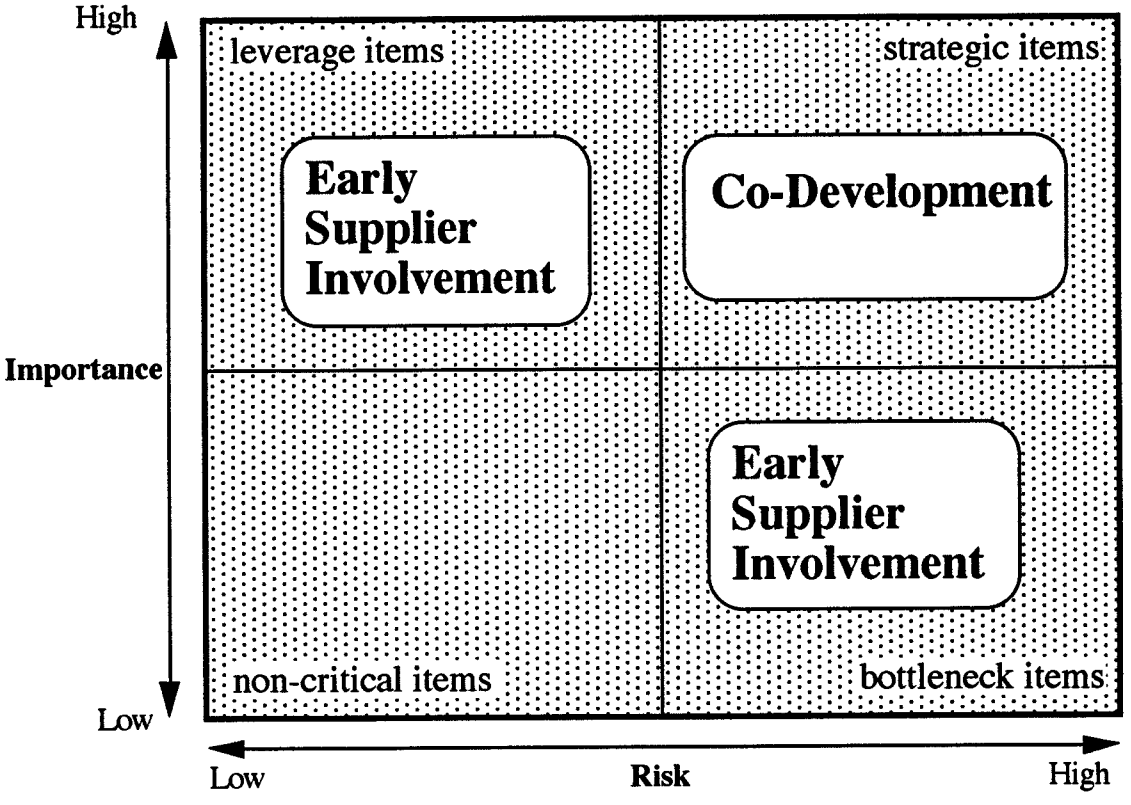

Figure 5.1: Océ-Van der Grinten's Development Matrix

(Source: author's interview with J.Joosten, R&D manager Mechanical Engineering at Océ - Van der Grinten, and Pothast, 1992)

After these four strategic issues - develop-or-buy, principles, organization and tools - we now discuss the issues at the first operational level: the organization of the supplier structure.

5.3 The Organization of the Supplier Structure[14]

In discussing the network approach in the second chapter, it has become clear that relationships between companies cannot be considered in isolation - relationships often influence one another.When managing (or studying) collaborative relationships with suppliers, these interdependencies have to be taken into account as well. The discussion of the four key issues has also pointed to the interactions between different supplier relationships. As a result, a company does not only have to pay attention to single development relationships with different suppliers, but it also has to consider its handling of the total supplier structure. Håkansson and Eriksson (1993) present some examples of these interdependencies, for example, in the case of the development of a special purification system for the pharmaceutical industry:

> " Biopharm cannot replace a supplier without consequences in other supplier relationships. This is a typical network effect when technical adaptions are made in several relationships, and it means that Biopharm is not only dependent on each single supplier relationship, but rather on the specific combination of relationships that has been created." (p. 21).

Reformulating the four key issues from our frame of reference, there are six basic tasks that have to be performed in the context of the organization of the supplier structure:

1. **monitor** technological developments at (potential) suppliers,
2. **exploit** the technological capabilities of suppliers (i.e. synchronizing),
3. **generate suppliers' interest** in developing (parts of) products the buying firm needs or wants (mobilizing, timing and synchronizing),
4. **coordinate** the different suppliers' complementary strengths (synchronizing and timing),
5. **make suppliers work with their suppliers** in a way that is beneficial to the buying firm (all four issues), and finally,
6. all these tasks need be carried out in **internal coordination** (synchronizing and timing).

1. Monitoring

The monitoring of the supply market is an activity, which is necessary in order to build up competence regarding the technological capabilities of suppliers. Examples of such a monitoring function are given by Axelsson and Laage-Hellman (1991), for instance, in the case of Electrolux Household Appliances (p.83). Knowledge about technical possibilities, and the capabilities of suppliers, seems to be crucial for the purchasing department in order to get involved in technological development processes.

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[14] Using the phrase 'supplier structure' instead of 'supply chain' has been a deliberate choice. 'Supply chain' has a more abstract, flow-oriented connotation, whereas 'supplier structure' emphasizes the fact that it is a set of identifiable actors that need to be organized and coordinated. Using the term 'supplier structure' is therefore more in line with our adoption of the network approach (see paragraphs 2.1 - 2.2), while the term 'supply chain' seems to be more related to the rather anonymous concepts of production columns.

As an illustration, we can name the business unit for polymers manufacturing of the Dutch chemical company DSM, where a lack of technological expertise prevents an active rol of purchasing in technological issues:

> In general, the contribution of business unit purchasing managers to these new construction projects is mainly limited to legal aspects. They also pay attention to the contractor's capability in project management, the quality of their organization and their use of subcontractors. The purchasers usually do not have the required technical knowledge to be able to function as a kind of supplier-expert. Therefore, purchasing is not heavily involved in technological innovation processes. Purchasers do not have sufficient knowledge to be involved in the design and engineering of new plants, and after a new plant has been built the choice for suppliers during the lifetime of the plant is, generally speaking, limited to those that supplied the original plant. Consequently, purchasers are not in an optimal position to make important contributions with regard to identifying new suppliers that offer new technical solutions and products.
> (Source: author's interview with P. Paes, purchaser business unit PP Manufacturing, DSM Polymers.)

The opposite seems to hold in the case of the Swedish chemical company Berol Nobel:

> Purchasers are also supposed to supply the manufacturing divisions with information on technical capabilities of suppliers, and the suppliers with information on the divisions' demands. For this, purchasers need to be knowledgable about production techniques. Even when direct contacts between technical mangers of both a division and a supplier are established, purchasing wants to remain involved: it can learn from the discussions, and it keeps an eye on the commercial aspects. The information exchange and technical transfer form the department's competitive edge.
> (Source: author's interview with S. Svengård, purchasing director Berol Nobel AB)

2. Exploiting

Monitoring is logically followed by the next task; exploiting the technological competences of suppliers. This exploitation implies an element of synchronzing the suppliers' - and the firm's capabilities; if not, the capabilities are too far apart to produce possible benefits. An example of this exploitation of suppliers' competences is provided by the packaging material division of Tetra Pak:

> Some years ago, Tetra Pak was under increasing pressure to improve the environmental characteristics of the production operations in Lund, which are situated in the middle of the city. It realized that it could not change things at the required speed all by itself, so paper-, ink-, and polyethylene suppliers were called in together to make a joint effort in developing a water-based printing process (flexography).
> (Source: author's interview with N.-G. Andersson, purchasing manager Tetra Pak Packaging Material AB)

Another example comes from the Dutch retail group Ahold, and its in-house supplier of private label goods (a.o. coffee, tea, and peanuts), Marvelo:

> Main driver of technological developments in the area of packaging materials has been the concern for the environment. The convenant between the Dutch government and the foodstuff industry regarding the reduction of the use of packaging materials has had a big impact on the speed of these developments. Ahold has signed this convenant as well.
> Following that, Ahold has developed a policy guideline on the reduction of packaging materials of its private label articles. It was then up to the production companies, like Marvelo, to come up with the technical solutions - they were expected to have the necessary expertise.
> (Source: author's interview with A. Sijpkes, purchasing officer, and J. Roos, packaging specialist, Marvelo)

3. Generating suppliers' interest

The next step is generating suppliers' interest in developing (parts of) products that the buying firm needs or wants. This task too clearly involves synchronizing , but also mobilizing and timing. To get a supplier interested is equivalent to mobilize his resources; for adapting to the buying company's needs and wants, the supplier has to consume some of his resources. One possibility for the buying company to mobilize these resources is to become interesting for the supplier, in other words, trying to get priority (see Håkansson and Eriksson, 1993, p. 29). This can be illustrated with an example from the R&D division of Tetra Pak:

> When at a certain point in time, things get more clear, and Tetra Pak is able to specify its demands and wishes, then the stage has come in which a development contract is concluded. Legal and technical experts provide input for these contracts. The contract arranges the potential property rights as regards patents and the like, and the financial compensations for the supplier. However, the contract may be based on just one of these aspects. The trick is to find the right compensation; working with a customer like Tetra Pak can be valuable even in itself. Tetra Pak can be a quite big customer, and in many areas it is technologically well advanced.
> (Source: author's interview with B. Rosengren, purchasing manager Tetra Pak Research and Development)

Getting suppliers to develop the 'right things' also takes timing. Håkansson and Eriksson (1993) give the example of an unsuccesfull collaboration project with a supplier that was trying to expand its operations somewhere else at the same time (pp. 19-20). Timing is important because resources are, generally, limited. It also serves to have all contributions fit together at the same time, to create the maximum interactive effects (see section 2.3).

4. Horizontal Coordination

The fourth task concerns the coordination of the complementary strengths of different suppliers. Like the previous task, this contains elements of synchronizing and timing. The efforts of different suppliers need to be coordinated in time and in content, in order to attain the maximum benefits. As Håkansson and Eriksson (1993, p. 30) argue "..efficiency is not only determined by the way separate relationships are handled, but also by how the different relationships are combined." [15].
We can take a look at Tetra Pak Packaging Material's development of flexography printing again, for an example of this coordination:

> ... so paper-, ink-, and polyethylene suppliers were called in together to make a joint effort in developing a water-based printing process (flexography). Up till then, only some of them would be involved in development projects at the same time. This 'partial approach' had a lot of disadvantages, as changes in the products of one supplier would affect the required specifications of the other suppliers' products. Involving all suppliers at the same time avoids these kinds of problems.
> (Source: author's interview with N.-G. Andersson, purchasing manager Tetra Pak Packaging Material AB)

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[15] See also our quote concerning the case of Biopharm on p. 38.

5. Vertical Coordination

The fifth task regards the efforts to make suppliers work with their suppliers in a way that is beneficial to the buying firm. This involves what is commonly called 'supply chain management', with special emphasis on innovation processes (Womack *et al.*, 1990; Lamming, 1993; Van Weele, 1993). As has been said before: innovation takes places in networks, not only in buyer-supplier relationships. To 'manage' technological development processes, it is therefore not sufficient to look at one 'stage' of buyer-supplier relations only. It is necessary to pay attention to interdependencies with other stages in the supply chain as well. This coordination of the efforts of secondary suppliers with those of suppliers and the buying firm, involves elements of all four key issues; prioritizing, mobilizing, synchronizing and timing.

In some industries, like the electronics - and auto industry, coordination between the innovative efforts of so-called first - and second tier suppliers seems to be widely practised . In our research up till now, we have, however, found little evidence for an active role of the buying company. Most of this coordination activities seem either to not exist at all, or only as the responsibility of the first tier suppliers:

> The suppliers that Ericsson works with in R&D projects are encouraged to direct their own R&D efforts in the direction Ericsson prefers them to. This is based on the technologies and functions Ericsson is aiming to offer to its final customers. ..... Ericsson tries to have its suppliers work with their suppliers in the same way. They are willing to do so, but they face a shortage of time. Time which is expensive as well, because it usually takes managers to do this kind of work.
> (Source: author's interview with J. Tufvesson, Vice-President Procurement, LM Ericsson Telefonaktiebolag.)

It is quite relevant to look at innovation processes from a broader perspective than just the individual buyer-supplier relationship, as is also shown by the experience of Riedel, a Dutch producer of fruit juices and -nectars:

> The interests of the retail channel often obstruct the introduction of new packaging forms. For example, Riedel had asked Tetra Pak to develop an aseptic version of its square, reclosable package with rounded edges (Tetra Top). Tetra has not done that, because it thought retail would object to the inefficient use of space. ..... However, the entire environmental discussion has had a positive influence on thinking in terms of chains - packaging material supplier, food producer, retail channel.
> (Source: author's interview with P. Preenen, deputy director Riedel Drankenindustrie)

6. Internal coordination

As we have argued in the first chapter, the purchasing function is not the sole domain of the purchasing department; other departments play a role in that function too. Likewise, the development role is not limited to the purchasing department. The five tasks that have been mentioned above as being part of the development role at the level of the total supplier structure can be carried out by different departments. We have seen, for example, that the purchasing department may not have the expertise to carry out a certain task. Instead, the production department takes responsibility for it. This means that, in order to carry out this role in a consistent and constructive manner, the efforts of various departments need to be coordinated, a task that may well be up to the purchasing department.

Summarizing, we have argued that purchasing has six 'development tasks' at the level of the total supplier structure - monitor developments, exploit capabilities, getting suppliers interested, coordinate complementary efforts, coordinate the 'development chain', and coordinate the efforts of various internal departments. In the next section, we deal with purchasing's development role at the level of single development relationships.

5.4 The Organization of Single Development Relationships

At the third level, purchasing's development role has to take care of the organization of single development relationships. It is difficult to analyze this activity in itself, both because it has so many connections with the organization of the total supplier structure, and because it is so closely related to the overall supplier relationship. It is therefore not so easy to describe the special tasks for purchasing at this level; in any case, they will resemble both the tasks we have mentioned in the previous section, and tasks that are related to more general supplier relationship management.
Again on the basis of the four key issues, it is possible to point out five basic tasks in organizing single development relationships:

1. **select** the right partner-suppliers (prioritizing),
2. **organize** the relationship,
3. **exploit** the technological capabilities of the suppliers (synchronizing),
4. **generate the supplier's interest** in developing (parts of) products the buying firm needs or wants (mobilizing, synchronizing, timing), and finally,
5. again, all these tasks need be carried out in **internal coordination** (synchronizing and timing).

1. Selection

The first task in organizing a collaborative development relationship, is to select the counterpart. This selection can be more or less deliberate. Evidence has shown that technological cooperation usually takes place in relations that represent large 'activity volumes', and that the causal relation runs from volume to cooperation (Håkansson, 1989). In that case, the choice of a cooperation partner seems to be determined by the character of overall supplier relationships. The selection can also take place the other way around: Håkansson and Eriksson (1993, p. 7) mention the example of Volvo, that in cutting its number of major sub-suppliers, used the suppliers' potential in technical development during the next ten years as the main selection criterion. In this case, the choice of suppliers with which to develop an overall relationship was based on their suitability as a cooperation partner.

Important criteria in the selection of collaboration partners are the potential interactive - and multi-competence effects (see 2.3).

Interactive effects arise at the interface of different knowledge areas, due to different perspectives on common problems. The confrontation of user- and producer perspectives often creates such interactive effects. Multi-competence effects arise when different competences are brought together; combined, they can produce totally new innovations (for example, in the case of information technology and telecommunications).

Ardon and Van Weele (1994) present a detailed check-list of criteria for the evaluation of potential cooperation partners. Axelsson (1987, pp. 150-166) emphasizes that when selecting cooperation partners, one should also consider the more indirect and potential networks the company can relate to. The choice of suppliers should not be static; attention should be given to technological areas that may be of interest in the future. Talking about close cooperation with suppliers, Axelsson and Håkansson (1984, pp. 31-32) put it this way:

> " One ensures that the internal development is in line with the network's development. Naturally, there is also a risk involved, because the developments in another network can, in the long term, give it competitive superiority over the network the company is currently part of .... This makes that the purchasing department should be monitoring the developments in different networks in relation to each other." (own translation)

The selection of cooperation partners should therefore be based on the company's long-term technological strategy, and its expectations on future technological developments. In that respect, this selection should be closely related to the company's develop-or-buy decisions (see section 5.2).

2. Organization

The second task concerns organizing the collaborative relationship. This primarily involves creating the right conditions for a 'productive' relationship to develop. Referring to the interaction model in 2.1, one aspect of these conditions that can be named here is 'atmosphere'. This atmosphere consists of various elements; power-dependence relationship, the degree of cooperation vs. conflict, overall cultural - and geographical closeness, and expectations. Long-term relationships seem to result in and benefit from a balanced power-dependence relationship, a mixture of high cooperation and high conflict, a high level of closeness and mutually shared expectations (Håkansson *ed.*, 1982). Organizing a collaborative relationship would therefore seem to involve creating these kinds of conditions. This cannot be achieved overnight; "The atmosphere is a product of the relationship ..." (op.cit., p. 21), and the development of a relationship is a lengthy process.

Another key element in organizing a productive collaboration concerns establishing information exchange. This is a crucial task, without which the next two tasks - exploitation of the capabilities of the supplier, and getting the supplier interested in certain developments - cannot be carried out. Axelsson (1983) presents some examples of the importance of this information exchange. Information exchange can be achieved with the support of 'tools' such as regular supplier meetings, and EDI connections.

3. Exploiting / 4. Generating the supplier's interest/ 5. Internal Coordination

The other three tasks are analogous to the corresponding tasks (nrs 2,3 and 6 respectively) at the level of the total supplier structure. Again, they involve synchronizing, timing, and mobilizing - be it now on the level of individual relationships. Whether the tasks of 'exploitation' and 'motivation' of suppliers have to be carried out at the level of the total supplier structure or the individual relationship, depends on the interdependencies between the (development efforts of) the different suppliers. The example of the development or introduction of flexography at Tetra Pak, is clearly an example of exploitation and motivation of a total supplier structure. Often, a development project calls for the performance of these tasks at both levels, as is illustrated by the example of Biopharm (Håkansson and Eriksson, 1993).

Coordination of the activities of different departments is also necessary at the level of individual development relationships; the R&D department, for example, may be handling the daily contacts with the supplier, while the purchasing department is only involved when it comes to commercial matters. Still, the coordination of the overall relationship is likely to be the task of the purchasing department.

Summarizing, we have argued that purchasing has five 'development tasks' at the level of the single supplier relationship - select the right partner-suppliers, organize the relationship, exploit the technological capabilities of the suppliers, make the supplier interested in developing (parts of) products the buying firm needs or wants, and carry out this activities in a coordinated manner.
In the next section, we deal with purchasing's development role at the level of single development projects.

5.5 The Organization of Single Development Projects

At the last level, purchasing's development role involves its contribution to single development projects. In section 3.1, we have been referring to the 'simultaneous engineering' (or concurrent engineering) approach, as a product development method that involves all the business functions that are, in one way or the other, affected by new product development (NPD). Thus, adopting a simultaneous engineering approach for NPD is crucial for purchasing when carrying out its development role at the level of single development projects.

In this section, we deal with the more specific tasks purchasing has to perform in NPD projects. One way to structure these tasks, is describing them according to the different stages in the product development process. After doing that, we will conclude by shortly mentioning some of the tools that could support purchasing in these matters. In our view, purchasing has four main tasks in the product development process:

1. **providing information** on sourcing options,
   and assisting in the development of specifications,
2. **suggesting alternative solutions,**
3. **ensuring the availability** of items that need to be purchased, and finally,
4. these tasks need be **coordinated across the different departments, and with the other activities** in the development project.

The first three tasks correspond to the three main phases in the NPD process: investigative phase, laboratory phase, and manufacturing and procurement phase (Burt and Soukup, 1985). Alternatively, these stages can be called product development, product design, and preproduction planning (Van Weele, 1994, p. 145). The fact that we have clearly separated these phases, does not imply that these phases follow each other in a sequential order - the next step beginning when the previous one has been completed. As has been demonstrated in section 3.2, the *'new* new product development process', as it is advocated by the simultaneous engineering approach, has stages that overlap each other. This means, for example, that considerations regarding the manufacturing should come into the development process not at the final stages of the NPD process, but earlier. This means that the three phases mentioned here overlap, and that the listed activities can take place simultaneously as well. However, we discuss them here as if they occur in separate stages.

The last task involves coordinating the first three activities across the different departments, and with the other activities in the development project. The first part may be less important here than at the other levels of the development role, as the three tasks mentioned here seem to be rather specific tasks of the purchasing department. Coordinating the three tasks with the other activities in the development project involves the key issues of synchronizing and timing.

Investigative Phase

In this first phase, purchasing's role is mainly informative. It can provide engineers with information on new components that are available in the market, or suggest potentially interesting suppliers. Purchasing should function as a kind of 'window' for engineers on the technological capabilities of suppliers. Erens and Van Stekelenborg refer to this function as 'enlarging the solution-space' (1993, p. 47). In other words, in the investigative phase purchasing has the task of increasing the number of options for solving a 'design problem'. Purchasing should also assist engineers in developing specifications. Preferably, these specifications should be functional, rather than technical. Engineers tend to write quite narrow specifications, often leading to 'sole sourcing' situations (Van Weele, 1994, p. 147). But, as Dowlatshahi puts it: "They should not be so narrowly defined that they stiffle creativity or negatively affect the level of competition in procurement." (1992, p. 23). The functional specifications should then form the basis for a dialogue between the designer and the purchaser.

Later in this investigative phase, purchasing can inform the designers and engineers about various suppliers' abilities to meet these specifications, giving information about costs, performance, market availability, quality and reliability of particular components (Burt and Soukup, 1985, p. 96). Suppliers are increasingly involved already in this stage of the NPD process. We have already mentioned the example of Océ - Van der Grinten, who involves its suppliers of strategic items in 'co-development' - starting in the very first phases of the product development process.

Laboratory Phase

In this phase, purchasing has as its main task suggesting alternative solutions. One way is to point out to designers other, interchangable, parts that have more common or commercially available specifications. This can reduce costs, and/or the number of suppliers needed. Another option is to demand part standardization or simplification. This reduces the time and cost of designing and producing the final product (Dowlatshahi, 1992, p. 24). A third way of investigating possible alternatives is by means of Value Engineering (VE). VE's aim is to maintain or improve functional and performance output of a new product, while reducing the cost input (see Heinritz *et al.*, 1991, pp. 355-356; Dobler *et al.*, 1990; pp. 123-127). It involves the critical review of a design, preferably done by design, purchasing, and manufacturing together. Axelsson and Laage-Hellman (1991, pp. 94-99) cite the example of IBM Sweden:

> Before, the Järfälla factory became involved when the prototype was ready, and the market introduction was being prepared (the so-called Phase III in the product planning cycle). Nowadays, they try to become earlier involved in the development process to be able to influence the design and thereby to lower manufacturing costs. These activities take place at IBM under the name Early Manufacturing Involvement (EMI).
> There used to be significant barriers between the laboratories and the foreign factories.
> The first were working close together with the American manufacturing units, that are often quite near to the laboratories. The foreign factories, however, were seldomly asked something. This has now been changed, and the factories can be along, and, amongst others, make cost calculations already in an early development stage.
> IBM Järfälla has, at its own expense, placed some 40 engineers at the different laboratories in the USA, in order to better be able to influence the design and the choice of components and suppliers. These so-called 'assignees' function as the factory's long arm. They have, amongst others, to monitor possible technical changes, and to operate as communication channels to the product developers. (own translation)

The input of suppliers can be very useful in this stage (Burt and Soukup, 1985, p. 94; Dowlatshahi, 1992, p. 24). Suppliers often have specific technological knowledge, and based on that they can often suggest alternative solutions that might be cheaper, or better than the design solutions the designers of the buying firm have devised. Again, we look at IBM Sweden:

> In a concrete example of what EMI can contribute, a component from one of Järfälla's domestic suppliers will be used instead of the American component that was proposed by the laboratory. In that case, the supplier had been given a free hand. The supplier then came up with its own construction solution that lowered the manufacturing costs of the part with some 15 % compared with the original proposal. This implies a not unimportant decrease in the final product's price.
> (Axelsson and Laage-Hellman, 1991, pp. 94-99, own translation)

Just like residential engineers (see section 3.1), Value Engineering with the specific involvement of suppliers is nothing new. Nishiguchi (1993, pp. 64-66) notes that already in the early 1960's, Toyota, Nissan and Mazda applied these techniques, with substantial results.

Manufacturing and Procurement Phase

In the last phase of the product development process - *preproduction planning* - purchasing has to ensure the availability of the items that will be purchased. After the (preliminary) design has been completed, a manufacturing plan is being made, leading to a procurement plan. Purchasing has the responsibility to ensure that the components and parts that need to be bought are available, economically the best choice, and 'otherwise in the company's best interests' (Burt and Soukup, *op. cit.*, p. 96). This should be done before the company dedicates itself to a final design and manufacturing plan.
Finally, when the configuration of a product is going to be changed during manufacturing, purchasing should assist in the evaluation of the effects of the engineering change on purchased parts. One way to prepare for these engineering chances is to develop contingency plans for different manufacturing options in case the most favoured option proves unattainable.

Again, suppliers can provide useful inputs in this stage of the NPD. They are the ones that know their production processes best, and should be able to point to possible problems and solutions. They should also provide information regarding, for example, the availability, and lead times of various components, and assure the buyer of their commitment for parts and materials that are critical to the design (Dowlatshahi, 1992, p. 25).

Throughout these three phases, purchasing can use some 'tools' that support its own (and other departments') involvement in product development projects.

Tools

The formation of *project teams* is one of the cornerstones of simultaneous engineering. Takeuchi and Nonaka (1986) mention three key conditions for such teams to be successful: autonomy, self-transcendence, and cross-fertilization. This means that they need to be independent from higher management levels, make breakthrough innovations, and consist of members of different functional specializations. In order to fullfil its development task, purchasing should be represented in these teams as well. Suppliers could, on some occasions, also be member of these project teams. This could be the case for suppliers that supply critical parts, like Océ - Van der Grinten's 'co-developers'. Car manufacturers like Ford and Honda often have supplier representatives on their development teams.

One way to organize the involvement of suppliers in project teams, is by *Colocation / Residential Engineering.*

This implies the location of suppliers' engineers at the customer site, in order to promote communication and common understanding (Nishiguschi 1993, pp. 71-73). While this may have important benefits, it also can carry some risks. At Ericsson Radio Communications, for example, residential engineering is not regarded as the optimal way to involve suppliers in the NPD process:

> Ericsson tries to make sure however, that the supplier is not knowledgable about Ericsson's core competences: this would threaten Ericsson's position, and it would decrease Ericsson's importance to the supplier. Because of this, Tufvesson is not in favour of having engineers of suppliers located at Ericsson facilities for common development projects (residential engineering). Rather, he prefers to have joint Ericsson-supplier teams located in separate common design centers.
> (Source: author's interview with J. Tufvesson, Vice-President Procurement, LM Ericsson Telefonaktiebolag.)

Another organizational tool is the assignment of *procurement engineers*. These engineers work with design engineers on a daily basis, supplying information on the commercial implications of various design approaches, and suggesting alternative supply sources (Burt and Soukup, 1985, p. 96). General Motors, for example, has a special department called 'Advance Purchasing', whose main task is to involve suppliers early in product development projects. The purchasers in this department are technically competent product specialists (Axelsson and Laage-Hellman, 1991, pp. 208-210). Nishiguschi (1993, p. 77) reports that

> "At Toyota, for example, every purchasing agent became technically trained so that whether or not the person was an engineer by profession they were able to evaluate a subcontractor's technical competence at first hand, ...".

More generally, *employee rotation* between engineering- and purchasing departments encourages understanding of the links between the two disciplines.

Another practical tool to support purchasing's efforts in part standardization, are *recommended parts lists*. Such a list, in the form of a catalogue or computerized files, could be linked to the company's CAD system. Designers would have to be encouraged (obliged) to use the standard parts that are listed. The use of such lists would help to reduce development time, and promote further standardization (Burt and Soukup, op. cit., p. 96). Parkkinen (1995, pp. 29-30) lists some of the pitfalls of such lists: old data, difficult access, and too easy adding of new components.

This list of the activities at the level of the single development project concludes the discussion of purchasing's development tasks.

5.6 Summary

In this chapter, we have been analyzing purchasing's development tasks and - activities at four different levels: overall strategy, the organization of the supplier structure, the organization of single development relationships, and the organization of single development projects.
These tasks and activities are summarized in table 5.1.

Strategy	1. Decide what kind of technical competences the company wants to control itself, and what to leave to suppliers (*develop-or-buy* question) 2. Determine the basic principles and objectives for purchasing's involvement in issues of technological development 3. Design the organizational lay out to support that involvement 4. Develop and select the 'tools' to support the development role
Supplier Structure	1. Monitor technological developments at (potential) suppliers 2. Exploit the technological capabilities of suppliers 3. Generate suppliers' interest in developing (parts of) products the buying firm needs or wants 4. Coordinate the different suppliers' complementary strengths 5. Make suppliers work with their suppliers in a way that is beneficial to the buying firm 6. Coordinate these tasks internally
Single Development Relationships	1. Select the right partner-suppliers 2. Organize the relationship 3. Exploit the technological capabilities of the suppliers 4. Generate suppliers' interest in developing (parts of) products the buying firm needs or wants 5. Coordinate these tasks internally
Single Project	1. Provide information on sourcing options, and assist in the development of specifications 2. Suggest alternative solutions 3. Ensure the availability of items that need to be purchased 4. Coordinate these tasks internally, and with the other development activities

Table 5.1: Summary of purchasing's development activities

In the final chapter, we discuss how we will use this framework of potential tasks for the purchasing function in technological development in our further research.

Chapter 6 Research Design

6.1 Research Questions

The three basic questions that have been posed at the start of our research project (spring 1994) are the following:

- What environmental and organizational conditions foster co-operation between suppliers and customers in technological innovation processes?
- How does this increased technological co-operation affect
  a) supplier relationships, and
  b) the customer's purchasing function?
- How can purchasing contribute to (play a role in) more efficient and more effective technological co-operation with suppliers?

The first question serves to set the background for our study, and its answer can largely be based on already available research (see chapter 3). This also applies to our second question, but our own research can also provide some answers, especially as regards the b) part. The third question will be the central issue of the research project. The ultimate goal of our research is to develop knowledge regarding the most appropriate involvement of the purchasing function in co-operative innovation processes, and to provide some guidance with regard to the realisation of this involvement.
In this chapter, we want to elaborate on the design of the research that aims at answering that question. First we discuss briefly what has been done so far.

6.2 Completed Research

In the first year, around 20 interviews have been done to get a better idea of the current state of purchasing's involvement in technological innovation in the six selected industries, and of the problems that occur (see chapter 4). Based on these interviews, and on an extensive literature review, we have presented a framework in which we specified a number of tasks we think form the potential 'role' of purchasing in technological development (see table 5.1). We do not argue that these tasks should be the domain of the purchasing *department*, or are the actual domain of the purchasing department in most of the companies we interviewed. Rather, we argue that these are activities that seem -- based on literature, and some empirical observations -- to be useful activities to carry out within the context of the development role of the purchasing *function*. That means that we do not exclude the possibility of some other department - engineering, or manufacturing - carrying out these activities.

The second phase in the research has been to translate a Scandinavian questionnaire, which is currently being used by a group of ± 20 Swedish and Norwegian researchers to analyze industrial firms. The questionnaire contains questions on the focal firm's five most important supplier- and customer relations, and technological development. It will be supplemented with questions focusing on the purchasing strategies, - organizations and - processes of the buying parties, where we will draw extensively on the data gathered from our explorative case studies.

The value of using this standard questionnaire for our own research is twofold. First, we are able to contribute to and make use of a database of around 120 company-cases (as of june 1995).
This database provides information that is quite interesting for our research, for example:

- It contains a whole set of questions on purchasing policies, with questions, for example,
  - on the way the company is trying to cooperate with suppliers in technological development,
  - whether the company is trying to influence their suppliers' buying behaviour, and
  - on the role of the purchasing department within the company.
- For each of the five most important customer- and supplier relations, there are detailed questions on the form and content of technological cooperation, on the role of the two partners in that cooperation, and on the influence of third parties.
- It also deals with the 'connectedness' of business relationships. For example, the technological cooperation of the focal company with supplier B can be affected by the company's cooperation with supplier A. Dealing with these kinds of interdependencies in technological cooperation is one of the tasks we specified as being part of purchasing's development role.

Thus, the database gives us the possibility to provide a wealth of relevant empirical data, also on companies outside the industries we have selected. This could, amongst others, help us to find out if we have selected industries that are special in any relevant aspect. The second advantage of carrying out the interviews with the standard questionnaire, is that it provides an excellent way of getting to understand the situation of the company. The questionnaire contains all kinds of questions regarding basic information, necessary whenever one is conducting a case-study on that particular company. Since we want to work with the same companies in the future as we are interviewing now, this is very beneficial.

Starting summer 1995, the slightly revised standard questionnaire is being used in carrying out interviews. Within each of the six selected industries, we aim to interview one pair of companies both in Sweden and in the Netherlands, each pair consisting of a customer and one of their suppliers.
This results in 'pictures' like figure 6.1.

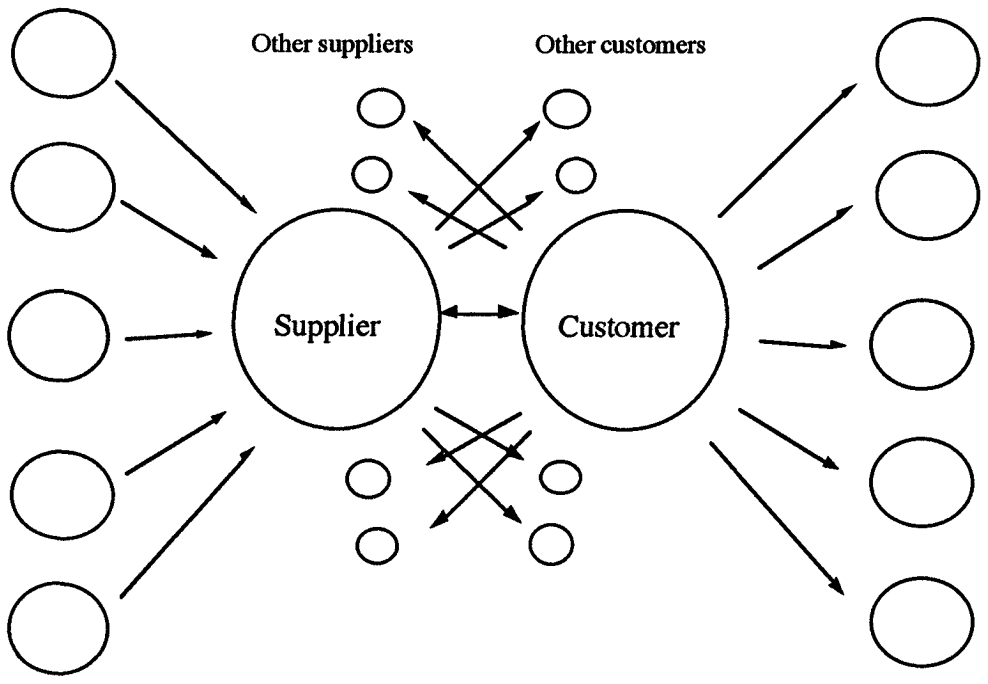

Figure 6.1: Result of the standard questionnaire interviews

The information from this picture will also enable us to study the horizontal interdependencies and the vertical interdepencies between the various relations. This issue of dealing with interdependencies in technological cooperation (f.e. does a company try to control the technological innovation activities of its second tier suppliers, and how) has been identified as one of the special interests in this project.
Interviewing pairs of suppliers and customers enables us also to contrast the views they both have of their relation in general and, in particular, the technological cooperation that is taking place (which is a conditio sine qua none for selecting the pairs).
What we then want to do is to take one of the companies of each pair (most often the customer)[16] , and study their way of handling technological cooperation with suppliers - especially from purchasing's point of view - more closely. That will be the next step in our research.

[16] It could be interesting to make the final choice of the companies in such a way that within each industry, the companies we select in Sweden and in the Netherlands are at different stages of the value chain.
While in that way we still would have two cases for every industry, they would be more complementary than if we did cases for the exactly the same kind of companies within each industry. The ultimate selection of the companies will depend to a large extent on their willingness to cooperate.

6.3 Next Phase

The ultimate goal of our research is to develop knowledge regarding the most appropriate involvement of the purchasing function in co-operative innovation processes, and to provide some guidance with regard to the realisation of this involvement. Again, we want to stress that it is not the purchasing *department's* involvement we are exclusively interested in: it is the set of purchasing activities, especially in the area of technological development. It is our strong belief that the people or departments responsible for carrying out those activities can vary from company to company, just as the extent and actual way of performing those activities can vary.

The aim is to investigate the occurence of patterns in organizing and performing purchasing's development activities, relate them to underlying factors, and see how this organization and performance can be improved. The five steps we have envisaged in the third and final phase of the project are the following:

1. **Analysis of the company's situation**, for example, regarding
   - the type of industry, production technology, kind of suppliers,type of inputs
   - the overall functional organization, organization of the purchasing function and - department

   Here the results of our standardized interviews are of great use.
2. **Description of the typical technological development issues**
   - knowledge areas: what are the in-house competences of the firm, and what is 'externalized'
   - kinds of innovations
   - organization of the product development process
3. **Diagnosis of the company's current organization of purchasing's development activities**
   - to what extent are the development activities as we identified them being carried out: in what ways, by whom, when, etc.

   Grouping together the different activities in a few areas (f.e. according to the four levels we distinguished in table 5.1) , we want to give the company 'scores' on each activity.

   This should result in a kind of profile for every company.

   This profile could then be related to some of the factors analyzed in step 1, on the basis of the comparisons and differences between the different profiles we find for the 12 companies.

4. **Comparing the diagnosis with the ideal organization of purchasing's development activities**

   - given some factors that can *not* be changed - the kind of industry, production technology, etc.
   - is there room for improvement, and in what specific areas?

   Here we could have 'ideal profiles' - three, for example, one for companies with process production, one with project/single unit production, and one for large series production - based on

   1) the best scores within our population for every area we distinguished in step 3,
   2) 'best practices' encountered in other companies and industries[17], and finally,
   3) more theoretical insights.

5. **Identifying the conditions that need to changed, and the best way to implement the proposed changes**

   Here, we want to take those factors that we identified in step 3 as influencing the current organization of purchasing's development role, and which *can* be influenced by the company, and see in what direction they should be adjusted to make the 'ideal organization' possible. Such a factor could, for example, be the organization of the purchasing department or the educational background of the purchasers. Following that, we want to investigate how the adjustment or change should take place. Here we should draw on literature in the field of organizational theory, change strategy, and purchasing organization. An interesting result would be if we can find a few different types of implementation processes, linked to, for example, the size of the difference between the actual and the desired state[18].

In figure 6.2, we have made a graphical illustration of these five steps.

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[17] It is our aim to do 2-3 case studies of companies that are considered to have spent a great deal of effort on developing purchasing's involvement in technological development, and seem to achieve good results from doing that (f.e. in terms of product quality, development costs, time to market). One way to collect this information, apart from own research, is through students' theses.

[18] Again, the theses of students can be a good and effective way of collecting such information. Already now, such a study is taking place at Philips CE in Hasselt, Belgium.

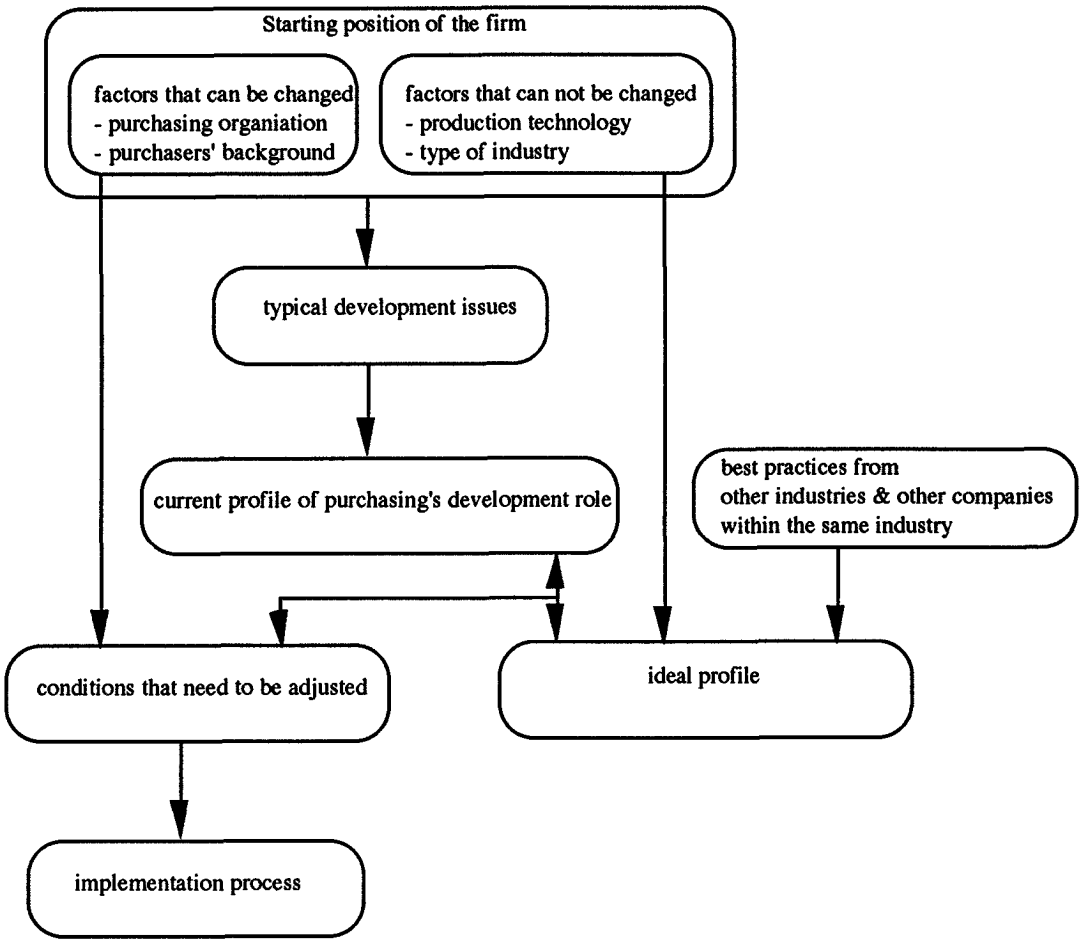

Figure 6.2: Third phase of the research

The core of the research findings should relate to the 'ideal profiles' regarding the organization and performance of the purchasing function's development activities. Additionally, depending on the outcomes of the research, and their robustness, it could be possible to generalize the diagnosis instrument we use. It would then be possible for individual firms to carry out steps 3, 4 and 5 themselves. This would most certainly contribute to the practical usefulness of our research findings.

Finally, as a test of our findings of step 5, the proposed changes and adaptions will be implemented in two cases. The first case will be carried out in the Netherlands, followed by one in Sweden. In order to benefit from experience, the cases will not be carried out simultaneously.
The companies will be selected on the basis of the results of our interviews. It seems appropriate to select the two companies from different production chains, in order to be able to test certain industry-specific attributes of our 'design'.

6.4 Conclusion

The last decades have shown an increasing attention for interaction oriented approaches in general fields of industrial economics (publications of the IMP Group; f.e. Håkansson, 1982; Ford, 1990), and in the field of technological development and innovation (Von Hippel, 1988; Biemans, 1992). Research into purchasing issues, using an interaction oriented aproach, has become more widespread too (Axelsson and Laage-Hellman, 1991). Recent publications have given attention to the changes in the process, function and management of purchasing (Van Weele, 1994; Gadde and Håkansson, 1993).

There seems to be an opportunity to investigate the effects and demands that buyer-supplier co-operation in the field of technological development has on the purchasing function. Both technical innovation and purchasing have been the object of numerous research projects and publications, but the research on the 'intersection' of the two is, in our opinion, still underdeveloped. Most of the research has been focused at purchasing's involvement in new product development projects, and limited to industries with large-series - or mass production like the automotive industry, or the electronics industry. Furthermore, a clear overview what the tasks and responsibilities of purchasing exactly could (or should) be is still lacking. Our research aims to fill these gaps. Additionally, by adopting the network approach in studying industrial markets as a theoretical framework, we are able to capture one aspect that is sometimes neglected as well: the interdependencies *between* the various cooperative supplier relationships.

Our final aim is to increase the understanding of how, by giving more attention to the development role of purchasing, technological innovation can be promoted.

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Appendix A - List of Companies Interviewed

(number of persons interviewed between brackets if more than one)

Sector:	**foodstuff packaging**
Netherlands	Marvelo (2) Riedel Drankenindustrie Heineken Nederland
Sweden	Tetra Brik Packaging Systems Tetra Pak Research & Development Tetra Pak Packaging Material SCA Emballage (2) Pripps Bryggerier
Sector:	**truck industry**
Netherlands	DAF Trucks (2)
Sweden	Scania Commercial Vehicles (2)
Sector:	**telecommunication**
Netherlands	PTT Telecom Ericsson Telecommunicatie BV NEDAP NV
Sweden	Telia LM Ericsson / Ericsson Radio Communications
Sector:	**chemical industry**
Netherlands	DSM Polymers (3) DSM Research
Sweden	Berol Nobel
Sector:	**construction industry**
Netherlands	HBW
Sweden	Skanska Siab
Sector:	**power generation**
Netherlands	-
Sweden	ABB Stal

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Een uitwerking toegesneden op de Industriegroep TV van
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