Purchasing involvement in product development

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ECIS

*Eindhoven Centre for
Innovation Studies*

Purchasing Involvement in Product Development

Finn Wynstra

Purchasing Involvement in Product Development

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Purchasing Involvement in Product Development

Proefschrift

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Preface

This study deals with the involvement of the purchasing function in product development. The involvement of purchasing and suppliers in product development has attracted considerable attention over the past few years. Partly, this is the result of the growing importance of innovation and product development as a means for creating competitive advantage, but it is also the consequence of the increasing awareness of the purchasing function's possible contribution to the firm's strategic position. However, existing knowledge is mainly limited to the possible impact of purchasing and supplier involvement on short-term efficiency of product development projects. Furthermore, most research exclusively focuses on experiences in the automotive and electronics industries. There appears to be no coherent view of what purchasing involvement in product development actually is.

This study develops an integrated framework of activities that purchasing involvement in product development consists of. These activities range from operational activities directed at the actual design of a new product, to strategic activities such as the formulation of policies for supplier involvement in development projects. This framework may help to implement, improve and audit the involvement of the purchasing function in product development. It draws on some 20 case studies in the Netherlands and Sweden, across a broad range of industries (a.o. trucks, food & beverage packaging and medical instruments). The research also investigates the driving and enabling factors that influence the need for and the ability of firms to carry out the various activities from the framework. In that way, it provides indications in which situations certain activities are more important than others, and suggestions as to how to enable an organisation to perform purchasing involvement in product development in an effective and efficient way. Finally, the study provides insight into the various roles suppliers may fulfil in manufacturers' product development processes, and the factors on which a decision on the extent of supplier involvement may be based.

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“Resan från att vara liten och tro man är stor, till att bli stor och förstå att man är liten.”
Nils Holgersson, Selma Lagerlöf, 1907

“Ah, but I was so much older then, I’m younger than that now.”
My Back Pages, Bob Dylan, 1964

Carrying out a doctoral research project and writing a thesis closely resembles climbing a mountain. The mountain is intriguing, but its height may be deceiving when you are standing at its foot. During the ascent, the summit at first does not seem to be getting any closer, and often disappears from view. However, there are several resting places underway, and after a while one gets a fascinating view over the valleys below. From time to time, unexpected difficulties arise, which make it necessary to change the route to the top. Bad weather may make orientation difficult, but when the sun is shining, there is no thing one would rather do than continue climbing. Finally, when you get to the summit there is a feeling of triumph and satisfaction. Sitting down to admire the view, other mountain tops become visible and form a tempting challenge for new travels.

As with most climbs, this research project has reached its peak with the help of various people. Professors Arjan van Weele and Björn Axelsson have been the ones that encouraged me to try the ascent, arranged the necessary permits and have been extremely experienced guides along the way. Their unrelentless support, and their sharp observation have prevented me from falling down from the cliffs, while they also pointed me to many interesting views and objects encountered on the way. From being guides, they have grown into true companions. I want to extend my gratitude also to their families, who directly or indirectly contributed to the undertaking too. Professor Mathieu Weggeman joined the team for the final and most difficult leg of the ascent, and his specific expertise and spirit have helped to overcome the dangerous slopes near the top. I have learned additional techniques and useful insights from professors Felix Janszen, Jacques Theeuwes, David Ford, Håkan Håkansson, Lars-Erik Gadde and Ivan Snehota.

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Finn Wynstra
Linköping, July 1998

Summary

Points of departure

Over the past decade or so, the interest in purchasing involvement in product development has increased considerably. Partly, this can be explained by the growing importance of innovation and product development in creating competitive advantage. Firms realise, however, that in subcontracting large parts of their production to external suppliers, they have also become dependent on these suppliers with regard to developing and innovating their products. Partly, it is also the consequence of the increasing awareness of the purchasing function's possible contribution to the firm's strategic position (Chapter 1).

Much of the interest in supplier and purchasing involvement in product development has been the result of studies in the late 1980's regarding the explanatory factors behind Japan's increasing success in the automotive industry. It turned out that a large share of the advantage of Japanese car manufacturers in terms of development time and costs, and product costs, could be attributed to the involvement of suppliers in the product development process. However, other studies in, for example, electronics and mechanical engineering industries found that supplier involvement does not always lead to improvements in development performance. In some cases, even deteriorations may arise. Rather than rejecting supplier and purchasing involvement as a means for creating competitive advantage, these studies lead to stressing the importance of managing supplier involvement in the right way. Previous research, however, deals with the management of supplier involvement only in a very limited way (Chapter 3). Available literature and research on the topic of supplier and purchasing involvement seems to have some major shortcomings. Firstly, most research focuses exclusively on individual development *projects*. Other, areas within product development where purchasing may provide a contribution are relatively neglected. These areas include more permanent or long-term activities, such as trying to have suppliers develop specific technological capabilities, and activities that are not directly related to managing the actual involvement of suppliers, such as market research for new technologies or develop-or-buy decisions. Secondly, most studies in this field have been limited to large-scale assembly industries such as the automotive and electronics sector. Little studies have been done in other industries. Thirdly, there is hardly any interest in the role of individual functions or departments of the organisational entities involved. The organisations of the manufacturer and supplier are treated as monolithic entities, where possible opposing interests between, for example, the development and purchasing department of the manufacturer are not explicitly analysed. Finally, most studies lack a clear delineation or definition of what purchasing involvement consists of, other than some fragmentary observations and recommendations (Chapter 1).

The objective of our research is to develop an integrated framework of specific activities that purchasing involvement in product development consists of. This addresses the existing lack of a coherent view on the issue. Related to this first objective, one specific research question in this study analyses what key processes purchasing involvement in product development should contribute to. A second research question analyses what areas this involvement consists of. A secondary research objective of this study is to develop preliminary insights regarding the factors that determine the need and the ability to carry out the various activities. Not all of the activities in the framework may be equally necessary for all kinds of firms or in all environmental contexts. Similarly, not every firm may be able to perform the activities.

Summary

Our empirical studies have been designed in such a way that they cover a variety of industries, so that we may be able to generalise our findings beyond individual industries (such as the automotive sector). They also investigate the role of individual departments and functions, so that it is possible to analyse purchasing and supplier involvement in product development not only as an inter-organisational, but as an intra-organisational process too. The studies span two different countries, but this has been done to be able to include several case studies within the same industry rather than to compare the two countries in terms of cultural factors and the like (Chapter 1).

Conceptual basis

First, an analysis has been undertaken of product development and the managerial activities taking place in order to identify the points where suppliers and purchasing can provide specific added value. However, the discussion of product development project phases and the (managerial) activities has revealed that most of the models do not consider to any great extent firms other than the one actually carrying out the 'focal' development project. Therefore, attention has been directed to theories that adopt an inter-organisational view of product development, and which are more focused on the underlying processes that generate product development. The Network Approach has been discussed as the approach that clearly points out some of these general processes: knowledge development, resource mobilisation and resource co-ordination. These three processes generating product development provide a starting point for considering the key processes underlying purchasing involvement in product development (Chapter 2).

Since managing the involvement of suppliers in product development can be seen as the cornerstone for the involvement of the purchasing function, an investigation of the main issues and problems in managing supplier involvement has been conducted. Therefore, we have analysed the major characteristics of technological collaboration with suppliers. In terms of products delivered, collaboration seems to take place most frequently with assembly and finished good suppliers. Technological collaboration relatively frequently involves single source suppliers. In those cases, the intensity of technological collaboration is also high. This intensity is also relatively high when the collaboration involves a customer with a dominating position in terms of share of supplier sales. Relationship age plays a role in the sense that technological collaboration seems the most continuous and the most balanced in longer existing relationships. Finally, the collaboration appears to be the least formalised in older relationships, relations related to semi-manufactures, equipment or services, or relations where the supplier or the customer are not so important for the other party in terms of volume. Regarding the objectives or motives underlying supplier involvement, a distinction has been made between the short-term, project-related objectives of reducing development time, development and product costs and improving product value, and the long-term objectives of getting access to the supplier's technological knowledge and aligning manufacturer and supplier technological capabilities. Besides these positive benefits of supplier involvement, there are also potential risks, such as increased dependency, reduced flexibility and information loss. Barriers which can prevent effective technological collaboration with suppliers can be found at the manufacturer, at the supplier and in the relation between the two. The thesis deals briefly with the role of contracts in managing (some of the risks regarding) supplier involvement in product development. Previous research has shown that contracts are relatively unimportant in the kind of collaborative relationships being used for technological collaboration between business firms. One explanation is that contracts provide little means for pro-actively managing supplier involvement (Chapter 3).

Based on an extensive literature study, four key processes are identified as underlying the purchasing activities related to product development: prioritising, mobilising, co-ordinating and timing. *Prioritising*

concerns not only the choice of actual collaboration partners, but also the choice for a specific form and intensity of supplier involvement.

Mobilising involves the mobilisation or motivation of suppliers to start working on a particular development. *Co-ordinating* involves the adjustment and adaptation of development activities and resources between suppliers and the manufacturer. *Timing* is a special kind of co-ordination, which involves the co-ordination and adaptation of development activities and resources in time.

Additionally, three different areas or objects for purchasing's involvement in product development are distinguished: Projects, Suppliers and Technologies. Each of the three areas has a different time-horizon, and each of them involves different kinds of activities and processes. The area of 'Projects' deals with the way product development is internally carried out and how this can be integrated with the development activities by suppliers. The area of 'Suppliers' is related to the permanent and long-term tasks of maintaining relations with suppliers in such a way that they contribute in an optimal way to the technological position and product development capabilities of the firm. The area of 'Technologies' regards the division of work between the manufacturer and its suppliers regarding the development and improvement of specific technological expertise and competencies. This area involves so-called 'Develop-or-Buy' discussions or decisions. The four key processes cut across these three areas, and together they provide the conceptual basis for developing an integrated framework of purchasing activities with regard to product development (Chapter 4).

The framework

The first series of nine case studies of manufacturer-supplier collaboration demonstrate that the concepts of prioritising, mobilising, co-ordinating and timing can effectively be used to describe and analyse supplier-manufacturer collaboration in product development. Most of the activities performed in connection with this collaboration can be related to these key processes. More importantly, the problems and successes in each of the nine collaborations can be interpreted in terms of activities related to one or several of the key processes. This supports the claim that the four key processes are essential for successfully managing supplier involvement in product development, and hence should form the basis for purchasing involvement in product development. The case studies also demonstrate that the key processes are applicable to supplier-manufacturer collaboration in product development across a fairly broad range of industries. This indicates that the processes of prioritising, mobilising, co-ordinating and timing are rather universal.

The second objective of the first series of case studies has been to study the influence of the various types of production on purchasing involvement in product development in terms of the underlying key processes and the main areas. We have argued that the four key processes seem to apply to different industries, but it is possible that one specific process is more important in some industries than in others. However, our analysis of the 9 cases concludes that for all industries, mobilising is the dominant process. The cases show that suppliers and manufacturers may have very different interpretations of the character of their relation in terms of intensity and balance. This may result in incorrect estimates by both parties of the importance of the collaboration to the counterpart and the extent and importance of its own efforts, which may especially hinder the mobilisation process. The case studies show there is neither a clear relation between the type of production and the dominant area of purchasing involvement. The overall conclusion would be that there is little difference between purchasing involvement in product development in different industries, neither in terms of the underlying key processes, nor with regard to the main areas of that involvement (Chapter 5).

The *specific activities* constituting purchasing involvement in product development have been identified based on examples of such activities taking place in the first series of case studies. Each activity has been related to one or more of the four key underlying purchasing involvement in product development: prioritising, mobilising, co-ordinating and timing. This results in an initial version of the proposed framework. The second phase of empirical studies, a series of mini-cases of Dutch manufacturers, has demonstrated that purchasing involvement in product development indeed is more than managing supplier involvement, and that the common underlying process for these additional activities is 'informing'. The mini-cases also lead to a distinction between different levels of responsibility within purchasing involvement in product development: policy, structure, preparation, operation and specification. The revised version of our framework integrates the two dimensions of responsibilities and areas, and differentiates between four management areas in terms of the time-horizon, the object concerned and the managerial level of activities: Development Management, Supplier Interface Management, Project Management and Product Management. Development Management combines the previous area of Technologies and the level of policy responsibility. In a sense, it includes activities that set the stage for the other areas of purchasing involvement in product development. The area of Supplier Interface Management combines the area of Suppliers and the structure responsibility, involving the permanent and ongoing management of supplier relationships. Project Management integrates the area of Projects and the preparation and operation responsibilities, including activities like preparing, planning and co-ordinating product development activities of suppliers during a specific development project, which per definition have a more limited time-frame than the activities within Supplier Interface Management. Within Project Management, a distinction can be made between Project Planning (before the project's start) and Project Execution (during the project) activities. Both Project Planning and Project Execution mainly encompass activities to enable and support the development *process*. In addition to that, however, there are activities that are not primarily concerned with the process of developing the product, but rather with the new product itself: these are grouped into the area of Product Management. For each area, specific activities are distinguished on the basis of either the first series of case studies, or the second series of mini-case studies (see Table S.1).

The framework, however, presents an ideal picture. It encompasses all kinds of activities and gives no particular indications of the conditions under which they need to and can be performed. These contingencies can be referred to as so-called *driving* and *enabling* factors. As driving factors we have chosen to focus on the following four aspects: company size, measured in terms of turnover; production type or technology; the overall dependence/reliance on suppliers measured as purchasing share in turnover; and the importance of product development, measured as R&D expenditure related to turnover. There are three areas which seem to be important facilitating or rather enabling factors. First, an effective *organisation* of the purchasing function, which is able to support the required communication and co-ordination in product development. Secondly, a well-organised exchange and recording of *information* relevant to the product development process and its management, possibly supported by IT tools. Finally, adequate *human resources* in terms of personnel with the right education, skills and experience (Chapter 6). The third and final round of empirical studies investigates the relationship between problems and successes in product development and the extent of purchasing involvement in terms of the various management areas and specific activities. Also the role of driving and enabling factors is investigated (Chapter 7 and 8). The findings are incorporated in the recommendations following from this study.

Table S.1: Revised framework

Areas	Activity	Key processes*
Development Management	<ul style="list-style-type: none"> Determining which technologies to keep/develop in-house and which ones to outsource to suppliers Formulating policies for the involvement of suppliers Formulating policies for purchasing related activities of internal departments Communicating policies and procedures internally and externally 	P C, T C, T I
Supplier Interface Management	<ul style="list-style-type: none"> Monitoring supplier markets for technical developments Pre-selecting suppliers for product development collaboration Motivating suppliers to build up/maintain specific knowledge or develop certain products Exploiting the technical capabilities of suppliers Evaluating suppliers' development performance 	I P M, C C I
Project Management	Planning: <ul style="list-style-type: none"> Determining specific Develop-or-Buy solutions Selecting suppliers for involvement in the development project Determining the extent ('workload') of supplier involvement Determining the moment of supplier involvement Execution: <ul style="list-style-type: none"> Co-ordinating development activities between suppliers and manufacturer Co-ordinating development activities between different first tier suppliers Co-ordinating development activities between first tier suppliers and second tier suppliers Ordering and chasing proto-types 	P P, M, C, T P, C P, T C, T, I C, T, I C, T, I C, T, I
Product Management	Extending activities: <ul style="list-style-type: none"> Providing information on new products and technologies being developed or already available in supplier markets Suggesting alternative suppliers, products and technologies than can result in a higher quality of the final product Restrictive activities: <ul style="list-style-type: none"> Evaluating product designs in terms of part availability, makeability, lead-time, quality, and costs Promoting standardisation and simplification of designs and parts 	I P, M, I I P, M, I

*: P= prioritising, M= mobilising, C= co-ordinating, T= timing, I= informing.

Applications and recommendations

The framework of activities can be used as an instrument by business professionals such as managers or consultants, for three purposes: implementing, improving and auditing purchasing involvement in product development. The first purpose it can serve is guiding the implementation of purchasing involvement in product development. For companies that are just starting to increase their collaboration with suppliers in product development, the framework can serve as a reference list for the kind of activities, decisions and processes that should be considered. The framework can also be of help to companies aiming for a structured organisation of purchasing tasks related to product development. As it is a list of quite generic activities, it can only 'guide' this implementation in terms of the aspects to consider, rather than give clear directives on how to implement specific activities. The second, closely related purpose of the framework is to guide improvements in a situation where, for example, supplier involvement in product development is rather chaotic and ill-managed, leading to problems in terms of communication and co-ordination. Alternatively, it can be used when purchasing involvement in development projects is effective in itself but very ad-hoc and costly, which makes management feel that a structured, long-term approach is necessary. As the framework of activities provides a comprehensive coverage of purchasing involvement by distinguishing different, tightly linked management areas, it may point business professionals to important aspects previously ignored.

Summary

The third purpose involves auditing. The framework can be used as a 'checklist' of activities, for which to identify the current level or state of involvement, which then may be compared to 'benchmarks' based on previous situations, future goals or other business units or companies. The audit could be performed as a qualitative assessment by an internal or external expert, or as a survey among purchasers, engineers and other employees concerned (marketing, product management).

The preliminary knowledge developed in this study on the driving factors behind the different activities or management areas can be interpreted as indications in which situations (specific parts of) the framework of activities are relevant or particularly important. In a sense, these indications, together with the knowledge regarding the requirements or enabling factors, form a first version of a 'manual' when and how to use the framework of activities. Based on the investigation of potential driving factors, the framework of activities seems to be largely applicable to firms with different sizes, different production types, different purchasing ratio's and different levels of R&D expenditure. As far as can be concluded from the case studies, it is only with respect to individual management areas that different firms seem to require different degrees of involvement. Development Management is an area that seems to require particular attention at large companies, and/or companies where product development is an important process (measured in R&D expenditure). Project and Product Management activities seem especially important for firms with assembly processes (that use a large number and/or variety in parts). Rather than quantitative reliance in terms of purchasing ratio, it is the qualitative dependency of manufacturers on suppliers in terms of the *kind* of products being bought and their contribution to innovations in the final product that determines the need for Supplier Interface Management.

The preliminary knowledge developed in this research on the enabling factors behind the different activities/management areas can be used for trying to establish or improve the firm's internal environment in terms of the means required for performing the activities, or even performing them (more) efficiently and effectively. Based on the investigation of potential enabling factors, it seems that the organisation of the purchasing department and the product development team supports purchasing involvement in the best way when this 'internal organisation' fits with the particular business context the firm is facing. This means that firms which have a great diversity in input resources, which face rapid technological developments, and which are highly dependent on product development, should have a fairly autonomous development team and a purchasing department with a strong specialisation and separation regarding initial vs. operational purchasing tasks. For all kinds of firms, however, participation by purchasing in the development team seems an enabling factor with regard to their involvement in the various activities defined in our framework. Registration and availability of information forms another enabling factor, especially for firms with development projects that are technically and/or organisationally rather complex. Finally, the quality of human resources seems to be the ultimate condition for purchasing involvement to be successfully achieved. When purchasers have limited education and little or no experience outside their department, and/or when they have little technical expertise and a limited degree of pro-activeness, this forms a barrier to achieving purchasing involvement in product development. In this context, it is very important how purchasers are perceived by others (primarily engineers).

With respect to some of the activities, we have formulated further recommendations by referring to examples of how these activities could be executed.

Shortcomings and recommendations for further research

Apart from possible contributions or merits the research may have, a number of shortcomings or limitations can be identified. In terms of the knowledge developed in the research, the first limitation regards the level of detail for the activities listed in the framework.

Although the case studies, from which the framework of activities has (partly) been derived, provide specific illustrations of the different activities, the framework describes the activities in quite general terms. In that perspective, the framework of activities is rather generic. The research has not structurally investigated how different companies execute the activities in different ways, and the (dis)advantages of the different alternatives. Instead, the study has focused at whether or not the 'generic' activities are executed, and at the reasons and the implications of (not) performing them. The second possible limitation pertains to the driving and enabling factors. In the research objectives posed at the beginning in the first chapter, the knowledge on those factors developed in this research has been described as 'preliminary'. This is reflected in the fact that, especially with regard to the driving factors, we have focused on a limited number of rather narrowly measured factors, which means that other aspects that possibly have an impact on the need or the ability to perform different activities, have been ignored. In terms of driving factors, notably little emphasis has been given to product development characteristics other than project complexity and total R&D expenditure. In terms of methodology, one limitation concerns the fact that we have not investigated the actual effects of the various activities in terms of development project performance (lead-time, costs, quality) or opportunities to benefit from technical developments in supplier markets. We have not carried out any 'before' and 'after' studies at a particular company, which could have measured some of these effects. On the other hand, we have argued that not all effects of purchasing involvement in product development are readily measurable, especially not the long-term effects.

Based on the results of this study, several directions for future research can be identified. First, it would be interesting to carry out investigations regarding the actual impact of performing the activities listed in our framework. This could be done in the form of longitudinal case studies, in which firms are studied that carry out an implementation or improvement project by using the framework of activities as a guideline. One way of assessing the effects of such an effort would be to compare similar development projects over time within a specific firm. The second recommendation for future research is to investigate the long-term effects of purchasing and supplier involvement in product development more closely. These long-term effects have been largely ignored in prior research, which seems to result in underestimating the potential benefits of involving purchasing and suppliers in product development. A third recommendation pertains to the different ways in which the generic activities can be executed. Further research may focus on comparing different approaches to individual activities, for example, over time within one company or simultaneously for different companies. A fourth recommendation concerns the use of contracts in managing supplier involvement in product development. This issue has not been investigated in-depth in the current study, partly because the use of contracts seems very limited in practice, partly because they are only one of the means in achieving some of the key processes underlying purchasing involvement in product development. Future research could focus more on contracts in manufacturer-supplier collaboration in product development, the reasons why they are used or not in specific situations, and *how* they are actually used in a relation. The fifth recommendation directly related to the present study would be to consider other potential driving factors than the ones covered by our empirical studies. This would primarily involve technical and development characteristics such as product technology (e.g. electronics vs. mechanics) and the dominance of process or product innovation in a certain industry sector. The final recommendation concerns the enabling factors. Especially the influence of human factors may be studied further. Interesting issues may involve the optimal mix of skills and knowledge within purchasing departments, and how training and hiring may be affected by the increasing process orientation of firms.

In a wider context, this research may provide interesting leads for research on achieving and maintaining collaborative supplier relations by focusing on issues such as mobilisation. It also indicates some aspects which may be worthwhile to consider in further research on the organisation of purchasing departments.

Summary

Chapter 1

Points of Departure

This study deals with the involvement of the purchasing function in product development, or more specifically: those activities related to product development that belong to the functional sphere of purchasing. It discusses what these activities should contribute to, what they exactly are, in what situations they should be carried out and how they can be organised. The topic lies at the intersection of two main management areas: purchasing and supply management on the one hand, and product development on the other hand. It also combines interorganisational and intra-organisational issues, as it involves relations both between suppliers and manufacturers and between different internal functions or departments, primarily purchasing and product development. In this opening chapter, the origins, objectives and approach of the study are discussed, and an overview is presented of its contents.

1.1 Origins

At the start of the research project underlying this thesis, some particular developments in business could be noted and, together with the available literature on the subject, these have guided our research objectives and questions. Before going into those questions in detail, let us consider these developments and the current knowledge in the field.

1.1.1 Developments in business

The past decade or so seems to have been dominated by increasing specialisation, or vertical disintegration, regarding business activities. 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; Quinn and Hilmer, 1994). This tendency towards specialisation has, in the eyes of some, become so strong that new terms have been introduced like the 'hollow corporation' or the 'virtual enterprise' (Business Week, 1986).

The origins and motives of this development can be said to be related to both technical and economical aspects. From a technical point of view, it may no longer be *effective* to carry out all sorts of activities in-house. As technological development progresses, and technology becomes more and more complex and divided into numerous specialisations, it becomes increasingly difficult, or even impossible, for firms to possess all the knowledge and competencies necessary to develop, produce and sell products on their own. From an economical point of view, it may no longer be *efficient* to keep all activities in-house. Specialisation is said to provide better economies of scale and scope plus learning effects, leading to reduced costs and cycle times and improved product quality. Obviously, these economical and technical motives are closely related.

Within this trend towards 'outsourcing', two different yet closely connected phases can be distinguished. In the first instance, this increased specialisation has been focused at production activities as reflected in manufacturers'¹ decreasing share in the added value of their products. Part of the production activities previously carried out by the manufacturer may be taken over by down-stream actors, but the greater part of this production specialisation takes the form of a growing reliance on the resources of suppliers.

¹ With 'manufacturer', we refer to the customer of a supplier that is not a user but a producer of goods or services.

This development is reflected in the increase of purchasing's share in companies' production value. Already a decade ago, in a great deal of industries this share was higher than 50 percent and many sectors nowadays show shares of 60 to 70 percent (Van Weele, 1994: 12; Gadde and Håkansson, 1993: 4-6). In the specific case of one of the world's major electronics manufacturers, Philips Electronics, the purchasing-to-sales ratio equalled around 48 % in 1975, grew to 53 % in 1985, and in 1995 it amounted even to 64 %. Other, comparable companies like Sony, however, even show ratio's between 80 and 90 percent.

In the second instance, the specialisation tendency has implications for activities related to product development, such as R&D. With production activities becoming more spread over different companies in the production or supply chain, technical development activities concerning the products or processes involved become more scattered too². Therefore, the need for inter-organisational collaboration in technical development grows. In itself, technical development to a great extent is and always has been a matter of interaction between different organisations (Von Hippel, 1988; Håkansson (ed.), 1987). But nowadays, perhaps more than ever, companies are really co-operating in technical development, jointly carrying out research and development activities.

In a study of over one-hundred small and medium-sized Swedish manufacturing companies, Håkansson (1989: 121) found that around 50 % of all technical development work is conducted as part of some external collaborative project. In a recent survey for the Netherlands, of the different methods of creating innovations, internal R&D is the most popular method (62 % of all innovators), followed by partnership with third parties under joint risk-sharing (32 %). Other methods are outsourcing development work (29 %) and purchasing technology in the form of licenses or new machines (27 %) (CBS, 1996: 60-63). These figures emphasise the importance of inter-organisational collaboration in product development.

Collaboration with external parties in product development becomes more important not only due to increased vertical disintegration and specialisation, but also because firms are increasingly focusing on innovation as a means of building and sustaining competitive advantages (Nonaka and Takeuchi, 1995; Wheelwright and Clark, 1992; Bolwijn and Kumpe, 1988; Foster, 1986). This tendency is reinforced by shortened product life cycles and increased development costs. Competitors and customers force firms to innovate, and at an increasing speed (Smith and Reinertsen, 1991; Stalk and Hout, 1990). Therefore, to create competitive advantage, companies need product innovations; and to realise potential innovations, and to realise them quickly and efficiently, they need to co-operate with other firms in their environment.

One category of possible partners in collaborative product development, apart from customers and competitors, is formed by suppliers. Actually, suppliers form a very important category; in the studies mentioned previously only 25 % of the Swedish manufacturers were *not* co-operating with any of their suppliers (Håkansson, 1989: 77). When Dutch companies undertake innovation with the help of third parties, two-thirds of them work with either suppliers or customers (CBS, 1996: 60-63). In the case of Japan, Nishiguchi (1993: 66) reports that in 1987, roughly 60 % of the suppliers in the electronic, machinery, transportation equipment and precision machinery industries were involved in the development of components, jointly with their customers.

² At this point, we make no explicit distinction between product and process innovation. This will be further discussed in section 2.1, but suffice it here to say that we are only concerned with process innovation as far as it involves product innovation - as it often does.

The interest for the role of suppliers in product development received a big impetus from the studies on differences between Japan on the one hand, and the US and Europe on the other, regarding the organisation of development projects for new automobiles (a.o. Clark and Fujimoto, 1991). These studies showed that Japanese manufacturers were able to turn out new automobiles at a faster pace, with more innovative features, and with less efforts in terms of development hours or number of engineers involved. The explanation forwarded was that in developing new cars, Japanese manufacturers relied more heavily on their suppliers. Using the extra and specialised development potential embedded in the skills, competencies and knowledge of suppliers makes product development more efficient, by increasing the output (a better product, a more innovative product, a faster market introduction) or - but ultimately *and* - decreasing input (less development costs, less design changes, less engineering hours) (*cf.* Clark, 1989).

At the same time, and partly caused by these changes, important developments have been going on within the field of purchasing management. In many companies, purchasing³ 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 (Gadde and Håkansson, 1993: 3-6; Van Weele, 1994: 107-124; Dobler and Burt, 1996). 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 increasing importance of the purchasing function, which can also be seen in the growing attention it attracts in research and education, is not only caused by the growing volume of purchases as discussed earlier. It is also caused by the changing nature of the products being purchased, the increasing focus on logistics, and the growing realisation of the impact suppliers and purchasing have on the quality of final products, to name just a few factors.

The combination of these two closely related trends - firms' increasing dependence on suppliers for innovating its products, and the growing strategic orientation towards purchasing - has led to mounting interest for the involvement of suppliers and the purchasing function in new product development. Many companies have started special projects to increase or improve the role of purchasing and suppliers in product development projects; General Motors with its PICOS⁴ project, Ericsson with its External Technology Provisioning policy and DAF Trucks with its Supplier Involvement in Product Development project, to name some examples. At the same time, researchers have started to develop an interest in this subject too⁵. However, despite the fact that the interest seems to be growing recently, supplier and purchasing involvement in product development is not a new phenomenon: it has been an issue of interest for quite some time already, both to practitioners (f.e. McLean, 1964) and researchers (Bergman and Johanson, 1978). This is also reflected in an advertisement from the American professional journal *Purchasing Magazine* published in 1961, see Box 1.1.

³ The word 'purchasing' will be used to refer to the function as such. In Chapter 4, the difference between the purchasing function and purchasing department is discussed.

⁴ PICOS stands for 'Purchasing Input Concept Optimisation with Suppliers', see Lilliecreutz (1996: Ch 4).

⁵ See: Burt and Soukup, 1985; Axelsson, 1987; Clark, 1989; Williams and Smith, 1990; Bonaccorsi, 1992; Dowlatshahi, 1992; Håkansson and Eriksson, 1993; Lamming, 1993; O'Neal, 1993; Birou, 1994; Hartley, 1994; Hines, 1994; Kamath and Liker, 1994; Mendez and Pearson, 1994; Nishiguchi, 1994; Peter, 1996; Ragatz *et al.*, 1997.

You were just included in the specs . . .

A new product is on the drawing board.

Design engineering has set the specifications and prepared the drawings. Who has been working with the designer on the entire project?

The Purchasing Agent.

How come? Because the PA is responsible for keeping costs in line. He locates suppliers and checks their capabilities. He reviews each component. Asks questions. Would a standard part do the job as well as a more expensive special part? Could this component be made of some other material? Are such tight tolerances necessary?

Pre-production purchase analysis and purchase planning at this stage are the modern way to control costs and add to profits.

Alert: suppliers know the PA's involvement at the design stage and the need to sell him on their products, facilities, capabilities, engineering assistance, etc. They advertise in PURCHASING Magazine, the one publication PAs read to keep them on top of their jobs.

Little wonder that PURCHASING Magazine's request circulation is among the highest of all business publications.

PURCHASING MAGAZINE

Read by more men who buy

A CONSUMER MAST PUBLICATION

Box 1.1: Purchasing and product development: an old issue

Source: Purchasing Magazine, 1961.

1.1.2 Current knowledge on purchasing involvement in product development

Although the role of purchasing and suppliers in product development has attracted considerable attention during the last 10 to 15 years, closer examination reveals that most of the available research and literature has some important limitations. These limitations manifest themselves in four aspects; the *scope*, the *empirical basis*, the *perspective* and the *cohesion* of the research.

First, most of the research has focused on managing supplier involvement in new product development projects (*c.f.* Burt and Soukup, 1985; Dowlatshahi, 1992; O'Neal, 1993; Birou, 1994; Mendez and Pearson, 1994). The discussion is usually concerned with improving the efficiency of product development projects in terms of costs and time, and improving their effectiveness in terms of product quality and functionality. Other areas of product development where purchasing activities are involved as well are relatively neglected. On the one hand, these other areas concern activities that are oriented more towards the long-term (*cf.* Bonaccorsi, 1992). On the other hand, these areas encompass activities that are not directly related to managing actual supplier involvement. Examples are participating in the discussion on the technological core competencies of the firm, or carrying out (supplier) market research with respect to new technologies. Consequently, by focusing only on managing supplier involvement in development projects, a systematic overview of all the appropriate purchasing activities regarding product development is still lacking. This can be said to be a limitation in scope.

Second, most studies have been limited to large-scale assembly industries, primarily the automotive industry (Clark, 1989; Lamming, 1993; Hines, 1994; Andersson and Augustson, 1996; Garel and Kesseler, 1996), or the electronics industry (Mendez and Pearson, 1994; Nishiguchi, 1994). Consequently, little is known about supplier involvement in product development in other industries, like those with unit/small series and process production. This is clearly a limitation regarding the empirical basis of most current research.

Third, the majority of publications focuses on purchasing and supplier involvement in product development as an inter-organisational phenomenon. In other words, both the supplier and the manufacturer are seen as monolithic entities. Of the two, the emphasis is usually on the role of the manufacturer. This perspective is quite narrow, nearly neglecting two other important aspects: the role of the supplier, and the role of individual departments. The lack of attention for the role of the supplier is reflected in a strong focus of a large part of the existing research on, for example, the strategies and instruments employed by the manufacturer, while the effects these have in terms of the 'reactions' of suppliers are barely investigated.

When the role of individual departments is analysed, it regards nearly exclusively the purchasing department (*f.e.* Williams and Smith, 1990; Atuahene-Gima, 1995). Only seldom, explicit attention is given to the perspective of other departments at the manufacturer, such as Product Development (R&D). It is hardly acknowledged that in reality, supplier and purchasing involvement in product development is managed by people coming from particular departments and that these may have different and perhaps even opposing ideas, interests and strategies (Dowlatshahi, 1992). Hence, the perspective adopted by most research is somewhat narrow.

Finally, and perhaps most importantly, there does not seem to be a coherent view of what purchasing involvement in product development actually is. Most research tends to identify rather fragmentarily a number of issues or processes, while there is no clear delineation, no integrated framework of what purchasing involvement consists of.

The research underlying this study aims to overcome these four limitations. It is not limited to purchasing involvement in product development projects, neither to the automotive and electronics industry, it includes a variety of actors, both internal and external, and aims to develop a more coherent delineation and definition of purchasing involvement in product development. This brings us to the problem definition of our study.

1.2 Problem definition

With regard to the problem definition of this research, two different aspects can be distinguished: research questions and research objectives (Verschuren, 1991: 32-33). In the research tradition within industrial engineering and management science at Eindhoven University of Technology, the research objective actually embodies a 'design' objective, i.e. the goal is to develop a method or organisational tool (Florusse en Wouters, 1991; Van Aken, 1994). The research objective of the current study is:

1. *To develop an integrated framework of specific activities that purchasing involvement in product development consists of.*

This framework may help

- to implement;
- to improve; and
- to audit

the involvement of the purchasing function in product development.

This is the primary objective of the study. There is also a secondary research objective:

2. *To develop preliminary insights regarding the application of this framework of activities in terms of:*

- the factors that influence the *need* to carry out the activities;
i.e. the driving factors, and
- the factors that influence the *ability* to carry out the activities;
i.e. the enabling factors.

This second objective clearly is a less 'ambitious' one.

The envisaged framework of activities may be used as an 'instrument' by business professionals such as purchasing managers, product development and general managers or external consultants, for three purposes. The first two purposes are relatively similar: guiding the implementation and the improvement of the involvement of the purchasing function and suppliers in product development. The framework has to be designed to cover all the activities related to this involvement, in order to provide a complete instrument for implementation and improvement purposes. The third, derivative, purpose involves auditing, in which the framework can be used to identify the current state of involvement, which then may be compared to previous situations, future goals or other companies.

The second objective involves insights about the factors influencing the need and the ability to perform specific activities from the (general) framework; in other words, the driving and enabling factors for these activities. The insights generated in this study will only be preliminary, primarily because just a limited number of factors will be investigated. These insights can be seen as a preliminary manual on how and when to use (parts of) the framework of activities, indicating the conditions under which (for example, in terms of company size) to carry out specific activities, and the requirements for performing them (for example, in terms of organisation and personnel).

Based on these objectives, the primary research questions in this study are:

1. *What are the key processes that purchasing involvement in product development should realise or at least contribute to?;*
2. *In what areas can purchasing involvement contribute to these key processes?;*
3. *What are the specific activities that realise or contribute to the key processes in the various areas?;*
4. *Which factors influence the need for a firm to carry out these specific activities?; and*
5. *Which factors influence the ability of a firm to carry out these specific activities?*

The first three research questions are related to the first research objective, and make a distinction between the underlying processes, the various areas and the specific activities of purchasing involvement in product development. The first two research questions are especially important in the perspective of one of the shortcomings of existing research previously identified: the lack of a cohesive framework, defining what purchasing involvement in product development actually is and consists of. Identifying the underlying processes and the various areas within purchasing involvement provides the basis for developing such a framework. The second research question, on the areas of involvement, also addresses another shortcoming of existing research: the exclusive focus on development projects.

The final two research questions are related to the second research objective, and seek to identify some of the contingencies for organising the activities of purchasing related to product development.

This study does not systematically investigate whether the involvement of purchasing actually contributes to making the firm more innovative or more efficient in developing new products. Instead, the appropriateness of the activities is based on their contribution to key processes regarding manufacturer-supplier collaboration in product development as identified in theory. In other words; the criterion for incorporating a specific activity in the framework has been whether it realises one of the key processes. Empirical studies are used to identify these activities, and to examine which activities are carried out in which situations, the degree of emphasis placed on different activities and who is responsible for them. Obviously, we will be able to say something about the product development processes involved in terms of problems and successes, but we have not made an explicit quantitative comparison between different projects in terms of budget, time and quality, and related the outcomes to changes in the level or form of purchasing (and supplier) involvement.

There are several reasons why the focus of this study is not primarily on the actual results or benefits of purchasing involvement. Most importantly, it is not yet fully understood what purchasing involvement in product development exactly is. The question of what constitutes purchasing involvement in product development precedes the question of whether it has positive effects. In other words, the 'wrong' kind of involvement can have negative effects. Also Clark (1989), for example, emphasises the way supplier involvement is managed as a crucial element in achieving positive results. Studies of the results of purchasing and supplier involvement in product development without close consideration of their form and content (f.e. Birou, 1994) provide little new insights compared to the current level of knowledge. Additionally, it is difficult to get objective and reliable quantitative data regarding the effects of purchasing involvement in product development, if only because of the often unique character of development projects (Peter, 1996: 143-147; Meyer, 1993: 232). Section 3.5.3 discusses this problem in more detail.

Before turning to the approach and methodology of the study, it is appropriate to briefly review the theoretical approach that has guided it.

1.3 Theoretical basis

The single most important theoretical 'building block' for and in our research is formed by the so-called 'Network Approach' as developed by a group of mainly European researchers in the area of industrial marketing and purchasing, also known as the IMP Group (Håkansson *ed.*, 1982). Encompassing its precursor, the 'Interaction Approach', the term Network Approach stands for an approach towards studying industrial firms and their behaviour mainly in terms of interorganisational relationships and the connections between these relationships (as described by the word 'network').

This group has also carried out numerous studies of technological development⁶. Because of this focus on interorganisational relationships and emphasis on technological development, the Network Approach is a theory very well suited as a basis for developing concepts regarding supplier involvement in product development. Additionally, the Network Approach is said to be built on both a sound theoretical and empirical basis (Meeus and Oerlemans, 1993: 58).

One central concept in the Network Approach are 'resources', being the material and immaterial sources that firms draw upon to perform certain activities (see also Pfeffer and Salancik, 1978). Resources are of central importance with regard to developing (product) innovations, and suppliers are in essence nothing more (or less) than external resources. Therefore, we will often - implicitly or explicitly - refer to this concept of resources.

It is important to note that the aim of this study does not primarily lie in the area of theory development. Its aim is mainly practitioner oriented; to develop knowledge for guiding (helping to organise, implement and support) useful involvement of purchasing (and suppliers) in product development. In that respect, the prime target-groups of the research are managers and other business professionals. On the other hand; we have claimed that current research into this area suffers from several flaws, and by addressing these supposed shortcomings we also aim to provide interesting and useful analyses and findings for researchers.

After this discussion of the problem definition and the theoretical basis of the current study, its approach and methodology are presented with specific attention for the role and objectives of the empirical studies.

1.4 Research approach and methodology

Apart from a review of existing theory and previously published empirical research, this dissertation relies on a series of original empirical studies. These studies have been carried out in two European countries, The Netherlands and Sweden, and across a number of different industries. The studies consist of three main phases⁷:

1. case studies of 9 manufacturer-supplier relations across five different industries in both countries;
2. mini-case studies of 9 Dutch manufacturers; and, finally,
3. three in-depth case studies at one Swedish and two Dutch manufacturers.

The three different phases each have a specific purpose within the research project, and that brings us to the research approach.

1.4.1 Research approach

The first phase in our research has been to select from available literature a number of concepts that seem to be key processes in manufacturer-supplier collaboration in product development, and to identify the main areas that purchasing involvement in product development consists of. In the second phase, these key processes and main areas have been used as a framework to analyse 9 cases of product development collaboration between manufacturer and supplier.

⁶ For example Håkansson (ed.), 1987 and 1989; Laage-Hellman, 1989; Waluszewski, 1989 and Lundgren, 1995.

⁷ At the very start of the project, explorative interviews at some 20 companies have been conducted in Sweden and the Netherlands to further refine the original research questions and guide the data collection in terms of the specific industries and companies that would be the most suitable to continue the research with. These interviews are not explicitly reported here.

The goal of this phase has been:

- 1) to find out whether purchasing involvement activities can be adequately described and analysed in terms of the underlying key processes;
- 2) to identify possible differences between industries in terms of the occurrence and importance of the key processes and the main areas regarding purchasing involvement in product development; and
- 3) to identify specific activities that can be seen to contribute to the key processes according to the different areas or objects.

Together, this should result in a set of activities forming purchasing involvement in product development; the realisation of our first research objective.

The nine case studies carried out in this second phase of the research (during the period 1995- early 1997) are based on interviews with 18 suppliers and manufacturers in five industries. The focus is on manufacturer-supplier relations, and especially the collaboration taking place regarding the development of new products. In essence, this phase involves a cross-sectional analysis of inter-organisational issues. Within every industry and each country, we have been interviewing pairs consisting of a supplier and a manufacturer. This provides the opportunity to look at purchasing's and suppliers' contribution to product development from the perspective of both firms. This has been done since one of the flaws in prior research, as mentioned before, is the almost exclusive focus on this contribution as seen from the manufacturer side.

The third phase in the research, being the second series of empirical studies, has consisted of 9 'mini' case studies carried out in co-operation with a working group of the Dutch Association for Purchasing Management (NEVI). These have been conducted between Spring 1995 and Spring 1996, nearly in parallel to the first series of empirical studies. (The fact that both the first and second series include *nine* case-studies is purely coincidental.) Purchasing managers from different companies have been invited to this working group to present a short case study of their respective companies, which have then been analysed to identify the major issues in new product development from the perspective of the purchasing function. The goal of these mini-case studies has been to create an overview of current practices in various companies in the Netherlands and identify a number of key issues in managing purchasing involvement in product development. The main result has been a redefinition of the different areas that this involvement may be focused at, and the identification of an additional key process besides the ones derived from literature. Despite the additional interviews and students' thesis projects that have been carried out at some of them, these companies and their ways of managing purchasing involvement in product development have not been studied very intensively as compared to the other two series of case studies. Hence, the label 'mini-cases'.

The fourth phase of our research (1996-1997) consists of three in-depth case studies, in which the set of activities developed through the previous phases of the research is used to analyse the situation at a specific company. The companies include two of the manufacturers studied in the first series of case studies on manufacturer-supplier collaboration, and one from the group of Dutch manufacturers studied in the mini-cases. In these three in-depth case studies, there are four major questions:

1. Of the framework, which management areas / specific activities are performed, by whom?;
2. What problems and successes does the company experience in its product development projects or process, and can these be related to the extent and the way the areas / activities are carried out?;
3. To what extent is the company putting special emphasis on certain areas / activities, and neglecting others based on its size, production type, its reliance on product development and on suppliers (driving factors)?; and
4. To what extent and in which areas is the company limited in its ability to perform the areas / activities in terms of organisation, information and human resources (enabling factors) ?

All three phases of empirical studies in the current study consist of case-studies, which have some specific methodological aspects that deserve some further explanation.

1.4.2 Research methodology

Of the three series of case-studies, the first two series are so-called 'exploratory' case studies. As the specific research questions for those two series of case studies indicate, these explorative cases are aimed at 'identifying and shaping ideas or, even stronger, hypotheses' (De Leeuw, 1996: 93). The third series of in-depth case studies have an explanatory character. As the four specific research questions for those cases indicate, the objective is to find out which management areas and individual activities from our framework are being performed and to what extent, and to use this 'pattern' to explain possible problems and successes the company is experiencing in product development. In its turn, the activity pattern may be explained by underlying enabling and driving factors (see Figure 1.1).

The combination of the three in-depth case studies can be described as an 'embedded multiple-case design' (Yin, 1994: 39). It is embedded rather than 'holistic' in the sense that the case studies include more than one unit of analysis: within each company, we also study individual departments or individual development projects. In other words, each case study is built on the analysis of sub-units, be it processes or organisational entities.

Figure 1.1: Explanatory variables

The quality of the research design or methodology should be judged on the basis of four aspects: construct validity, internal validity, reliability and external validity (Yin, 1994: 33). *Construct validity* refers to having the right measures for the concepts being studied. Two measures have been taken to increase construct validity in the first and third round of case studies: using multiple sources of evidence (see section 7.1) and having the draft case study report reviewed by key informants, which increases the accuracy of the case studies (Yin, 1994: 144-146). In addition to that, the main concepts studied in the third round of cases are the four management areas (see section 6.4), and they are quite operational since they encompass specific activities that can be relatively easily identified.

The quality of the research design in terms of the other three aspects (internal validity, reliability and external validity) should mainly be achieved in the final series of (explanatory) case-studies. *Internal validity*, establishing causal relationships, is mainly achieved by using appropriate analytic strategies. For explanatory case studies, explanation building is a useful strategy: analysing the case study data by building an explanation about the case (Yin, 1994: 33-35, 110-113). In the three explanatory cases, we aim to analyse the data by explaining how certain problems in product development are related to the purchasing involvement activity pattern, and how this pattern is related to particular driving and enabling factors. This explanation building takes place in narrative form, but also by using theoretical insights. *Reliability* involves the reproducibility of the study: can it be repeated with the same results. In the three case studies, the aim has been to increase reliability by using multiple sources of evidence and by maintaining a chain of evidence, i.e. establishing explicit links between the research questions, the collected data and the conclusions (Yin, 1994: 90-99)⁶.

External validity refers to the domain to which the studies' findings can be generalised. Case studies rely on *analytical* rather than statistical generalisation. Instead of generalising from a sample to a larger universe with regard to the frequency of certain problems in product development and the occurrence of particular purchasing involvement activity patterns, the case study investigator aims to generalise a particular set of results to some broader theory. Regarding the third series of explanatory case-studies, this theory concerns the causal relationships between driving and enabling factors, purchasing involvement activity patterns and product development problems and successes. This analytic generalisation is not automatic, however, but should be based on replications (reproduction) of the findings (Yin, 1994: 35-36, 45-50). This brings us to the reasons why the third phase of empirical studies includes multiple cases.

In multiple-case studies, cases should be selected to predict either similar results (literal replication) or contrasting results but for predictable reasons (theoretical replication). We have chosen to use theoretical replication: in other words, select case studies that differ in terms of the key variables (represented in Figure 1.1) and pursue, in each case, the proposition that a number of driving and enabling factors affects the purchasing involvement activity pattern, which affects the problems and success in product development. Rather than selecting case companies that differ widely in terms of their product development problems and successes or their enabling factors, the choice has been made to select a variety of cases in terms of the driving factors. These factors, as defined in section 6.5.1, can be established more quickly and easily than the enabling factors and the product development outcomes, which makes the case selection process more efficient. In section 7.1, the selection criteria for the three explanatory cases are discussed in further detail.

Before relating the research approach to the structure and contents of the current study, it is appropriate to explain briefly why the case-studies have been conducted in two different countries.

⁶ In contrast to Yin's recommendations (1994: 98-99), the case studies contain few citations of specific documents and interviews. However, specific observations of events or circumstances are cited to support the various conclusions.

1.4.3 Two countries

As indicated in section 1.4.1, the case studies have been conducted in two countries: the Netherlands and Sweden. The decision to carry out research both at Swedish and Dutch companies has been based primarily on the consideration that it would broaden the empirical basis. This applies especially to the first round of case studies. Rather than studying some industries in Sweden and some others in the Netherlands, we decided to structure our research in such a way that each industry would be covered by two case studies. In that way, similarities between the case studies in each industry could be identified as common characteristics for that industry (at least within the context of our studies) and compared to the characteristics of the case studies in other industries. Doing two case studies within the same country may be difficult in terms of finding suitable companies, especially manufacturers.

An additional reason for carrying out research in two countries has been that doing so in only one country, especially if it is relatively small like the Netherlands or Sweden, carries a greater risk of being affected by a 'parrot culture' where popular management ideas and new 'fads' are quickly communicated through professional affiliations, conferences or written media. These are the so-called bandwagon effects (Abrahamson and Rosenkopf, 1993: quoted in Vosselman, 1997: 10).

The objective of carrying out research in both countries has not been to identify the influence of cultural factors on purchasing involvement in product development. In that case, we should have chosen countries whose business cultures differ more significantly than those of Sweden and the Netherlands.

1.5 Structure of the study

As indicated in Figure 1.2, the current study is divided into three major parts plus the current introductory chapter. The first part, Analysis, deals with the theoretical basis for the study, and the second part, Design, deals with the development of the framework concerning purchasing involvement in product development, according to our primary research objective. In the third part, Evaluation, this framework is tested by using it to analyse and explain certain problems and successes regarding product development in a few case studies, thereby evaluating the influence of a number of driving and enabling factors on performing these activities.

The Analysis part begins with Chapter 2 which concerns the product development process. It starts by defining what it is, continues by examining the activities involved in managing product development, and concludes by arguing that product development is primarily a process of interaction between different actors. Chapter 3 deals with the role and involvement of suppliers in product development. First, it briefly reviews the occurrence and the different forms of technological collaboration with suppliers, among which involvement in product development. Then it discusses the objectives of supplier involvement in product development, and the various forms of involvement, analysing the different factors that determine the need for and the usefulness of involving suppliers in product development. It continues to consider the potential risks and problems of supplier involvement, in the context of which it reviews some of the results of supplier involvement as revealed by previous research. Finally, Chapter 3 discusses the role of contracts in managing supplier involvement. Chapter 4 concludes the Analysis part by investigating the relation between product development and purchasing. It starts by reviewing what the purchasing function actually is; what its goals are and which activities it involves. From that, it continues by discussing what the underlying processes and the main areas are regarding purchasing activities in relation to the product development process. The chapter concludes with a brief review of the risks related to purchasing involvement in product development.

Figure 1.2: Overview research approach

The Design part of the study starts with Chapter 5, presenting the first series of empirical studies of nine manufacturer-supplier collaborations. It uses these empirical studies to develop the first version of the framework of activities regarding purchasing involvement in product development. The key processes previously identified are used to describe the collaboration process taking place and to explain some of the possible problems encountered. Potential differences between the different cases and industries are analysed in terms of the (importance of) the key processes and the areas of purchasing involvement in product development. Finally, specific activities are identified that contribute to the key processes, in the different areas. In Chapter 6, these activities are combined into an integrated framework of activities. The second series of empirical studies, mini-cases of Dutch manufacturers, is used to refine this framework.

The Evaluation part of the study begins with Chapter 7 that contains three in-depth cases, in which we analyse to what extent and by whom the different activities from the set of activities are carried out. This analysis is used to explain some of the problems these companies have in product development, and to establish why certain activities (do not) *need* to or *can* (not) be carried out. Chapter 8 combines the findings from the different in-depth case-studies to discuss the driving and enabling factors in more detail. Finally, Chapter 9 summarises the findings of this study, and presents the framework of activities regarding purchasing involvement in product development, as well as preliminary guidelines for organising this involvement in terms of the conditions under which certain activities need to be carried out and with which means they can be carried out. It concludes with practical and research recommendations.

1.6 Summary

This first introductory chapter has set out to describe the origins of the study in terms of a number of current developments in business and the existing limitations of available research into purchasing involvement in product development. Most research has been said to be too limited: to short-term involvement in specific development projects, to large-scale assembly industries such as the automotive sector, and to the relation between the manufacturer and the supplier as opposed to the relations between individual (internal) departments. Finally, related to all these limitations and perhaps most serious of all: there is no coherent definition of what purchasing involvement in product development actually is. The research reported in this thesis aims to develop an integrated framework of activities that purchasing involvement in product development consists of, and to identify some of the driving and enabling factors that influence the extent to which particular activities need to and can be carried out. It does so on the basis of three series of case studies across a variety of industries in the Netherlands and Sweden, in which we look at the positions and views of different actors involved: manufacturers versus suppliers, but also purchasing versus product development departments. After discussing the research approach and methodological issues involved, the chapter concludes by reviewing the contents of the study.

Analysis

Chapter 2

Product Development

The first chapter of the Analysis part of this thesis seeks to identify the key processes and activities involved in developing new products. It starts by discussing the definition of 'product development' and related terms like 'innovation' and 'technological development'. The second section deals with the managerial aspects of product development. From most of the available literature, a picture emerges in which the manufacturer of a product is the most important driver of product development. In contrast, section 2.3 argues that product development is primarily a process of interaction between different actors. This shifts the attention to different external actors being involved in product development, and to the processes underlying the collaboration or interaction between these actors. These processes provide the starting point for the next chapter, which investigates the involvement of suppliers in product development.

2.1 Definitions

This study deals with the involvement of purchasing in product development - but what does 'product development' exactly mean, and is it the right term to use within the current study? Ideally, one wants to use a term that refers both to the process of developing a new product and the new product itself. That is because, as becomes clear in the following chapters, purchasing (and suppliers) can contribute to the process of developing a new product, but also to the new product itself. There is a whole variety of terms that relate to the process and/or results of activities in the field of research and development regarding new products. A short review of three frequently used related terms - 'technological development', 'innovation' and 'product development' - is therefore appropriate.

2.1.1 Technological Development

The process of developing new technological solutions in the form of products or production processes is sometimes referred to as *technological development*. The term 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 new products and processes over time. In that sense, it clearly is a concept that is defined at a level which is more general, both in time and in unit of analysis, than the individual new product or process¹. Technological development or technological change is indeed often referred to as taking place within a certain industry, or a certain (technological) area, encompassing the development of a total technological 'complex' including equipment, process technologies and the relevant knowledge and skills. Since the current study is concerned with individual firms and their products, not with a specific sector or technology in itself, the term technological development seems less appropriate.

¹ Sometimes however, the term 'a technological development' is used as well, meaning a more specific development project.

At this point, it may be useful to indicate what we mean by 'technology' or 'technological' as opposed to 'technical'. In the definition of Berting (1992: 19-20), 'technology' refers to three closely intertwined aspects:

1. the combination of physical objects designed and constructed by humans;
2. the human activities connected to using, maintaining and producing the physical objects; and
3. the knowledge necessary to develop new solutions regarding the design, construction and application of technical possibilities.

Without going into the details of this definition, it serves to illustrate that the adjective 'technological' is much broader than 'technical', and refers not only to the physical properties of objects but also to human activities and knowledge regarding those objects. The definition by Berting differs somewhat from the one by Weggeman (1997: 55), who defines technology as 'a collection of methods and procedures for controlling the execution of one or more technical processes'. Both, however, emphasise the importance of human knowledge and actions within the concept of 'technology'. In the remainder of this study, the term 'technological' collaboration (between suppliers and manufacturers)² will be used rather than 'technical' collaboration in order to indicate that in this collaboration, developing the knowledge of both parties with regard to the design and application of specific materials or products may be just as important as developing the actual physical object.

2.1.2 Innovation

In general, innovation is synonymous with words such as *modernisation*, *novelty*, *change*, *variation*, *transformation*, *renovation* and *recasting* (Concise Oxford Thesaurus, 1995). Apart from technological innovations, there can be innovations in organisational structure, in marketing strategy, etc. This thesis is restricted to innovations that are, at least initially, purely technological.

Within the literature on technological innovations, there is a wide variety of definitions of the term 'innovation'. Zaltman *et al.* (1973: 7-9) argues that the term 'innovation' refers to one of the following three concepts: the process of adopting the new item, the new item itself, or the process of developing the new item. These three views are closely related to each other, be it that they look at innovation from different viewpoints. The first view takes the perspective of the adopting unit, the last one takes the perspective of the developing unit. These can be different units, but also one and the same, as in the case of a firm developing a machine for internal use. Let us consider the three perspectives in order to see which one could be relevant for our research.

The *process of adopting the new item* has to do with how a customer receives and uses the innovation. This adoption process is not a particularly relevant issue in the context of this study. In Chapter 1, it has been indicated that the focus is on the technological collaboration between manufacturer and supplier; in other words, producers of goods and services and suppliers of materials or parts that go into the product of the producer. The customer of the manufacturer, the firm using the product³, is not seen as a key player in this collaboration process, apart from the demands it will impose on the new item developed by the manufacturer and the supplier.

² In Chapter 3, we discuss how supplier involvement in *product development* is related to manufacturer-supplier technological collaboration in general.

³ In some of the cases in Chapter 5, the customer of the manufacturer is not a user, but another manufacturer.

If innovation is viewed as *the item being innovated*⁴, there is a broad range of forms of innovations. One classification of the different forms of innovation, viewing them in terms of outcome or effect, regards the degree of 'newness'. Again, it is important from which perspective the innovation is perceived; the developing unit or the adopting unit. For either side, innovations can range from routine to radical, from traditional to non-traditional, from normal to revolutionary, from variation to re-orientation (Biemans, 1989: 30). Moreover, the degree of newness of a particular innovation need not be the same for both parties: something can be new to the developing unit, but not to the adopting unit or the market in general, and vice versa. Therefore, typologies of innovations have been developed that take into account both perspectives at the same time, see Figure 2.1.

Figure 2.1: A classification of product innovations

Based on: Booz, Allen and Hamilton, 1982; Gobel and Brown, 1987; Crawford, 1994.

Apart from classifications regarding the degree of newness, there is the distinction between *product* innovations and *process* innovations (Utterback and Abernathy, 1975). Product innovations concern new products introduced to the market to meet user demands, while process innovations involve new equipment or methods to produce (new) products. However, this distinction can not always be strictly maintained. A new piece of equipment represents a product innovation to the manufacturer of the machine, but a process innovation to the user of the machine. In other words, many process innovations (but not all; for example, when existing machines are used in a new way) rely on product innovations. The classification product vs. process innovation is therefore mainly a matter of perspective. Since in the current study, the focus is on product development through manufacturer-supplier collaboration, innovation is viewed from different perspectives, and it is therefore good to realise that one and the same innovation can represent both forms.

Finally, innovation seen as the *process of developing the new item* focuses at the decisions and activities going on at the manufacturer of the product. This involves a broad range of tasks such as market research, fundamental technical research, product and process development.

⁴ 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 refers to a realised commercial product: 'Innovation = invention + exploitation' (Roberts, 1988: 13).

Although the term 'innovation' thus can refer to both the process of developing the new item and the new item itself, and therefore would be useful for the purpose of our study, it will not be used as a central phrase. Especially because it often also includes adoption processes, it may be too broad or at least not specific enough to indicate the activities and process that are of prime interest here.

2.1.3 Product Development

'Development' refers both to verbs like *originating*, *forming*, *breeding*, and to words such as *event*, *occurrence* and *outcome* (Concise Oxford Thesaurus, 1995). In other words, it expresses both a process and a result.

As a process, product development is one of the key phases in the overall innovation process, consisting of development, adoption and diffusion (Biemans, 1989: 88). Also Trygg (1991: 4) discusses product development as part of the technological innovation process. According to this author, innovation is concerned with the whole process from interpreting market needs up to the first new sales, whereas product development refers to the phases of product planning, engineering design and process planning, see Figure 2.2. Research and development differs from product development in the sense that it not only includes planning and engineering activities, but also basic and applied research.

Figure 2.2: Innovation and product development

Based on: Trygg, 1991: 4.

Also Weggeman (1995: 56) relates product development explicitly to research and defines it as 'radical or incremental improvement of research results, or combining them within a system (product or process)'. A more detailed definition of product development is given by De Graaf:

'Product Development is a sequence of design processes that converts generally specified market needs or ideas into detailed information for satisfactory manufacturable products, through the application of scientific, technical and creative principles, acknowledging the requirements set by succeeding life-cycle processes.' (De Graaf, 1996: 12)

Compared to the definition by Trygg, De Graaf explicitly considers the requirements placed on the new product from the perspective of subsequent phases of the product's 'life' such as using and disassembling/recovering the product. Both definitions, however, clearly define product development as a conversion of technical possibilities and market needs into efficient and effective product designs.

This conversion process can be characterised as a set of activities that seek to develop and identify solutions to specific problems, thereby increasingly reducing uncertainty.

Seen as a result, product development has the same connotation as the word 'innovation' in the meaning of the new item itself. Unlike innovation, however, the term product development is not directly linked to a discussion on the degree of newness of the development. As the degree of newness is not a key aspect in this study, this may be seen as an advantage. Therefore, in order to describe both *the process of developing a new or improved product* and *the result of that process* itself, 'product development' is used as the central phrase in this study. Choosing this term also underlines that this study is neither concerned with the broad process of adoption and diffusion of new products ('innovation'), nor with (long-term) processes of change in specific technological areas of industry sectors ('technological development').

A further analysis of product development and the decisions, activities and processes taking place may be useful for identifying the moments or aspects where suppliers and purchasing can tie in, in order to provide added value to product development. This analysis starts by looking at the managerial activities involved.

2.2 Managing product development

Most descriptions of the management of product development are based on the different stages that can be distinguished within the development process. These stages are related to the various activities that are carried out in product development projects. The rationale behind this is that the process of developing a new product can better be managed by identifying different phases in the project, with different tasks to be completed in each phase, by different people. By setting reference points such as phases and mile-stones with accompanying work-packages, the development process can be structured and thereby better steered and controlled. For the remainder of the thesis, in which we aim to determine the activities by which purchasing can provide added value to the product development process, it is useful to have a specific conception of these stages of product development.

There is a whole range of models of the different stages of product development, and after a review of the different kinds of models in the first part of this section, attention is given to a specific group of so-called 'activity stage' models. This section on managing product development concludes with the discussion of the more recent 'concurrent engineering' approach, which de-emphasises the different stages in product development projects and actually advocates that the different stages overlap to a great extent in order to achieve a more efficient development process.

We will not deal with the less familiar, non-linear models of innovation and product development, such as the 'chain-linked-model' by Kline and Rosenberg (1987; in Oerlemans, 1996: 152-153). These models take into account that development processes may occur in a variety of ways which do not always follow the logical sequence of the linear models. Additionally, relations with external actors are more explicitly acknowledged in these non-linear models. By allowing for the possibility of overlaps and feedbacks between the different phases, and by focusing on the contributions of external suppliers, we aim to compensate for some of the shortcomings of the linear models.

2.2.1 Models of the stages of product development

Models of the different stages of product development can be classified into five different categories (Saren, 1984; quoted in Biemans, 1989: 44-63): (1) departmental stage models; (2) activity stage models; (3) decision stage models; (4) conversion process models, and (5) response models.

Departmental stage models represent the product development process by a series of stages referring to the departments within the firm that are involved in the process, usually in the order R&D - Engineering/Design - Production - Marketing. The problem is that these models do not describe the actual activities carried out in the development process, and that possible overlap and feedback between the various departments involved is ignored. *Activity stage models* describe the development process by a sequence of activities, for example idea generation - problem solving - implementation (Utterback, 1974). These sequential models, however, do not describe the interactions between the different stages, and assume that each stage is completed before the next one starts. Only some activity stage models have introduced feedback loops. One of the most well-known activity stage models is the one by Booz, Allen & Hamilton (1982). This model distinguishes as subsequent activities:

- new product strategy development - an overall strategy is drawn up;
- exploration - a number of ideas is generated;
- screening - ideas are evaluated;
- business analysis - future sales and costs are estimated;
- development - prototypes are developed;
- testing - the prototypes are tested, and
- commercialisation - the product is brought on the market.

Decision stage models are an extension of the activity stage models, and explicitly include evaluation points assuming that the product development process can be broken down into different decisions. A well-known decision stage model is the one by Cooper (1983), see Table 2.1 (Biemans, 1989: 64-65; Frambach, 1993: 46-50). Each of the different phases is concluded by a 'go-no go' decision moment at which point it is determined whether or not to enter the next phase. The interesting aspect of Cooper's model is that it also makes an explicit distinction between technical or production activities and commercial or market activities.

Table 2.1: Cooper's decision-stage model

Based on: Cooper, 1983

stages development process	market activities	technical / production activities
1: Idea	..	..
2: Preliminary assessment	prel. market assessment	prel. technical assessment
3: Concept	concept identification and concept test market study	concept generation (technical)
4: Development	development of marketing plan	product development (engineering design and prototypes)
5: Testing	prototype test with customers	prototype testing in-house
6: Trial	finalisation of marketing plan test market	finalisation of design trial production
7: Launch	market launch	full production

All these three types of stage models (departmental, activity and decision stages) describe the process of product development as an orderly and logical sequence. Seeing product development as a not so rational and ordered process leads to viewing it as a system with inputs and outputs, the so-called *conversion process model* (Cooper, 1982). The definition of product development by De Graaf (1996), presented in section 2.1.3, is an example of a conversion process model. Finally, *response models* describe product development as a matter of responses, in the form of innovations, to stimuli or changes. These models mainly focus on the conception of new product ideas.

Since the focus of the current study is on the involvement of purchasing in product development, and especially on what this involvement consists of in terms of activities (see 1.2.1), it seems appropriate to choose either an activity stage or a decision stage model as the starting point for a more detailed consideration of the issues of managing product development projects. Conversion process and response models are too general to distinguish specific activities within the product development process, and departmental stage models usually do not even consider the purchasing department, let alone suppliers. Of the activity stage and decision stage models, the former provide us with the most continuous view of product development and are therefore chosen as a point of reference in this study.

2.2.2 Activity stages in the product development process

Wheelwright and Clark (1992: 6-8) describe a typical product development project as consisting of four phases: (1) Concept Development; (2) Product Planning; (3) Product/Process Engineering; and (4) Pilot Production / Ramp-up. In the first two phases, information about market opportunities, technological possibilities and production requirements are combined for decisions on product architecture, conceptual design, desired performance, target market and investments. The concept is sometimes tested through models, small-scale testing or discussions with lead customers. When the new product concept is approved, the project moves into *detailed engineering*, which entails the design and construction of prototypes and tools and equipment for commercial production. Only after the model delivers the desired performance, usually after a series of design changes, the product specifications are 'released' or 'signed off', which marks the end of the detailed engineering phase. During *pilot production*, volume production will be proven out in pre-series of the product, factory start-up takes place, and the new or modified production process is tested. All tooling and equipment should be in place now, and suppliers should be geared up and ready for volume production too. In the final phase, *Ramp-up*, processes have been refined and debugged, and volume is increased from relatively low levels to targeted commercial levels.

It is clear that this description is mainly oriented on the situation of large-scale assembly firms, but apart from the phase of pilot production / ramp-up, it fits with formal development project plans in most industries. Ramp-up is actually a term that is usually restricted to the automotive industry, and can be replaced with the more general 'Start-up'. Individual companies may use other definitions of the major project phases such as:

- Conceptual design, Technology demonstration, Feasibility demonstration, Process capability demonstration, Design review and Production readiness (Eastman Kodak, in: Gehani, 1992: 188);
- Product Definition, Contract Development, Development through manufacturing start-up, and Program wrap-up (Motorola, in: Wheelwright and Clark, 1992: 138-161); and
- Policy, Feasibility, Overall Design, Detail Design, Engineering-Integration-Testing / Market Preparation, and Production start-up / Market introduction (Philips Electronics, in: Halbmeyer and Botter, 1986)⁵.

⁵ Actually, Philips' so-called Systems Management tool of planning and managing product development projects is a decision stage model, and not an activity stage model, based on review sessions of so-called base-line documents.

Based on the description by Wheelwright and Clark, and the phases distinguished by Philips, we propose the following description of the major phases in a product development project:

1. Concept Development;
2. Basic Design;
3. Detail Engineering; and
4. Pilot Production / Start-up.

With regard to the activities in the different phases, we follow the description by Wheelwright and Clark (1992) as above. Identifying and distinguishing these *different* phases, however, does not mean that these are *separate* phases; they clearly are connected phases of one and the same process or project. During the last decade or so, practitioners and academics have become increasingly dissatisfied with the strict separation in activities (but often also in departments and people) between the different phases of a development project that had often occurred in practice. In other words, the product development phases were often treated as 'sequential'. The new approach has been to make these phases more overlapping, or 'concurrent', with mutual, more frequent, and earlier exchange of information between the (groups working on the) different phases (Simonse, 1998: 76-81).

2.2.3 Concurrent engineering

Concurrent engineering - sometimes referred to as simultaneous engineering, or parallel engineering - implies the simultaneous consideration of all product development activities, and especially the simultaneous design of the product and the respective manufacturing processes (Winner *et al.*, 1988). Simultaneous engineering is alternatively used to refer to the simultaneous consideration of all needs and wants resulting from the different phases in the product life cycle or the parallel development by different design disciplines (e.g. electronics, mechanics) (Erens and Van Stekelenborg, 1993: 38-39).

Concurrent engineering is the opposite of so-called sequential engineering, where in every next stage of the development process, each department will mainly consider its own interests. Simply stated: subsequent product concepts/designs 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". Gehani (1992) posits that the baton does *not* always steadily move forward. Tasks go back and forth between the different departments as designers, developers and marketers often reject each other's suggestions. This results in the product development process resembling an iterative 'Ping-Pong match' (Gehani, 1992: 190).

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" (Takeuchi and Nonaka, 1986: 137). By providing 'downstream' receivers in the organisation with incomplete yet early information, these are capable to prepare themselves "for a future pass from their upstream team-mates" (Gehani, 1992: 191). For example, marketers inform developers, engineers and manufacturers information about customers' needs even when these are not fully complete. Carrying out development activities in parallel, with each development phase partially overlapping with the next and the previous phase, contributes to decreasing development lead times, or time-to-market (Smith and Reinertsen, 1991). Woodruff (1990) estimates that the adoption of concurrent engineering leads to a 30 to 70 percent reduction of development time. In addition to reduced development time, concurrent engineering can also have positive effects on development and product costs, see Womack *et al.* (1990: 104-137) and Clark *et al.* (1987).

After this discussion of product development, the different project phases and the (managerial) activities taking place, it is clear that most of the models discussed here do not explicitly consider other actors than the firm actually carrying out the 'focal' development project. Although the theories on concurrent engineering have provided a fruitful basis for increased interest in the involvement of external suppliers since they are the ones that need to produce (parts of) the newly developed products, there is no specific attention for their involvement inherent to the concurrent engineering approach itself (see also De Graaf, 1996: 164). In other words, the picture that emerges is that product development is carried out by the manufacturer of the new product. Other actors seem only to be consulted; customers whether they want to buy the product and suppliers whether they can produce the product. This 'intra-organisational' view of product development is a limited one, and one that is certainly not productive in considering the role of purchasing and suppliers. Therefore, attention is now directed towards theories that propose a more 'inter-organisational' view of product development. These theories also deal with the more general processes underlying product development, and in that way may provide a better starting point for considering the key tasks in managing the involvement of external actors such as suppliers.

2.3 Product development through interaction

In the preceding section, it has become clear that the process of managing product development is primarily seen as a process of managing internal development activities. However, this view of product development as an intra-company phenomenon does not only apply to the issue of managing the development process; it has traditionally also applied to the more general process of generating product development. The development of new products and processes, even knowledge in general, has for a long time 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 (Håkansson (ed.), 1987: 3). In the 1970's, however, this simplistic view of product development gave way to more complex views. One of these views focuses on the different initiators or sources of product development.

2.3.1 Different sources of product development

Among the first to challenge this traditional view on product development was Von Hippel (1976; 1978; 1982):

"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: 3).

According to Von Hippel's findings, new products are not always developed by product manufacturers, but also by suppliers or users of the products. Von Hippel introduces the concept '*functional source of innovation*' to categorise firms in terms of the functional relationship through which they derive benefit from a new product. Users benefit from using the new product, and manufacturers benefit from producing the new product. Suppliers benefit from supplying components or materials necessary to build or to use an innovation. The functional source of innovation differs significantly between various (technological) categories of product developments and provides a possible explanation for this variance as well in terms of the distribution of the profits expected by potential innovators. In the context of the current study, it is important to note, however, that Von Hippel is concerned with a very specific role of suppliers in product development:

"Suppliers might develop an innovation that they did not expect to sell or use, if that innovation would result in a large increase in demand for something they did want to sell." (1988: 36).

The new products originating from suppliers thus regard complementary products or machines that use the supplier's products. For example, a supplier of metal caps develops or helps to develop a bottle-filling machine for a food producer. The goal is not to sell the machine, but to sell more caps, although the development is in the machine and not in the caps. This conception of the role of suppliers in product development is more limited than in this thesis. For example, we see the supplier of metal caps contributing to the development of a new product, with a new metal cap and glass bottle, at the food producer, through development work on the cap itself. In Von Hippel's terminology, the functional source of innovation in this case would not be a supplier, but a manufacturer - the manufacturer of the caps. In this study, we conceive a supplier developing its component in the context of a manufacturer's new final product also as supplier involvement - in the development process of the manufacturer.

Focusing on manufacturers and users, Von Hippel has 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 analyses needs, and 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: 40). The MAP and CAP concepts can be compared to technology-push and demand-pull effects respectively.

The relevance of the Customer Active Paradigm for industrial products is supported by a number of studies, such as the one by Utterback (1974), which concluded that three out of four successful 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 and customer orientation such as uniqueness of the product, benefits to the user, etc. (a.o. Biemans, 1989: 39-41; Halman, 1994: 9-13). However, the Customer Active Paradigm (CAP) has been criticised by some researchers for still being focused too much on an active role of the manufacturer (cf. Biemans, 1989: 97-100). Foxall and Tierny (1984: 13) argue that CAP refers to customer-initiated innovation, but that it ignores the possibility of customer-led entrepreneurship with regard to actually developing and producing the product. In general, there is a growing realisation that neither the MAP nor the (revised) CAP solely represent reality. Some authors have proposed a continuum of user/manufacture interactions in industrial new product development (Bergman and Johanson, 1978; Foxall and Johnston, 1987). Several models that combine both pull and push forces - 'interactive' models - have been introduced. One of the most prominent schools of thought in this area is formed by the so-called Network Approach.

2.3.2 Product development in the Network Approach

The network approach has its origins in empirical studies into relationships in industrial markets that challenged some of the assumptions of established industrial marketing theory and research. The group of founding researchers, the International Marketing and Purchasing (IMP) group, criticised among others (Håkansson (ed.), 1982: 1):

- the concentration of the industrial buyer behaviour literature on the analysis of a single discrete purchase,
- the common view that implies an atomistic structure in industrial markets, and
- the separation that has occurred in analysing the process of either industrial purchasing or marketing.

Instead, the IMP group emphasised aspects like:

- 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, and
- the stability of industrial market structures, where buyers or sellers know each other well and are aware of any developments in either the buying or selling market.

These empirically based observations have driven the IMP group to develop a conceptual framework to analyse these phenomena⁶. This development has taken place in two main steps. The first step was the formulation of a dyadic relationship model - the so-called *interaction model*. In this model, a relationship between two business actors is seen as the result of an interaction process 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 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 Henders, 1992: 24).

One of the key contributions of the network approach to studying industrial firms is that it places the firm and its behaviour in a context or environment that is 'individualised'; it does not describe the environment as an anonymous set of factors but rather in terms of individual counterparts and relations between them, which captures the opportunities and especially the limits for the firm's actions more realistically. The network model is voluntaristic rather than deterministic; firms can choose how to act, but the possibilities are determined by the often long-lasting relations they have with customers, suppliers, competitors, producers of complementary goods, customers of the customers, etc. On the other hand, these relations also form the basis and means for change - such as product development.

What makes this approach a *network* approach, is the proposition that relationships are not just an affair between two firms or actors, but that they are also affected by (and affect) the interests of several other actors (Håkansson, 1994: 256; Anderson *et al.*, 1994). For example, the relation between supplier A and manufacturer B may be affected by the relation between B and its (final) customer C. When C, as the only one of B's customers, demands a special component to be used in his product and this component is best produced by A, the continuation of the relation between A and B is to a certain extent dependent on the B-C relation, and vice versa. Similarly, when B wants to develop a new version of its product for C to retain this customer, this may involve (and be dependent on successful) collaboration with A. Conversely, when the relation A-B is negatively affected by ongoing quality or logistical problems, the B-C relation may suffer from that. These 'connections' between different firms and between their different relations are the central aspect of the network 'model'⁷.

⁶ Key publications and useful overviews include: Håkansson (*ed.*), 1982; Ford (*ed.*), 1990; Axelsson and Easton (*eds.*), 1992; Håkansson and Snehota (*eds.*), 1995; Ford (*ed.*), 1996.

⁷ The network approach is presented here as if it were a monolithic, homogeneous group with 'a' specific model. This is true as far as the basic elements are concerned, as discussed here. If the network approach were to be analysed further, important differences between the various researchers would be found.

The network model

The model's basic concepts are *actors*, *activities* and *resources*. They are connected to each other in the overall structure of networks. Actors are firms or organisations that 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.

The key element in the network model are the *relationships* between actors (Håkansson and Snehota (eds.), 1995: Ch 2). Relationships are said to consist of three elements; *actor bonds*, *activity links* and *resource ties*. Actor bonds indicate to what extent and in what areas actors are oriented towards each other, and/or have mutual interests. Bonds are created by means of, for instance, ownership connections, or extensive social contacts. Hammarkvist *et al.* (1982) distinguishes five categories of bonds: technological, time, knowledge, social, and economical/juridical bonds. Activity links refer to the connections between 'transfer' and/or 'transformation' activities in activity cycles. Transformation activities are controlled by one actor, and change resources in some way (e.g. raw material into a finished product). Transfer activities transfer direct control over a resource from one actor to another (e.g. sale, license). Examples of activity links are a production activity relying on the purchase of a special input, or the sales processes of two complementary goods (e.g. printers and toners).

Ties between resources occur when actors make adaptations in the resources they control, in order to achieve a better 'fit' with the resources of other actors they have relationships with. Examples of resource ties are one firm using the by-product of a raw material used by another firm, or a supplier having employees in its R&D department dedicated to a single customer⁸. These resource ties are quite important, because of the 'heterogeneity' of resources. Resources are heterogeneous, meaning that their value varies depending on which other resources they are combined with. The use and value of resources is also dependent on the activities they are utilised in, and on the functions they have in the network.

Axelsson and Håkansson (1979: 7-11) distinguish five resource areas; raw material, manpower, financial, technological and marketing resources. In other words: inputs, labour, capital, technological knowledge and skills, and output-related knowledge and skills. Relations with other firms can also be conceived of as resources, as they can enable a firm to undertake certain actions. For instance, the relation with a local supplier may be instrumental for a manufacturer in setting up a market presence in a foreign country by means of the effects this relation has on the manufacturer in terms of image and reputation.

Product development in the network approach

In the view of the network approach, product development processes take place in the form of interaction between different actors. Product development relies on three main processes that occur through this interaction: *knowledge development*, *resource mobilisation*, and *resource co-ordination* (Håkansson (ed.), 1987: 3). Knowledge development, and consequently product development, is promoted by bringing together different knowledge 'bodies', creating two effects. One effect is due to the fact that new knowledge often emerges at the interface of new knowledge areas or perspectives. 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*.

⁸ The concept of resource ties bears some relation with Williamson's notion of asset specificity (1985).

The other effect is related to the fact that new products are often using several technologies. By bringing together competencies in several areas, exchange situations can produce certain *multi-competence* effects. Knowledge development thus relies on the combination of resources in the form of technological knowledge and skills.

For creating product development, resources need not only to be combined, they also need to be mobilised and co-ordinated. 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 product development process therefore involves adaptations, learning and acceptance. These processes require, and to some extent consume, resources like capital, labour (time) and input materials. These resources have to be *mobilised*: their availability and possible consumption for the development process has to be arranged / motivated/ negotiated for. This mobilisation effort is not directly targeted at the resources themselves, but rather at the firm(s) controlling the respective resources.

Combination and mobilisation, however, is still not sufficient. Development resources also need to be *co-ordinated*. The resources that different actors bring to the table have to be geared to each other: if one firm does have the labour resources necessary to undertake a specific development effort, but the firm demanding that development does not have the capital to finance it, the development effort is unlikely to proceed and succeed. A similar lack of co-ordination exists when the collaboration partners do not have the necessary complementary technological skills and knowledge to resolve problems in the design or production of the new product.

Obviously, knowledge development, resource mobilisation and resource co-ordination are processes that can hardly be performed by a single actor but primarily require interaction between the different actors that control the different resources. Product development, therefore, should not be seen as the product of a single actor but as the result of interaction between two or more actors. Consequently, in the network perspective, product development is nearly synonymous with technological collaboration.

The network approach emphasises the critical role of resources within product development. Resources, however, are a key concept not only within the Network Approach, but also in other theories on interorganisational relations. Van der Zaal (1997) distinguishes two main schools of research regarding the role of resources in inter-organisational relationships. In the so-called 'resource dependency' view of the firm (Pfeffer and Salancik, 1978) the acquisition, management and control of resources is perceived as the central element in the capability of organisations to survive. This school of thought is strongly oriented on analysing the dependency of an organisation on its environment, and the nature of the resources is mainly taken as given. In the 'resource based' view of the firm, however, the nature of these resources and their creation is the central element. Additionally, in the 'resource based' view, the relevant resources are located within the organisation, while in the 'resource dependency' view, these are located outside the direct boundaries of the organisation. The 'resource based' view (f.e. Wernerfelt, 1984) is closely related to the theories on 'core competencies' (Prahalad and Hamel, 1990) (Van der Zaal, 1997: 100-107).

In this perspective of different 'resource-approaches', the network approach and its conception of resources, in our view, keeps the middle between the two other approaches by focusing on the combination and interaction of external and internal resources. Exactly because of this focus, the network approach is a useful theoretical starting point for analysing the key processes in managing the involvement of external suppliers in product development at the manufacturer, and the role and activities of purchasing related to those processes.

Previous, related research at the Faculty of Technology Management at Eindhoven University of Technology, has also adopted the network approach as a theoretical model. In his study of the role of potential users and third parties in the development of innovations in the medical equipment industry, Biemans (1989: 116) argues that the most compelling reason for studying innovations from a network perspective is that it matches reality: manufacturers are increasingly developing innovations through co-operation with other organisations. In a more recent study of innovation processes in industrial networks, Oerlemans (1996: 103) concludes, on the basis of a critical review of conventional micro-economic theory of the firm, that the network approach is one of the few models that allows for the *possibility* that (long-term) relationships between economic actors are economically valuable and productive. This possibility is one of the underlying premises of this study, as is discussed in Chapter 3. In addition to that, the network approach, according to Oerlemans (1996), has explicitly been developed and used for analysing technological innovation, and has also been empirically tested.

2.4 Summary and conclusions

This chapter started by identifying 'product development' as the term that best reflects both the process of developing a new or improved product and the product as the result of that process itself. This dual meaning is required since purchasing involvement may focus both on the new product itself and the process leading to it. A further analysis of product development and the managerial activities taking place has been undertaken in order to identify the points where suppliers and purchasing can provide added value. Reviewing different kinds of descriptions of product development projects, a choice has been made to use a detailed description in terms of activity stages, being: Concept Development - Basic Design - Detail Engineering - Pilot Production/Start-up.

However, the discussion of product development project phases and the (managerial) activities taking place has revealed that most of the models do not consider to any great extent firms other than the one actually carrying out the 'focal' development project. The project models do indicate which development activities take place, and in what (general, more or less overlapping) sequence and hence provide a useful reference point for *locating* the activities that suppliers and purchasing are involved in. The models do not determine *which* activities these are, and what the reasons or arguments for supplier and purchasing involvement are.

Therefore, attention has been directed to theories that adopt an inter-organisational view of product development and are more focused on the underlying processes that generate product development. Of these theories, the Network Approach has been discussed as the approach that clearly points out some of these general processes: knowledge development, resource mobilisation and resource co-ordination. These three general processes generating product development provide a good starting point for considering the key processes underlying purchasing involvement in product development. Before dealing with purchasing involvement, however, the following chapter first considers the involvement of *suppliers* in product development. Supplier involvement is usually seen as the cornerstone of any involvement of the purchasing function in product development.

Chapter 3

Supplier Involvement in Product Development

In the previous chapter, product development has been introduced in terms of the managerial issues involved and its underlying processes. This second chapter of the Analysis part of the thesis deals with the involvement of *suppliers* in product development. Managing supplier involvement is usually seen as the 'raison d'être', the cornerstone, of purchasing involvement in product development. Therefore, supplier involvement provides a natural starting point for investigating the role and substance of purchasing involvement in product development. The introductory section discusses available research regarding aspects such as the extent, frequency and characteristics of technological collaboration with suppliers in general. This includes new data on the level and character of technological collaboration in some 500 Scandinavian supplier relationships. Section 3.2 deals with different forms and time-frames of technological collaboration with suppliers in order to place supplier involvement in product development in a broader perspective. The third section discusses the motives for supplier involvement in product development, and section 3.4 takes a closer look at supplier involvement in product development in terms of two key dimensions: the degree and the moment of involvement. Section 3.5 deals with the risks and problems or disadvantages of supplier involvement, among others by reviewing prior studies on the actual results of supplier involvement. Section 3.6 discusses the role of contracts in dealing with some of the risks regarding supplier involvement in product development. The chapter draws to an end with a summary and conclusion in section 3.7.

3.1 Technological collaboration with suppliers

During the last decade, there has been an increasing interest in the development of co-operative supplier relationships (Carlisle and Parker, 1989; Womack *et al.*, 1990: 138-168; Helper, 1991; Hines, 1994; Van Weele, 1995; Lewis, 1996). The collaboration can be targeted towards different strategic or more operational areas; for example, improvement of logistical procedures through earlier and more efficient exchange of information, reduction and simplification of administrative and financial issues, and co-ordinating and harmonising quality inspections and control systems (Ellram, 1991). This development of closer relationships is often accompanied by a reduction of the firm's total number of suppliers (Morgan, 1987; Burt, 1989). This occurs because of two reasons. First, reducing the supplier base is associated with increased dependency of the manufacturer on the remaining ones. In order to prevent this dependency from turning into risk, the manufacturer needs to get 'closer' to the remaining suppliers. Secondly, collaboration takes time and effort, which are scarce resources. Therefore, the total number of collaborative ventures has to be limited and hence the number of suppliers is reduced.

One of the most common and important reasons for firms to develop closer relationships with suppliers is to better benefit from their technical knowledge (Burt and Soukup, 1985; Håkansson and Eriksson, 1993; Lamming, 1993). This points to the underlying assumption that technological collaboration with suppliers is promoted by long-term relationships, as opposed to market-based transactions with changing suppliers. The reasons that are put forward for long-term relationships benefiting technological collaboration are that they, simply stated, reduce the efforts and increase the returns of the collaboration.

Analysis

Long-term relationships facilitate information exchange, communication and understanding through shared experiences, and in that way reduce the costs and efforts involved in collaborating. Relationships also decrease the uncertainty regarding the returns on investments in the collaboration, among other because counterparts will choose 'voice' rather than 'exit' as a response to problems or failures (Hirschman, 1970).

Instead of looking at the influence of long-term relationships on the extent and success of technological collaboration, one can also investigate the character of the relationships in which collaboration does take place. Within the network approach of studying industrial markets (section 2.3.2), considerable research has been done on the nature of interorganisational technological co-operation. In a cross-sectional study of roughly 120 small and medium sized Swedish manufacturing companies, Håkansson (1989) found that technological co-operation with suppliers is widespread, with around 75 % of the investigated companies having important co-operation relationships with suppliers. More than half of the companies have development relationships with at least three suppliers. These collaborative relations are characterised by, among others: a long duration; little formal aspects (i.e. few contracts); a close connection between business volume and the propensity for collaboration; and, finally, not only co-operation and friendliness, but also conflicting interests and tensions (Håkansson, 1989: 75-82, 108-119; Håkansson and Eriksson, 1993: 12-15).

A survey of 689 industrial firms in the province of Noord-Brabant (Netherlands) regarding the importance of their external relations for innovation is reported by Oerlemans (1996). The survey has found that for 46 % of these firms, the external relation with the most important impact on the innovation process concerns a *supplier* (for 49 %, it concerns a customer). In line with the findings by Håkansson, these relationships are characterised by (Oerlemans, 1996: 352-354, 454):

- a long duration
 - nearly 60 % of these innovation-relationships with suppliers have existed for at least 5 years;
- little formal aspects
 - more than 40 % of the relationships involve no contracts whatsoever, and only 17 % involves long-term contracts;
- considerable economic importance
 - nearly 20 % of the firms buy 40 % or more of its total purchasing volume from this individual supplier.

The research also demonstrates that there is a positive correlation between the duration of the relationships with suppliers and the degree to which knowledge is being transferred in the relation, although the strength of this correlation is dependent on industry and innovation-process characteristics of the manufacturer (Oerlemans, 1996: 358).

It may be interesting to complement these findings with some original data on supplier relationships of industrial manufacturing firms in Norway and Sweden, which will be referred to as the 'Scandinavian database'.

3.1.1 The Scandinavian database

Part of the empirical studies underlying this study (i.e. the case studies in Chapter 5) have been carried out in association with a database project carried out by a number of Scandinavian researchers from the IMP Group (see section 2.3.2). This project was designed to collect information on customer and supplier relations of industrial firms across different sectors¹. This information regards business volumes, production and delivery processes, communication patterns etcetera. The objective was to collect basic data for a large number of business-to-business relationships which could be used for quantitative analyses, still allowing the different researchers (such as the author) to pursue their own more specific research interests. About 100 companies have been interviewed about five of their most important supplier relationships (usually in terms of volume), and a number of questions pertain to technological collaboration.

We focus on three aspects of collaborative technological development within these supplier relations :

- the extent or intensity of the collaboration, as reflected in (1) the area of collaboration (product, process, both), (2) the number of projects going on, and (3) the labour invested;
- the balance in the collaboration between the supplier and the manufacturer, as reflected in (1) the party determining the specifications, (2) the initiator of the collaboration and (3) the most active party in the collaboration; and
- the formalisation of the collaboration, as reflected in (1) the existence and form of contracts and (2) the existence of cost-sharing arrangements.

The database provides us with the opportunity to investigate to what extent these three aspects of technological collaboration are influenced by four basic relationship characteristics:

- the age of the relationship;
- the kind of product being exchanged;
- the importance of the supplier to the customer regarding that specific product; and
- the importance of the customer to the supplier regarding that specific product.

For each of these four characteristics, several groups are distinguished which then are compared with regard to their scores on the aspects of extent, balance and formalisation of the collaboration. No firm conclusions can be drawn about possible causal relationships. For example, the fact that a supplier is a single source for a specific product may increase the possibilities for (and likelihood of) technological collaboration with the customer, but technological collaboration may also lead to such a single source position in the end, for example because the manufacturer adapts his final product to the supplier's component. The analysis thus only reveals whether certain aspects of technological collaboration are associated with basic relationship characteristics. The discussion subsequently considers the role of relationship age, type of product, supplier and customer position. Detailed figures are available in Appendix B.

¹ In the period 1994-1997, face-to-face interviews were carried out usually with general, purchasing and marketing managers lasting several hours. It was a joint project by researchers from Chalmers University in Göteborg, Norwegian University of Science and Technology in Trondheim, and Uppsala University. The complete interview guide is listed in Appendix A.

Age

In the sample, the influence of age on the *intensity* of collaboration is not as evident as is usually suggested. Only for relationships younger than 3 years there is a clearly a large group with no technological collaboration at all, while relations older than 50 years show really more frequent collaboration. For the relations from 3 to 50 years there are no clear differences. In older relationships, however, the collaboration is more continuous, be it still mainly with a limited intensity (see Figure 3.1).

Regarding the *balance* in the collaboration, the only clear tendency seems to be that for older relations both parties are equally active as compared with younger relations where the manufacturer is usually the most active (see Figure 3.2). This is not evidently correlated with the degree in which specifications are jointly determined. Considering the *formalisation* of the collaboration, age plays a somewhat clearer role: the older the relationship the less contracts and cost-sharing arrangements. Summarising, technological collaboration between manufacturers and suppliers becomes less formalised, more balanced and more continuous, but not more intensive as the relationship are older.

Product

Focusing on the *intensity* of collaboration with different groups of suppliers in terms of the product involved, suppliers of assemblies and finished goods (e.g. for re-sale) are relatively often involved in product development collaboration (see Figure 3.3). In the case of assemblies this is not surprising, as they usually form an important part of the final product in terms of functionality and costs (see section 3.4). Suppliers of raw materials and semi-manufactures are relatively seldom involved in technological collaboration. This contrasts with prior findings that suppliers of raw or processed materials are most often chosen as collaboration partners (Håkansson *ed.*, 1982 and 1989; Turnbull and Valla, 1985). On the other aspects of intensity, there are no clear relations with the type of product involved.

The difference between these and earlier findings regarding the relation between the type of product and the intensity or rather *occurrence* of collaboration may be due to a different sample of manufacturers. Following the taxonomy of Pavitt (1984), Oerlemans (1996: 351, 454) has found that the type of supplier the manufacturer is most likely to co-operate with depends on the type of sector. For example, suppliers of equipment are the most important collaboration partners especially for manufacturing firms in industries that focus on process-innovations such as the textile and clothing industries and the food sector. The Scandinavian database and the sample of Håkansson may include different (distributions of) manufacturers in terms of industry sector. However, the difference between our findings and those of Håkansson seem to be largely explained by methodological aspects. Håkansson looks at a sample of identified supplier *collaborations*, while we analyse *all* supplier *relations* for a specific type of product. The former sample may be influenced by the fact that there are more relations with a specific type of supplier to start with. Such types of suppliers are then 'over-represented' in the group of collaborations².

Regarding the *balance* in the collaboration, the specifications for equipment and services are most frequently jointly determined and, surprisingly, rather infrequently so for assemblies where the supplier seems to have a more dominant role. For all types of products, the manufacturer is most often the initiator of the collaboration. It is also the most active party during the collaboration relatively often in the case of raw materials, components and assemblies (see Figure 3.4). Finally, looking at contracts and cost-sharing arrangements, relations with suppliers of semi-manufactures, equipment and services are the least *formalised*.

² In fact, Oerlemans' findings may also be biased in a similar way.

Fig. 3.1: Intensity; number of current joint projects as a function of relationship age (percentage of all cases)

Fig. 3.2: Balance; most active party as a function of relationship age (percentage of all cases)

Fig. 3.3: Intensity; form of collaboration as a function of type of product (percentage of all cases)

Supplier position

The position of the supplier in the manufacturer's supplier base for the product involved has a strong correlation with the *intensity* of the collaboration³. When the supplier is a single source, collaboration does not only take place most frequently (especially in product development), but it is also more continuous and time-intensive, at least for the manufacturer (see Figure 3.5). The relation between *balance* and supplier position is ambiguous. Single source suppliers seem to be neither the most active party during nor the initiator at the beginning of a collaboration. 'Dominating' suppliers seem to fulfil this role more frequently. This could be explained by arguing that single source situations are often consciously created by manufacturers seeking to reduce supplier base complexity, but in which they still want to maintain the initiative. Dominating supplier positions may be more often the result of actions by the supplier itself, which is then reflected in its more active role. There is no clear correlation between the supplier's position and the *formalisation* of the relation.

Customer position

The position of the customer (manufacturer) in the supplier's customer base for the product involved is clearly connected with the *intensity* of the collaboration. The more important the customer, the more frequent the collaboration. However, collaboration with 'dominant among few' customers is more intensive than with single customers (see Figure 3.6). This may be explained by the possibility that single customer situations relatively often include (result from) customised parts but which do not demand intensive technological collaboration. Regarding *balance*, there are no clear relations between the position of the customer and its role in the collaboration being more or less active. Concerning *formalisation*, development contracts occur most frequently for dominating customer positions, while cost sharing takes place the most for single customer relations. This may be due to the absence of a strong need for development contracts when there is only one customer (e.g. smaller risk of information leakage) or when there are many customers (the collaboration is not so intensive or sensitive), while in the case of a dominating position, the manufacturer stands the risk of losing more. Cost sharing arrangements can be considered to be the most appropriate in the case of single customer positions as the supplier has less opportunities there to recuperate his costs through sales to third parties.

Summarising, we can draw the following conclusions for this sample of supplier relationships:

- collaboration occurs most often with assembly or finished good suppliers, and with single sources;
- the intensity of technological collaboration is the highest for supplier relations that involve single source suppliers, or 'dominant among few' customers;
- the collaboration is the most continuous for longer existing relationships;
- the collaboration is the most balanced for longer existing relationships;
- the collaboration is the least formalised for longer existing relationships, relations that concern semi-manufactures, equipment or services, or involve 'minor positions' of either the supplier or the customer.

³ Both supplier and customer position reflect their relative importance to the counterpart regarding the supply respectively the demand for the specific product concerned. The respondent could choose from a limited number of alternatives, as indicated in figures 3.5 and 3.6. When possible, these qualifications were corroborated with quantitative data.

Fig. 3.4: Balance; most active party as a function of type of product
(percentage of all cases)

Fig. 3.5: Intensity; form of technical collaboration as a function of supplier position
(percentage of all cases)

Fig. 3.6: Intensity; number of current joint projects as a function of customer position
(percentage of all cases)

These findings contrast with earlier research by Håkansson (1989: 81) concerning the kind of products that are most often selected for supplier collaboration, and the influence of relationship age on collaboration intensity. The results (roughly) confirm Håkansson's findings on the influence of business volume (in terms of the relative importance of the supplier and the customer to the other) on collaboration intensity.

Overall, the new data and prior research discussed here give further arguments to assume that technological collaboration is indeed promoted by or at least associated with fewer supplier relations that last longer.

Technological collaboration, however, encompasses a whole variety of activities, besides the involvement of suppliers in product development that we focus on: joint basic research, joint process improvement, etc. Analogous to the discussion in Chapter 2 on technological development, innovation and product development, it is appropriate to briefly review the different forms of technological collaboration in order to indicate what distinguishes product development collaboration from other forms of technological collaboration. This also serves to place supplier involvement in product development in a broader context.

3.2 Forms of technological collaboration

One common way of distinguishing different forms of technological collaboration is by looking at the phase of the research and development process the collaboration is focusing on, such as: joint fundamental research, joint applied research or joint product development and design. An example of such a distinction is found in Laage-Hellman (1996: 29-33), where three basic forms of technological collaboration with suppliers are discussed: (1) pure technology transfer; (2) development-related technology transfer; and (3) joint development. This distinction (see Figure 3.7) builds on a conceptualisation of the research and development process into three building blocks: Development (D), Technology (T), and Product (P). Technology, in other words, embodies the 'reservoir of knowledge' that results from research and development activities, which is then applied to a new product.

Pure technology transfer (A) entails transferring and applying technological knowledge that is not being developed or 'processed' any further. The firms do not start-up joint development activities, and do not exchange products. A typical example is traditional licensing. This form of collaboration is not specific for supplier-manufacturer relations; licenses, for example, are often given to firms that serve the same markets or even to direct competitors.

Figure 3.7: Modes of technological manufacturer-supplier collaboration

Based on: Laage-Hellman, 1996.

Development-related technology transfer (B) is concerned with the creation of new technologies, as in the case of R&D co-operation. In some cases, the transferred technology is adapted or further developed by the receiving firm before putting it into use if the new technology has to be integrated with internal technologies (B1). For example, a research institute may develop knowledge regarding the application of specific metal alloys, knowledge which a truck manufacturer then uses in designing a new engine block made of those alloys. In other cases, the development-related technology transfer is combined with product transfer (B2). This is the case when a manufacturer purchases a component from a supplier that is also (partly) responsible for the design of the component. In order to enable the supplier to carry out this design work so that it meets the specifications, the manufacturer may need to transfer some knowledge about interfaces, user-conditions and the like. Finally, joint development (C) means that both parties actually bring together their R&D resources (or divide the work-load) and together develop a new product or technology. The supplier and manufacturer are developing a new product (application) together, which is intended for use by the manufacturer. The supplier acquires sales potential and knowledge, which can (depending on the specific arrangements) be used in serving other customers.

In the current study, we have already indicated to focus on supplier involvement in product development. This means: supplier-manufacturer collaboration that involves a product to be produced by the supplier and delivered to the manufacturer, and which is at least partly developed by the supplier. In the terminology of Laage-Hellman (1996), we focus on collaborations that involve development/product-related technology transfer (B2) or joint development (C)⁴.

However, the various forms of technological collaboration differ not only in the kind of activities taking place but also regarding the time-frame of the co-operation. Different forms of collaboration could be placed along a continuum with long-term, continuous co-operation at the one extreme and short-term, focused co-operation at the other. Short-term co-operation is usually limited to the development of a specific component, often within the frame of a larger development project concerning the end-product. Long-term collaboration usually focuses on basic research regarding more 'profound' technological problems, and may result in different technological options to be pursued later on. In the industry for glass packaging, for example, manufacturers of glass bottles often co-operate with food-producers in developing a new specific packaging solution (short-term collaboration), while they have an ongoing co-operation with the suppliers of glass-producing equipment regarding new raw material mixtures or new mould-technology. Long vs. short-term collaboration forms are often governed by different contractual arrangements (Håkansson, 1989: 115). Box 3.1 illustrates these differences using the example of Swedish producer of trucks and buses Scania (one of the case-companies in Chapter 5).

Scania distinguishes between two forms of technological co-operation with suppliers. One form regards basic technological research projects, which typically last 3-4 years. For these projects, Scania uses development contracts, and suppliers are financially compensated. These kind of long-term projects involve mainly suppliers of components that are critical to the performance of the truck, for example injection systems. Topics that are covered by this sort of projects are new materials, durability, etc. The other form regards co-operation within large projects for the development of new trucks. The co-operation is very much focused on developing or adapting a specific component for use in the new model, and is limited to the period it takes to develop the new model (which may, however, last for several years). It usually takes place with single source suppliers, as involving more suppliers would require too much resources. There are no contracts for this development co-operation: the supplier usually gets a position as single source for an initial period.

Box 3.1: Long-term vs. short-term collaboration at Scania

Source: own interviews

The current study focuses on supplier involvement in product development and hence, the focus is primarily on short term collaboration as opposed to long-term collaboration, which is more oriented towards research activities. However, as long-term collaboration activities often co-exist with short-term collaboration within the same supplier-manufacturer relationship, they cannot be ignored completely.

⁴ A closer comparison between joint development and technology transfer reveals that joint development, per definition, leads to a product, component or material that is new both to the supplier and the manufacturer. In the case of technology transfer, the supplier may only have to adapt an existing product to the specific demands of the manufacturer. In other words, to the supplier, joint development means product innovation (and also to the manufacturer), while technology transfer means product adaptation. For the manufacturer, technology transfer may entail a new product but not necessarily so.

3.3 Objectives of supplier involvement in product development

In section 2.3, it has been argued that the key processes underlying technological collaboration with any external actor are the combination, mobilisation and co-ordination of resources. These processes could thus also be seen as the objectives that should be achieved during the collaboration. However, the objectives of resource combination, mobilisation and co-ordination are no goals in themselves: they are a means to an end. The ultimate objectives for firms to involve suppliers in product development can be found in areas that are close to creating or sustaining competitive advantages. Literature provides us with different objectives, see Table 3.1.

Table 3.1: Objectives of supplier involvement

Authors	Objectives mentioned
Clark (1989: 1260)	lead time reduction development man-hours reduction more unique parts, better product performance
Birou and Fawcett (1993: 5)	better resource utilisation development and sharing of technological expertise network effectiveness
Mendez and Pearson (1994: 7)	efficient manufacturability minimisation design-to-market cycle time
Bonaccorsi and Lipparini (1994: 136)	reduction development costs higher product quality with fewer defects reduced time to market supplier-originated innovations
Zirger and Hartley (1996: 145-146)	time savings reduction part production problems easier communication early problem identification
Dobler and Burt (1996: 150,158)	reduction of start-up problems prevention of costly delays reduction of material costs improvement of product quality
Ragatz et al. (1997: 191)	reduction concept-to-customer cycle time reduction of costs reduction of quality problems improve overall design effort
Hartley et al. (1997: 69-70)	reduction development costs improvement of the buyer-supplier relationship long-term mutual benefits
Bonaccorsi (1997: 3-4)	incremental product innovation radical product innovation reduction in development time access to new technological knowledge

What becomes clear from this overview, is that we can make a general distinction between long-term and short-term objectives. Long-term objectives include aspects like getting access to new knowledge and improvement of the supplier relationship. Short-term objectives are related to the specific development project the supplier is involved in. Of these short-term objectives, reducing development time, reducing development and product costs, and improving product quality, are quoted most often.

It is important to observe that most of the literature in Table 3.1 has focused on the short-term objectives. Despite the fact that this chapter primarily deals with supplier involvement in product development projects, i.e. not with long-term (basic) technological collaboration, we argue that the objectives and benefits of this involvement are and should not be limited to the context of the development project itself. Note that the focus on improving the efficiency of development projects through managing supplier involvement has been indicated as a too limited view of the role of purchasing in product development (section 1.1.2). It is necessary to consider the long-term objectives of supplier involvement as well because these have ramifications for the process of managing supplier involvement, and thus also for purchasing involvement in product development.

Each of the four short-term objectives - reducing development time, development costs and product costs, and improving product quality - are now subsequently investigated. Finally, the long-term objectives are analysed.

3.3.1 Reducing development time

Supplier involvement is often referred to as one of the instruments to shorten development time, or 'time-to-market'. Introducing a new product earlier than competitors can give 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 market share (Woodruff, 1990). Data from the PIMS (Profit Impact of Market Strategy) project indicates that pioneers obtain market shares of around 30 %, well above those of followers and late entrants (Robinson and Fornell, 1985; Robinson, 1988). Studies found that in the market for electronic products, half a year delay in product introduction leads to reduction of profits by one-third (Fortune, 1989; Gupta and Wilemon, 1990). The importance of time-to-market is enhanced by shortening product life cycles. As products last shorter in the market place, being late with product introduction carries a higher penalty.

There can be, however, also disadvantages in being the first to introduce a new product. The first innovator often incurs considerable expenses in 'creating and educating' the market. Moreover, the desire to be the first to introduce a new product should not weigh more heavily than the development process itself. Overhasty introductions of products that have not been fully thought through and tested can lead to failures, with potentially disastrous effects for the company. House and Price (1991) present a possible method for dealing with such trade-offs.

While concurrent engineering (see section 2.2.3) is primarily meant as an instrument to let internal functions and departments co-operate earlier and more efficient primarily by using cross-functional development teams, it ideally also involves suppliers (O'Neal, 1993: 5; Simonse, 1998: 96). In a series of case studies on the implementation of concurrent engineering approaches, De Graaf (1996: Ch 7) found that after the internal implementation of concurrent engineering, further reductions in development time were dependent on external suppliers: they had now come to lie on the 'critical path'.

There are different ways in which suppliers can contribute to reduce development time. In the first place, almost trivially, suppliers can provide *extra* development potential that makes it possible to employ more (human resources) at any specific point in time. The manufacturer may not be able or may not want to involve more engineers internally, for example because potential participants are tied up in other projects or all of them are already in the current project.

Other things equal, the extra amount of external resources obviously decreases the period under which internal resources need to be employed and reduces potential bottle-necks (King and Penlesky, 1992). In the second place, suppliers can provide *more specialised* development potential, which makes their development activities usually more efficient. Clark (1989: 1249-1250) notes that

"... simply 'farming out' work will not reduce lead time unless the parts are on the critical path, and unless suppliers bring *additional capability* to the project." (emphasis added).

Suppliers like Valeo and Bosch (see section 5.3) have groups of engineers working full-time with respectively oil coolers and injection systems, who are constantly developing new designs and applications for different customers. Although truck manufacturers like Scania and DAF Trucks have engineers working in related areas, the engineers of the suppliers can specialise more in the different aspects of their products because they are with a larger group ('critical mass'). Additionally, they benefit from being exposed to different kinds of customers and thus different kinds of solutions and applications. This experience and specialisation makes that they can identify potential problems more easily, and more quickly pick or develop the appropriate solution. Therefore, involving suppliers in the development of parts in which they are specialised leads to quicker development than when the manufacturer would carry out the development.

In the third place, suppliers can provide information that can be used to *prevent or at least reduce design changes*. Changing the specifications of a product design can not only increase development costs but also lead to delays because of the need for rework. Especially when the change is being carried out in the later phases of a development project (f.e. in Pilot Production, see section 2.2), the effects on costs and time-to-market can be very high as many other specifications have already been set and perhaps even translated into production settings. The earlier a change is carried through, the less the negative impact on the costs and time schedule of the project. The relation between elapsed time in a development project and the room for changes in specifications and thus for purchasing actions is shown in Figure 3.8.

Figure 3.8: Room for achieving cost reductions through product design

Based on: Van Weele, 1994: 146.

The early involvement of a supplier in developing the specifications of the product it is going to produce provides the supplier with the opportunity to voice its opinion regarding the design of the product. It creates time and room to suggest alternative specifications, especially concerning the makeability of the product. The early exchange of this information reduces the need for design changes by setting specifications 'first-time right', or results in design changes earlier on in the project, which is also positive in reducing development time (Simonse, 1998: 80; Sie, 1996: 24-25). The changes involved regard in the first place the supplier's specific product, but in addition also components that have interfaces with that product or are otherwise dependent on its specifications.

Summarising, supplier involvement should lead to reduced development time through the deployment of extra resources, which are also specialised and therefore more efficient, and through the additional information that decreases design changes or at least limits their delaying effects.

3.3.2 Reducing development costs

The arguments why supplier involvement leads to reduced development costs are rather similar to those regarding development time. In the first place, by co-operating with suppliers in product development, manufacturers shift some of their development costs to suppliers⁵. This aspect of sharing costs is supposedly becoming more important, as total development costs for new products are said to rise⁶. Examples of such cost-sharing product development ventures between suppliers and manufacturers can be found in the computer industry where hardware and software producers are increasingly working together on new generation software and operating systems, and in the aircraft industry where, for example, Airbus is looking for development partners to share the costs of its new super-plane, the A3XX.

In the second place, the involvement of suppliers leads to lower development costs because of the suppliers' specialisation that results in economies of scale and scope regarding development work. Development costs are thus not only shifted from the manufacturer to the supplier, but at the same time decreased. In the third place, the less and/or earlier engineering changes that result from timely supplier involvement also contribute to lower development costs.

3.3.3 Reducing product costs

In addition to development cost reductions, supplier involvement can also lead to lower costs of the final product. Although the costs of designing and developing a product represent just a minor part of the total costs of a product, the choices and decisions that are made during the development process determine a major part of total product costs. Some studies even indicate that design and development fixes 80 % of total product costs (Whitney, 1988). In other words; after a product has been developed, only 20 % of its total costs can be influenced through improvements in production efficiency, wage reductions, etcetera⁷. This observation highlights the importance of having all knowledge and information relevant to the design of a product available as early as possible.

⁵ The supplier, however, may try to compensate for its increased development costs by expensing these in the piece price of the product: in that way, the manufacturer ends up paying the development costs all the same, be it in a different way.

⁶ While this might be true in absolute figures, it is not entirely clear whether in general, development costs for a product in relation to the company's sales of that product have increased as well.

⁷ This holds especially for mass-production items, and less for small-series and unit-production.

The knowledge and information that suppliers may contribute in a development project with the purpose of reducing product costs, takes different forms. In the simplest form, it involves suggestions regarding the makeability of the product involved. Since the supplier is usually going to produce the product (or at least part of it), its knowledge about the equipment involved, the materials used or the production process in general is very useful. Useful not only in determining whether the product can actually be made according to the proposed specifications, but more specifically in establishing if and how the specifications need to be changed to minimise production costs (keeping product quality constant).

Other possible cost reduction suggestions a supplier may provide during a development project include:

- the use of other, cheaper material;
- the simplification of a design, f.e. by splitting up a part into separate components; or
- the use of an off-the-shelf invention or standard part instead of a customised product.

The degree to which the supplier can provide these inputs is highly dependent on the level of detail of the specifications that the manufacturer presents to the supplier, and its flexibility in adhering to these specifications. This issue is discussed in more detail in section 3.4.

3.3.4 Increasing product value

Supplier involvement can also lead to a higher quality or value of the product. Value is the more appropriate term here, since we do not only refer to the technical quality of the product ('accordance to specifications', 'durability') but also to the functionality ('value in use') and the innovativeness ('degree of newness') of a product. The ability of a supplier to increase product value is again based on its specialised knowledge and capabilities. This concerns not only the product itself, but also the processes involved in manufacturing the product. The kind of ideas that a supplier may provide with regard to increasing technical product quality is closely related to the sort of information that serves to decrease product costs and may concern, among others: (1) the modification or elimination of specifications that make the product difficult to produce, (2) design simplifications, which make the product more reliable in use, or (3) the use of other, more durable material.

With regard to increasing functionality and innovativeness of a product, the supplier may suggest:

- the use of a more environment-friendly material or production process;
- (re-)designs that make the product more easy to service or better suitable for recycling;
- adding features that make the product suitable for a wider range of use(rs); or
- incorporating innovative features that make the product more attractive to the customer.

•

All these positive effects of supplier involvement – reduced development time, reduced development costs, reduced product costs and increased product value – pertain in first instance to the product, part or component developed and produced by the supplier. In the second instance, these effects also regard the total development project: more efficient and more effective development of parts ultimately translates into more efficient and more effective development of the final product. To what extent the effects on part level result in effects at the final product level is dependent on the characteristics of the part relative to the total product and the interrelations with the other parts. These characteristics and interrelations, therefore, determine the need for and degree of supplier involvement. These aspects are the topic of section 3.4. Before that, consider finally the long-term objectives of supplier involvement in product development.

3.3.5 Long-term objectives

Apart from improving development project performance in terms of time, cost and quality, manufacturers may have an interest in collaborating with suppliers in product development for reasons that are rather related to long term objectives. These long-term objectives include the access to the technological knowledge of suppliers, and the long term alignment of technology strategies (Bonaccorsi, 1992: 36). Maintaining co-operative supplier relations provides manufacturers with a possibility of getting permanent access to external knowledge (Bonaccorsi, 1997: 1). In the long run, manufacturers may even have an interest in influencing supplier decisions with regard to the kind of technologies to make investments in, in order to provide the best conditions for future technological collaboration. These kind of long-term alignment efforts are visible in the so-called 'technology roadmaps' that companies like Ericsson and AT&T draw up together with their suppliers, which serve to identify technological trends for both parties and to provide a basis for discussing future investments (see Ekas, 1995).

Compared to short-term collaboration, long-term collaboration is much more focused on supporting the development of underlying technologies and capabilities than on designing a specific new product. In essence, this difference could be described as the long-term *creation* of technological resources vs. the short-term *exploitation* of resources. Manufacturers and suppliers, in the long run, may even (decide to) develop joint capabilities, as in the case of telecommunication equipment manufacturers and internet technology providers developing Internet Protocol (mobile) telecommunication applications. Such joint capabilities may be highly specific to the combination of the knowledge of the manufacturer and the supplier, due to the heterogeneity of resources (see section 2.3.2).

3.4 Forms of supplier involvement

So far, supplier involvement has been discussed as an 'all or nothing' phenomenon: either there is supplier involvement, or there is not. No explicit reference has been made to the possibility of different degrees or levels of involvement, although in practice, we see a wide range of levels of involvement. Actually, all forms of supplier involvement in product development can be described in terms of (a) the degree of development responsibility given to the supplier and (b) the moment that a supplier becomes involved in the overall development project. In contrast to much of the existing research, we submit that these are two separate, although closely related, dimensions.

3.4.1 Degree of involvement

The decision how much development responsibility should be given to each supplier - in other words, what the degree or extent of involvement will be - may largely be based on a comparison between the knowledge and capabilities of the supplier and those of the manufacturer itself. The greater the knowledge of the supplier relative to the manufacturer, the more it can contribute to the development of that part, and therefore the greater its responsibility.

In section 2.3, it has been argued that the different forms of collaboration in product development can be placed on a continuum, ranging from production oriented development ('technology push') where the producer does all development, to user-initiated development ('market-pull') where the user does all development work. In the middle, there are all sorts of interactive forms of product development. Distinguishing a similar continuum for different forms of supplier involvement in product development, the two extremes correspond to situations where, respectively, the supplier develops a 'proprietary' product entirely on its own, or the manufacturer develops and designs a product and lets the supplier produce it.

Related to this continuum we find, both in literature and in practice, different ways of categorising suppliers regarding the extent of their involvement in product development and the kind of information or input they may provide. This section considers some of these supplier involvement typologies.

Based on research in the automobile industry, Clark (1989) distinguishes three main categories of parts, in order of increasing development responsibility for the supplier:

- *detail-controlled parts*: developed entirely by the assembler;
- *black-box parts*: functional specification by assemblers, while detailed engineering is carried out by parts suppliers; and
- *supplier proprietary parts*: entirely developed by suppliers as standard parts.

Lamming (1993: 123-138) adds that for black box parts, the customer specifies only the interface details and performance requirements for a part, leaving the supplier to develop the technical specifications to comply with this demands. 'Grey box' parts would refer to black box parts where the customer has a little more knowledge and influence on the internal functioning.

Bidault and Butler (1995: 6) make a similar distinction between kinds of supplier involvement:

- *Design Supplied*: the supplier has almost no input in the development;
- *Design Shared*: customer and supplier have equal input to a joint design; and
- *Design Sourced*: the supplier takes care of the complete design.

In the case of Design Supplied products, the supplier only provides input regarding its equipment and capabilities. For Design Shared products, the supplier may give feedback on the manufacturer's design regarding possible cost and quality improvements. Within Design Sourced involvement, the authors make a more detailed distinction between three different levels of increasing involvement: (a) significant participation in part/component design by executing detailed drawings; (b) full responsibility for part/component design from concept to manufacture; and (c) full responsibility for system/subassembly design from concept to manufacture. The distinction between different levels of involvement is not only based on the development phases the supplier is responsible for, but also on the kind of product involved.

Kamath and Liker (1994) distinguish four different supplier roles, based on research in different Japanese industries. The four types of suppliers each are involved in a different way, see Table 3.2.

Table 3.2: Different supplier roles according to Kamath and Liker (1994)

	Partner	Mature	Child	Contractual
Design responsibility	Supplier	Supplier	Joint	Customer
Product complexity	Entire subsystem	Complex assembly	Simple assembly	Simple parts
Specifications provided	Concept	Critical specification	Detailed specifications	Complete design
Supplier's influence on specifications	Collaborate	Negotiate	Present capabilities	None
Stage of supplier's involvement	Pre-concept	Concept	Post-concept	Proto-typing
Component-testing responsibility	Complete	Major	Moderate	Minor
Supplier's technological capabilities	Autonomous	High	Medium	Low

It is important to note that the different roles vary with the characteristics of the delivered product, here being the 'hierarchical level' of the product: subsystem, (complex or simple) assembly, and part. Kamath and Liker refer to this as 'product complexity'. For an illustration of the differences in supplier involvement between detail-controlled parts (Design Supplied) and supplier-proprietary parts (Design Sourced), consider the example of DAF Trucks (Box 3.2).

These typologies of supplier involvement in product development all suggest that the more complex a specific part, the greater the degree of supplier involvement (see also Dijkstra *et al.*, 1997: 26). One of the underlying arguments is that those suppliers that produce such complex products as complete systems or subassemblies possess knowledge and skills, which makes it both possible and useful to give them design and engineering responsibilities. The great extent of self-developed technological capabilities is, for example, forwarded as an explanation of the high involvement of suppliers in product development in Japan (Hines, 1994; Nishiguchi, 1994).

DAF Trucks makes a distinction between DAF-designed parts and supplier-designed parts, so-called 'components'. DAF-designed items are those parts that are exclusively manufactured for DAF; usually not very technology-intensive, but often using special production knowledge and techniques. This means that the supplier is focused on process development. Examples are metal cast products, and plastic parts for the interior of the truck cabin. Components are nearly standard products that are produced for a number of customers. Some of these components consist of several parts, are made using different production techniques, and are relatively technology-intensive. Examples are injection pumps, gearboxes, and braking systems. Other components are relatively simple products, usually manufactured using one production technology. The precise measures or dimensions of the product are sometimes adapted for the customer. Examples are oil coolers and suspensions.

The differences between customer-designed parts and supplier-designed components are reflected in the character of the technological co-operation with different suppliers. Technological co-operation with suppliers of customer-designed parts is usually a process where the customer (manufacturer) sets the specifications of the product in terms of, for example, form, dimensions, quality and weight. Depending on its knowledge of the production technology involved, the customer will also put demands on the materials used, the machinery, etc. The supplier tries to produce the parts according to the customer's specifications, but discusses other alternatives with the customer when the specifications cannot be met, for instance due to restrictions in the production process. Depending on the kind of relationship the companies have, the supplier may also suggest alternative designs that are cheaper in terms of material or production, or which have a superior quality.

Technological co-operation with suppliers of supplier-designed parts, on the other hand, is quite different. Here it is the supplier that has determined the product characteristics. A particular customer may want to purchase a specific version of this product, adapted to its specific needs in terms of dimensions, material, special additional features, extra high quality, etcetera. The supplier will consider the specific wishes of the customer, not only on the basis of their technical implications and possibilities, but also on the basis of the profitability of adapting to these wishes. Co-operating with the customer on a special version of the supplier's product may result in a new improved product, additional business with that customer or others, increase the supplier's understanding of the assembly process at the customer and the product's interaction with other parts and components in the complete final product, or may lead to other long term advantages. Compared to the situation of customer-designed parts, there is little discussion on the production technology being used.

Box 3.2: Different degrees of supplier involvement at DAF Trucks

Source: own interviews

The more complex a part in terms of the variety of technologies included, the more difficult it also becomes for the manufacturer to have the knowledge and capabilities necessary for developing such a product. That leads us to another factor that determines the degree of supplier involvement, apart from the complexity of a product: the willingness of and appropriateness for the manufacturer to invest resources in the development of the product.

Important considerations in that perspective are:

- Given the firm's core technological competencies, into how much detail does it want to go regarding developing specifications?
 - Are there any suppliers with more relevant product or production knowledge than the manufacturer has for this particular part?
 - Are there any suppliers that can carry out the development more efficient than the manufacturer can?
- These considerations clearly focus on the technological capabilities and capacities of the customer firm versus those of the supplier. They are closely related to the overall development or technology strategy of the firm (Wheelwright and Clark, 1992: 36; Ford and Saren, 1996).

3.4.2 Moment of involvement

The second dimension of the form of supplier involvement within a specific project concerns the moment when a supplier of a specific part is involved in the development project for the complete final product. This moment is related to the sequence in which the different parts of the product will be dealt with by the engineers during the development project. It is therefore closely associated with the characteristics of the part itself relative to the other parts. For example, the longer the development lead time of a part, the earlier in the project that part is dealt with in order to make the project deadline, and therefore the earlier the supplier of that part will need to be called into the project.

The reasons for distinguishing a sequence of different moments of supplier involvement in a larger project are both technological and economical. In a technological perspective, involving all suppliers at the beginning of a project is not possible nor useful since so many specifications are still unclear. The uncertainty is too large to involve a wide variety of parties to deal with it; the range of options is still too large and has to be limited before meaningful involvement of all suppliers can be realised. This implies that suppliers will be involved in order of the 'technological importance' of their part for the total product. In an economical perspective, manufacturers do not have unlimited resources to handle supplier involvement, and therefore have to set priorities. Involving suppliers not only yields benefits but also takes time and money for co-ordination, communication etc.; not only for the supplier, but for the manufacturer firm too. Therefore, the manufacturer wants and needs to set priorities, in order to adjust its efforts and costs depending on the need and the potential benefits from the co-operation in terms of development time, development and product costs, and product value. Just as for the degree of involvement, several typologies have been proposed with regard to the moment of supplier involvement.

One example of such a typology is the purchasing portfolio (Kraljic, 1983; Van Weele, 1994) in the way it is used by Océ-van der Grinten, a Dutch manufacturer of copiers and drawing room equipment. Océ uses this typology to determine which parts and suppliers need attention to what extent and at which moment in the development project, see Figure 3.9 (Pothast, 1992; Wiegerinck, 1996). While Kraljic used the horizontal dimension to indicate the availability of the product in the supply market, in other words the *supply* risk, in the case of Océ it also encompasses specific *design* risks.

The vertical dimension is related to cost; the middle-line is chosen so that the parts above it represent 80 % of all costs (which usually equals roughly 20 % of the number of parts). Strategic part suppliers are involved early; in the Concept phase of a development project. In the Engineering phase, suppliers of leverage and bottle-neck items become involved. Attention for the leverage products is focused at cost reductions; either by playing the market, or by intensive co-operation. For bottle-neck products the emphasis is on risk reduction, for example, through standardisation. The involvement of non-critical item suppliers does not start until the final stages of the development project. The interesting aspect of this approach is that it gives explicit attention to the aspect of costs.

Figure 3.9: The portfolio approach of Océ-van der Grinten

There are three characteristics that seem to determine the sequence in which parts and their suppliers are involved in a development project: product complexity (just as in the case of the degree of supplier involvement), costs and 'development risk'. All typologies indicate that suppliers of complex products not only have greater responsibility for the development of their product but also become earlier involved in the total project. By developing the larger building blocks of a product first (systems, subassemblies) uncertainty is reduced relatively quickly.

Costs are the second factor in determining the 'development sequence'. Explicitly determining supplier involvement priorities on the basis of costs is useful in managing the costs of the new final product. By starting with the more expensive parts in the beginning of a project, when the freedom in setting specifications is the greatest (see Figure 3.8), the biggest potential cost savings are considered first. While it generally is true that the more complex a product, the more costly it is in relation to the final product, there may be exceptions. Some simple components, for example, especially when they contain expensive or a lot of raw material, may be more costly than sub-assemblies.

The third factor regards 'development risk' or development importance. This degree of risk or importance includes different aspects, such as (Wijnstra and Sie, 1997):

- the extent to which the part contributes to the new functionality of the total product;
- the degree of novelty of the part in terms of technology;
- the extent to which the specifications of other parts are interdependent with the product concerned (the amount of interfaces, or 'external complexity'); and
- development lead-time (whether or not it is on the critical development path).

Usually, it is assumed that the more complex a part (the higher it is in the product hierarchy), the more it contributes to the *new functionality* of the product. This need not be the case; especially in product modification or improvement projects, the newness of the end-product may be derived from a rather small component. The *degree of technological novelty* is an indicator of the uncertainties and potential problems that may be experienced in developing the part. While these first two aspects concern the amount of development work that goes into a specific component, the aspects of *external complexity* and *development lead time* focus more on the logical sequence of developing parts. Some very simple, more or less standard parts can be important in setting interface requirements for other, larger parts. Similarly, a specific part may take a relatively long time but not so many resources to be developed, like some moulds or dies.

This variety of the parameters determining the moment of supplier involvement - product complexity, costs, development risk⁸ - implies, for example, that suppliers of large internally complex parts which have a low development risk can be involved later than suppliers of simple parts that have a high development risk, as was found in an analysis of a number of development projects at a manufacturer of medical equipment (Wijnstra and Sie, 1997; Sie, 1996; see also Appendix G). This results in a more differentiated approach to determining the degree and moment of supplier involvement in product development projects than the models presented in this section, which treat the two dimensions as nearly identical. The claim that degree and moment of supplier involvement are two separate dimensions and have to be decided separately, is also supported by the findings of Hartley (1994: 94). In her survey of 79 manufacturers mainly in electro-mechanical industries, the stage of supplier involvement and the role assumed by the supplier in component design were not correlated.

After these discussions of the different objectives and forms of supplier involvement, it is necessary to also consider the downside in terms of the problems and risks, among others by looking at the actual results of supplier involvement. This may contribute to a balanced appreciation of the potential benefits of supplier involvement in product development.

3.5 Potential risks and problems

Despite all the positive observations so far, supplier involvement is not without its risks and problems. Risks or potential disadvantages of supplier involvement, as discussed in previous research, include increased dependency of the manufacturer on specific suppliers and the resulting 'lock-in' into specific technologies. Problems in or barriers to achieving supplier involvement can be related to three categories of factors. In the first place, supplier involvement may be difficult to implement because of obstacles internally at the manufacturer, such as resistance by technical departments that see the involvement of external development resources as a threat to or at least a complication of their work. In the second place, supplier involvement may be difficult to implement due to the suppliers themselves, such as being insufficiently capable or willing to collaborate. Finally, the problems may reside in the relationship between the manufacturer and supplier, such as insufficient communication or unfavourable reward structures.

These potential risks and problems can seriously affect the actual benefits of supplier involvement. In this section, we briefly review these risks and problems and conclude with an overview of available research into the actual results of supplier involvement.

⁸ Like external complexity, product or *internal* complexity could also be subsumed under development risk. These concepts are discussed in more detail by Nishiguchi (1993). See also Garel and Kessler (1996: 312).

3.5.1 Risks

The main risks associated with supplier involvement in product development relate to *increased dependency, reduced flexibility and information loss*.

Increased dependency of the manufacturer on the supplier is the effect of increased collaboration, the information exchange that goes with it and especially of the commitment to and possible selection of a supplier taking place in an early stage of a development project. The underlying assumption is that supplier involvement is associated with single sourcing; in other words, supplier involvement decreases competition. This, however, need not be the case. Bonaccorsi and Lipparini (1994: 135-136) distinguish three modes of supplier involvement in terms of the degree of competition among suppliers at the time of involvement. At the one extreme, all approved suppliers of the firm can be involved but only at the final stages of the development process. At the other extreme, only one supplier is selected in an early (Concept) stage of the development project. In the intermediate model, a limited number of preferred suppliers is involved before the definition of specifications. In this model, supplier selection does not necessarily take place in an early phase of the development process. Since the involvement of suppliers demands resources and time, the manufacturer has to weigh the benefits and costs of involving several suppliers for the development of the same component. The choice for one or more suppliers also depends on the number of available suppliers and their relative technological capabilities.

In the automotive industry, for example, it seems common practice to involve two or three suppliers in the form of a 'Design Contest'. The supplier with, for example, the best technological solution or a price that is closest to the original 'target cost' set by the manufacturer, wins the contract to produce and deliver the product. In some cases, one of the other suppliers becomes, for instance, a secondary or back-up supplier and is provided with the specifications as developed by the 'winning' supplier. Alternatively, this supplier may be the preferred partner for a following new car model (Dyer and Ouchi, 1993: 57). Harryson (1995: 83) notes that in Japan, despite early and intense collaboration, the manufacturer still maintains relations with other suppliers "thus enabling the double-checking of costs and the threat of a potential shift". One additional explanation for the fact that in Japan, manufacturers are so closely co-operating with suppliers in product development is that the increased dependency is less perceived as a risk because of the extensive ownership connections. Canon, for example, owns at least 50 % of its roughly 250 first-tier suppliers, and the situation is similar for Sony (Harryson, 1995: 90-93). These connections make it possible, to some extent, to counterbalance some of the technological dependencies.

Supplier involvement is thus not automatically related to single sourcing and, therefore, does not always imply increased dependency. On the other hand, increased dependency is not only a risk. It can also be a condition for being able to motivate or demand a supplier to make a commitment in working with the manufacturer. This goes back to the positive correlation between technological collaboration and the duration and importance of a manufacturer-supplier relation (see section 3.1).

The second risk, *decreased flexibility*, is closely related to the aspect of dependency. By working closely and up-front with specific suppliers, manufacturers may forego alternative technological solutions developed by competing suppliers. The search for better solutions may be limited by the need to fit with the existing supplier's capabilities and investments (Bonaccorsi, 1992: 37). For example, at the outset of a particular development project it may not be totally clear which is the best technology for a specific component. If in that case a supplier is selected with competencies in only one specific area, for instance, in plastic injection moulding but not in ceramics, the manufacturer is more or less 'locked' into this technological option.

This risk of decreased flexibility is particularly relevant in projects with a high degree of innovation. Eisenhardt and Tabrizi (1995: 101-105) argue that for less predictable projects, manufacturers looking for ways to speed up product development may prefer last-minute supplier selection or buying standard components in order to maintain design flexibility. In a study of 72 development projects at 36 large computer companies in the US, Europe and Asia, they found that supplier involvement⁹ does not significantly increase the pace of product development. However, splitting their sample into projects that were more predictable from a technological viewpoint (mainframes and minicomputers) and those that were less certain (personal computers and peripherals), they found that for the predictable projects supplier involvement does lead to an increase in development pace.

Related to this risk of reduced flexibility is the fact that suppliers may develop a component that can only be produced by themselves, for example because of very specific forms or materials. The adaptations that may be made in the overall design of the final product to accommodate the special component make it more difficult to switch to another supplier for future models. Manufacturers may therefore refuse to accept component designs that can only be produced by one supplier. In our own research interviews, several suppliers indicated that in order for a manufacturer to accept, for example, a new component material, it has to be available from several suppliers. Therefore, these suppliers were not so interested in keeping certain new developments only for themselves and would rather license it to other suppliers in order to speed up acceptance and diffusion of the new component. In the mid-1980's, in a related example, one of the world's only two producers of rayon fibres for car tires, Rhône-Poulenc was about to close its factories when its competitor, Enka Glanzstoff, offered its assistance to upgrade these factories. The motive for Enka was that if Rhône-Poulenc would close its factories, tire producers like Michelin, Continental and Goodyear would start looking for other fibres than rayon in order to become not too dependent on Enka Glanzstoff.

The third risk, loss of information, arises from the (early) disclosure of technical details regarding the new product or from the disclosure of technological knowledge of the manufacturer in general. As indicated in section 3.2, joint product development always entails some exchange of technical information or knowledge. Especially the spread of information on new products via suppliers, for example to competitors of the manufacturer, is a sensitive issue. In some cases, suppliers may have restricted areas at their premises where development work is carried out for one specific manufacturer. Access is limited to specific team-members and representatives of that manufacturer. The risk of a spread of information regarding the manufacturer's general technological competencies is more relevant in the long run. Potential spread of information is said to be one of the reasons why, for example, European and US car manufacturers are reluctant to involve Japanese component suppliers, since these have such close (ownership) connections with Japanese car producers.

One way of reducing this risk is by selecting suppliers that do not work for competitors, or demanding that they don't. Such exclusivity arrangements work, however, against the supplier achieving economies of scope and learning by interacting with several customers (Bonaccorsi, 1992: 38). This exposure of external suppliers to different manufacturers and the positive effects it has on knowledge and skills is actually one of the arguments why they are involved in product development in the first place (Praat and Alders, 1998: 57-59; see also see 3.3).

Summarising, increased dependence, reduced flexibility and spread of information are some of the important risks of supplier involvement in product development. Apart from these risks, however, there are also problems in (barriers to) achieving supplier involvement.

⁹ Supplier involvement was defined as having one or more employees of a supplier as members of the development team, and was measured by the number of stages in the development process in which they actually participated.

3.5.2 Problems

Manufacturer related problems

Problems at the manufacturer itself, related to the involvement of suppliers in product development, exist in a number of areas. In the first place, the product development process may be based on vague policies and guidelines and, therefore, provide an unclear picture of where and when suppliers should be involved. Internal problems may also arise due to the ways of working and attitudes of the departments that are most directly involved in and affected by it; purchasing and development. The initial experiences of DAF Trucks with increasing suppliers' involvement in product development in the early 1990's, for example, showed that one of the barriers was formed by the conventions and attitudes of some of the purchasers. They felt insecure and were reluctant to select suppliers in an early stage of the development project when they did not have a finished product to base their selection on (Van der Sloot, 1993). Often, purchasers may try to maintain competitive relations with suppliers in order to create 'leverage', by not willing to compensate suppliers for their development effort. They may even transfer technological information from a development partner to competing suppliers in order to achieve a better price, as Saab and some other automobile manufacturers have been accused of doing in the early 1990's.

Development engineers may erect barriers for supplier involvement when they feel their work is threatened. They may reject the involvement at all, arguing that the communication with suppliers adds too much complexity to their already difficult work, or that suppliers can never achieve the same quality standards they have. During the collaboration, they may impose unrealistic targets and provide insufficient information in order to make the task for suppliers as difficult as possible. In Chapter 4, on the involvement of purchasing in product development, more attention is given to these internal problems by discussing the respective orientations of the purchasing and the development function of a firm.

Supplier related problems

Suppliers themselves can pose different problems with regard to joint involvement in product development with manufacturers. In the first place, they may not be sufficiently capable of product development collaboration. Obviously, manufacturers will try to select for involvement those suppliers that do have sufficient knowledge and skills, but this may not always be possible. In many countries and industries, increased supplier involvement in product development is a relatively new development and suppliers may not have had the opportunity to align themselves with the new demands placed on them. However, in order to collaborate with manufacturers in product development it is not sufficient to have only technological knowledge and skills; capabilities related to project management, product documentation, and quality tools are equally important. It is interesting to note that those manufacturers that have been heralded for their extensive collaboration with suppliers in product development, such as Motorola and Honda, provide their suppliers with substantial support in these areas (Dyer and Ouchi, 1993: 57; Van Weele and Rozemeijer, 1996: 76-80). In Japan, the associations formed by the suppliers of each car manufacturer are particularly important in disseminating new technologies and best practices in manufacturing and management (Womack et al., 1990: 153; Harryson, 1995: 82).

In the second place, suppliers may not be able or willing to commit the necessary time, labour and capital. This can be due to the supplier having other customers that demand a high commitment as well, or being uncertain about the potential returns of his investment in the collaboration.

Relation related problems

Finally, there may be problems that can not be attributed only to the manufacturer or the supplier, but which are rather connected to the relationship between the two. Problems may involve a lack of trust, insufficient communication and diverging expectations. A lack of trust between the two parties may hinder efficient collaboration as both parties will see large potential risks (see 3.5.1). Because of that, it may be especially difficult to collaborate with suppliers that are new to the firm which may be necessary, for example, when the manufacturer needs a totally new component. Communication problems may arise, for example, when the manufacturer and supplier have totally different ways of formulating and interpreting technical information. Problems may even be caused by such practical obstacles as incompatible CAD systems or different languages used in technical drawings. Additional problems arise when the manufacturer fails to communicate clearly to suppliers what it expects from them in terms of development responsibility for the products they produce. This leads to suppliers forming inaccurate assumptions as to what this responsibility may be, possibly even basing strategies and investments on those incorrect assumptions.

This discussion of risks and problems associated with supplier involvement in product development is not exhaustive. Neither is the distinction into problems related to the manufacturer, the supplier or the relation a very strict one, since most problems are closely related to each other. Nevertheless, it provides an overview that can help us to better understand some of the findings of empirical research into the actual results of supplier involvement.

3.5.3 Actual results of supplier involvement

Research into the actual results of supplier involvement has been limited to the short-term benefits of supplier involvement, as discussed in section 3.3: reduction in development lead time, development and product costs, and improvement in product quality. Although all three elements - time, cost, quality - are widely cited as the key benefits of supplier involvement in product development, Bidault and Butler (1995: 3-6) argue that the importance placed on the different elements varies with the experience manufacturers have with supplier involvement and the extent of that involvement. The more experience and the greater the extent, the less emphasis is placed on cost reduction and the more on quality improvement. This would imply that cost reductions are easier to realise than quality improvements. Ragatz *et al.* (1997: 195) finds that in the most successful cases of supplier involvement, improvements in product quality are the most prominent, followed by reduced development time and costs. This indicates that product costs are not the most critical issue. Prior to the discussion on the relative importance of the different benefits, however, comes the question whether there are any actual benefits at all.

In general, the evidence with regard to the results of supplier involvement is rather anecdotal. For example, Asmus and Griffin (1993) claim that a major designer and manufacturer of mechanical equipment, with a total purchased volume of \$ 1.3 billion a year, saved some \$ 80 million in product development and specification annually by improving the involvement of suppliers in product development. Burt (1989: 129) mentions new product development time and cost reductions of 50 % at the Xerox corporation as being partly the effect of new supply partnerships. Bidault and Butler (1995), reporting on research into the benefits of 'Early Supplier Involvement' at 25 manufacturers in Europe, the US and Japan, claim that *some* companies slashed development time between 30 and 50 %.

Of the few large-scale empirical studies that have been done in this area, the most publicised work is by Clark and Fujimoto (Clark *et al.*, 1987; Clark, 1989; Clark and Fujimoto, 1991). Within the International Motor Vehicle Program, these researchers investigated 29 major automobile development projects in the US, Europe and Japan in order to determine which factors explain the Japanese manufacturers' better performance in terms of development time and costs. Clark (1989: 1251) found that in Japan, black-box parts (for which the supplier undertakes most development, see 3.4) account for 62 percent of total procurement costs, versus 16 and 39 % in the US and Europe respectively. Clark argues that at Japanese car manufacturers, this high degree of supplier involvement accounts for 4-5 months lead time reduction and saves the manufacturer roughly 800 thousand engineering hours in an average new car development project (1989: 1260).

Outside the automotive industry, the few studies that are available present evidence, contrary to the expectations, that supplier involvement in product development is not always beneficiary. One such study is by Eisenhardt and Tabrizi (1995), discussed in section 3.5.1, although it does not exclusively focus on supplier involvement. Three other recent studies in the United States do focus on this issue. Hartley (1994) presents a survey of 79 small to medium-sized companies in a range of assembly industries, including industrial equipment, computers and analytical instruments. She comes to the conclusion that early supplier involvement and a greater responsibility of the supplier for the development of its product do not lead to decreased product costs or to higher product quality. Additionally, early and extensive supplier involvement does not lead to a significant reduction in development lead time.

Birou (1994: Ch 5) arrives at even more surprising findings. She presents evidence for 83 development projects in the automotive, electronics, defence and medical equipment industries that the influence of supplier involvement on the success of product development is *negative*. Supplier involvement results in higher product and development costs, and does not achieve better but sometimes even worse product performance and often longer development time. Interestingly, Birou makes a distinction between quantitative and qualitative aspects of supplier involvement. Quantitative aspects encompass the man-hours invested by the supplier, investments in knowledge and equipment and the number of meetings attended. Qualitative aspects cover the supplier's attitude to collaboration and its ability to communicate. Even greater supplier involvement in qualitative terms, however, has a predominantly negative influence on the results of product development projects.

In the third study, Ragatz *et al.* (1997) present findings for 60 companies indicating that the most successful¹⁰ cases of supplier involvement for each company result in median improvements of 40 % for product quality, 25 % for development cycle time, and 15 % in product cost. In the least successful cases, however, even deteriorations arise; the strongest now in development time, but the weakest still in costs. Because it is not clear how many successful and how many unsuccessful supplier involvement projects the companies have had, it is difficult to draw conclusions about the average effects of supplier involvement.

Do these studies imply that supplier involvement in product development is an inappropriate strategy? In our opinion, not at all. There may be various plausible explanations for these remarkable findings, especially the ones in the studies by Birou (1994) and Hartley (1994; also reported in: Hartley *et al.*, 1997).

¹⁰ 'Successful' is measured as 'overall degree of satisfaction with results' and 'overall degree of achievement of established goals'.

Hartley indicates that one possible explanation can be that the effects of supplier involvement take some time to emerge; in her sample, there was no information whether the suppliers that were involved had prior experience in joint product development. Additionally, technological capabilities were considered the most important supplier selection criterion only in 11 % of all cases (Hartley, 1994: 67). Weighting technological skills more heavily in supplier selection could improve the results of supplier involvement. Another possible explanation may be the limited interest of a supplier in working with the manufacturer, for example because it represents only a minor share of the supplier's total sales. In section 3.1.1, indications have been presented that supplier-manufacturer collaboration is most intensive when the manufacturer represents a large share of the supplier's sales. Involving suppliers that are not quite that dependent on the manufacturer, may result in the suppliers not being that committed to collaborating, leading to less positive or even negative effects on project performance.

Moreover, all these studies involve development projects at different manufacturers. Measuring in such a way the effects of different extents of supplier involvement in product development projects is quite problematic. Because of the specific nature of the process - the development of new products - no project is the same, and many variables may change from project to project. While a comparison of projects within one industry may be justifiable when controlling for specific variables (as in Clark, 1989), it is hard, if not impossible, to single out the effect of (increased) supplier involvement for projects across different industries. Most studies control for moderating variables such as the complexity of the new product (Birou, 1994) and supplier capabilities or even the duration of the buyer-supplier relations (Hartley et al., 1997) but not, for example, for the prior experience the manufacturer has in supplier involvement and the way this is managed. Neither is it apparent from these studies which kind of suppliers have been involved by the manufacturers and on the basis of which considerations. In other words, the manufacturers may have selected the wrong suppliers in terms of the components they make, leading to increased co-ordination and communication efforts and costs that are not compensated for by savings in development time and costs or by product improvements (see section 3.4). Supplier involvement is not a panacea for all product development illnesses.

In addition to these reservations, the effects of supplier involvement - if they can be measured accurately at all - are rarely unambiguous. What if in comparing two comparable development projects, increased supplier involvement leads to reduced development or product costs, but to increased development time? There seem to be very few guidelines to handle such trade-offs (f.e. House and Price, 1991) and, moreover, time, costs and quality are not equally important for all development projects. In that perspective, the results of supplier involvement have to be evaluated in the context of the project's specific targets.

Finally, none of the studies reviewed here have investigated the long term benefits of supplier involvement in product development, such as access to technological knowledge and long-term alignment of technological capabilities. These are even more difficult, if not impossible to measure. A lack of actual short term benefits of supplier involvement does not automatically exclude long term benefits. Because of these problems interpreting project data, and - more importantly - the limited value of evaluating what the results of supplier involvement are without having defined what it exactly involves (see section 1.2.1), the current study does not concentrate on a cross-sectional analysis of the actual benefits of supplier involvement in product development, but is rather concerned with the elements in managing supplier involvement.

Before concluding this chapter, we briefly consider the role of contracts in managing supplier involvement in product development. Contracts may perhaps be used to mitigate or counterbalance some of the risks and problems in supplier involvement.

3.6 The role of contracts

Contracts are often regarded as tools to decrease the risks pertaining to a business transaction. As in many textbooks on purchasing management, Van Weele (1994: 49-56) regards 'contracting' as one of the crucial steps in the overall purchasing process (see Figure 4.1). By 'contracts', Van Weele refers to the explicit, formal agreements between the buyer and the supplier. The precise definition of contractual arrangements is, according to Van Weele (1997: 156), an important step in improving the results in doing business with suppliers.

With regard to collaboration in product development, there are specific forms of contracts that may be used to counter some of the risks mentioned in section 3.5.1, especially the risk of information loss. On the one hand there are contracts that concern the *outcomes* or results of the collaboration. These contracts may contain specific agreements on the intellectual property rights regarding the 'innovations' resulting from the collaboration, such as patent agreements and the like. Alternatively, the contracts mainly aim to prevent specific information or knowledge leaking to third parties, such as in the form of non-disclosure agreements or secrecy agreements. On the other hand, there are contracts that concern the *inputs* of the collaboration. These inputs may be defined in terms of people, specific 'pools' of knowledge (for example, when two parties agree to combine their expertise in certain technologies) or costs based on, for example, the number of working hours spent by the different parties.

Blumberg (1997: 112-113) makes a distinction between different forms of contract clauses regarding technological collaboration, based on two variables: the *aspects* covered and the *purpose* they fulfil. Blumberg distinguishes four different aspects: financial, technological, internal and external. The purpose of a specific clause may either be to create mutual confidence or to co-ordinate more operational aspects. Table 3.3 presents the different possible contractual clauses for technological collaboration between manufacturer and supplier according to these two dimensions.

Table 3.3: Contractual clauses for technological collaboration

Based on: Blumberg, 1997: 113.

aspect	purpose	confidence building	co-ordination
financial aspects		<ul style="list-style-type: none"> • cost calculation • sanctions in case of work delay • sanctions in case of payment delay 	<ul style="list-style-type: none"> • payment period • delivery period • cost changes • arbitration • arbitration rules
technological aspects		<ul style="list-style-type: none"> • confidentiality • intellectual property rights put into the collaboration • intellectual property rights resulting from the collaboration • access to premises 	
internal relations		<ul style="list-style-type: none"> • agreement prolongation • exchange of employees • provision of equipment • purchase obligations 	<ul style="list-style-type: none"> • quality norms • replacement parts • warranties • up-dating • planning • flexibility • contacts • evaluation • joint management
external relations		<ul style="list-style-type: none"> • exclusivity 	<ul style="list-style-type: none"> • participation by third parties

Contracts may not be equally necessary or relevant in different conditions, and different contracts may be used in different situations. Especially in 'younger' business relationships, contracts may be relevant because other, less formal mechanisms that may help to control the risks within the relationship, such as trust (Sako, 1992; Fukuyama, 1995; Dodgson, 1996), may not yet have fully evolved. Similarly, when the potential impact of a risky event is large, contracts are more relevant than when that impact is limited, for example because the product involved in the business relationship is of only minor technical and/or financial importance. The more is at stake, the more elaborate a contract may be.

One way of distinguishing between the elaborateness of different contracts is by measuring the number of clauses in them. In his study of 94 technological collaborations at 5 different companies, Blumberg (1997: 162-163)¹¹ found that (both market and technical) uncertainty did not significantly affect the number of clauses in the contract. This applies to all four different groups of clauses discussed above (financial, technical, internal and external). *Internal* uncertainty faced by the manufacturer in terms of a limited amount of knowledge regarding the technical aspects of the collaboration only had a significant positive effect on the number of technical clauses in the contract. The most important explanatory variable, however, with regard to the number of clauses in the development contract, regarded the size of the budget for the collaboration. The greater the expenditure in terms of dedicated personnel, investments and materials, the more elaborate the contract – in all four different groups of clauses.

Interestingly, Blumberg (1997: 150-152, 173-175) found that instead of increasing the number of contractual clauses, external (market and technical) uncertainty does lead to more extensive search, negotiation and planning activities at the beginning of a collaboration. The implication is that increased uncertainty requires more flexibility for which search and planning activities may be better management tools than contracts.

Generally, the occurrence and the importance of these contracts regarding supplier involvement in product development seems limited. Williamson (1985: 141-159) argues that for relationships in which innovation plays an important role, normal (market) contracts are insufficiently capable to govern the relationship and organisations have to resort to 'hybrid' governance forms. According to Williamson, these hybrid forms closely resemble the long-term relationships or network-type of organisations described by the IMP network approach (Oerlemans, 1996: 75). On a general level, IMP researchers Håkansson and Snehota (1995: 8) argue that:

'Formal contracts are often ineffective in taking care of the uncertainties, conflicts and crises that a business relationship is bound to go through over time. Informal mechanisms have been pointed out in several of the studies (on relationships between companies, FW) as being more effective for the development of relationships than formal contractual arrangements.'

In section 3.1, we have already presented some empirical studies which show that innovation-intensive relationships are little formalised (Håkansson, 1989; Oerlemans, 1996). Also the data from the Scandinavian database (3.1.1) show that supplier relationships are rather seldom governed by explicit written contracts, especially when they have existed for a longer time. Often there are no general long-term contracts within the relationships, but more specifically even, manufacturer-supplier collaboration in product development is often not accompanied by cost-sharing agreements.

¹¹ This study was also partly financed by the Dutch Association for Purchasing Management (NEVI).

Oerlemans (1996: 276, 456) found that the use of contracts in technological collaboration relationships with suppliers is especially low for those manufacturers that carry out incremental (product and process) innovations, which is also the largest group of innovating firms (vs. manufacturers that carry out more radical innovations).

Anticipating the case-studies described in Chapter 5, the research in the current study has also found that collaborative supplier relationships are little formalised (see also Appendix D). In many of the cases, we found that contracts – if they do exist – play a very limited role in actually managing the relation and the involvement of the supplier in product development. If contracts are being ‘pulled out of the drawer’, it is usually the last resort and often already too late (Blumberg, 1997: 190; Macaulay, 1963). Contracts can hardly be used in a pro-active way: they are essentially a ‘re-active’ instrument. One possible benefit of contracts, however, is that they may include (or at least lead to) a definition or description of what will actually be developed or what kind of development efforts will be undertaken. This ‘plan’ may be helpful in clarifying the expectation, intentions and demands of the parties concerned. However, product development processes have a high degree of uncertainty, so the development plans may need to be constantly adjusted. Contracts are usually too ‘rigid’ to accommodate for such adjustments (see the discussion above of the study by Blumberg (1997)). Another possible benefit of contracts is that they may provide an incentive to the supplier to collaborate, for example by specifying a certain amount of money to be paid by the manufacturer as a compensation for the efforts by the supplier.

Because of their limited possibilities for actively managing supplier involvement, and because of their limited actual use, the role of contracts will not be considered explicitly in the remainder of this study. In the following chapter, we aim to identify the underlying, more pro-active processes that are necessary in managing supplier involvement. For some of these processes, contracts may in some cases be used to (partly) achieve such processes (for instance, in motivating a supplier to collaborate).

3.7 Summary and conclusions

This chapter has been devoted to analysing supplier involvement in product development, looking at the different forms of supplier involvement in product development that can be distinguished, and the factors the differentiation between these forms is based on. It has also looked at the problems and risks in supplier involvement in product development, partly as reflected in existing research on the actual results of this involvement. Since managing the involvement of suppliers in product development can be seen as the cornerstone for the involvement of the purchasing function, an investigation of the main issues and problems in managing supplier involvement is useful in analysing purchasing involvement.

In section 3.1, some general aspects of technological collaboration with suppliers have been reviewed. In terms of products delivered, collaboration seems to take place most frequently with assembly and finished good suppliers. Technological collaboration relatively frequently involves single source suppliers, in which case also the intensity of technological collaboration is high. This intensity is also relatively high when the collaboration involves a customer with a dominating position in terms of share of supplier sales. Relationship age plays a role in the sense that collaboration seems the most continuous and the most balanced for longer existing relationships. Finally, the collaboration is the least formalised for older relationships, relations that involve semi-manufactures, equipment or services, or which concern ‘minor positions’ of either the supplier or the customer.

Section 3.2 has looked at different forms of collaboration based on the focus of the collaboration (development, technology or product) and the time-horizon of the collaboration. Supplier involvement has been described as primarily short-term collaboration, focused at product transfer and joint development. In section 3.3, the objectives or motives of supplier involvement have been investigated. A distinction has been made between the short-term, project-related objectives of reducing development time, development and product costs and improving product value, and the long-term objectives of getting permanent access to supplier technological knowledge and aligning manufacturer and supplier technological capabilities. In 3.4, the degree of supplier responsibility for developing its product and the moment of involvement during the development project of the final product have been identified as the two main dimensions distinguishing between different forms of supplier involvement.

Section 3.5 has reviewed the potential risks and problems and the actual results of supplier involvement. As potential risks we listed increased dependency, reduced flexibility and information loss. For sources of problems or barriers, we looked at the manufacturer, the supplier and the relation between the two. The review of actual results of supplier involvement has revealed that especially outside the automotive industry, the positive effects of supplier involvement have not yet been fully demonstrated. Rather than discarding supplier involvement as a strategy for improving product development processes, this points to the importance of choosing the right suppliers to work with, balancing the costs and benefits by focusing on the most important components, and managing supplier involvement in a constructive way. In other words, the way supplier involvement is *managed* is very important. In section 3.6, we have briefly discussed the role of contracts in managing (some of the risks regarding) supplier involvement in product development. The conclusion has been that contracts are relatively unimportant in the kind of collaborative relationships being used for technological collaboration between business firms, because they provide little means for pro-actively managing supplier involvement. This provides the link with the following chapter, which concludes the Analysis part of the thesis by considering the essence of managing supplier involvement and by building on this to define purchasing involvement in product development.

Analysis

Chapter 4

Purchasing Involvement in Product Development

After having considered the product development process and the involvement of suppliers in that process, this final chapter of the Analysis part investigates the involvement of purchasing in product development. First, it introduces purchasing in terms of the various definitions of its contents and tasks. Following that, the chapter considers what is called the three fundamental roles of purchasing, as these roles form the background for purchasing's involvement in product development. In section 4.3, the key processes underlying purchasing involvement in product development are defined. This serves as a first step towards answering research question number one: what are the key processes that purchasing involvement should realise or at least contribute to? Additionally, the different objects or areas within purchasing's involvement in product development are distinguished, in answering research question two: in what areas can purchasing involvement contribute to the different key processes? The key processes cut across these different areas, and together they provide the concepts that are used in Part II for developing an integrated framework for purchasing activities related to product development. Section 4.4 briefly reviews the risks and potential problems or barriers in achieving purchasing involvement in product development, and the chapter closes with a summary and conclusion.

4.1 Definitions of purchasing

Håkansson (*ed.*, 1982) defines purchasing as 'securing of the resource inputs of materials, components, and equipment into the business'. Heinritz *et al.* (1986: 9) refers to purchasing as 'buying materials of the right quality, in the right quantity, at the right time, at the right price, from the right source'. Scheuing (1989: 4-5) describes purchasing as 'the acquisition of needed goods and services at optimum cost from competent, reliable sources'. According to this author, 'It consists of both the act of and functional responsibility for securing necessary inputs from outside sources.' (*ibid.*).

Van Stekelenborg (1997; Ch 5) reviews these and other frequently used definitions, and concludes that they range from fairly operational to more strategic. The definitions also differ in their focus, which is either on objectives or on the activities that are carried out. Torvatn (1996: 58-59) submits that in earlier literature, purchasing has been interpreted in a narrow and operational way. This has led to a strong orientation on the position of the buyer, and a 'narrow understanding of the organisational issues pertaining to the solution and organisation of purchasing tasks'. However, in the past decade or so the conception of what purchasing is has broadened considerably to a more strategic understanding of the underlying processes. This ties in with the developments in business practice where purchasing, from having been a mainly administrative unit earlier on, has more and more become a strategic function aimed at 'managing the external resources of the firm' (Van Weele, 1994; Dobler and Burt, 1996). Gadde and Håkansson (1993: 13) describe purchasing even as broad as 'a company's behaviour in relation to its suppliers'.

Analysis

Van Weele (1994: 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.'

In this study, we adopt the following definition:

'managing the external resources of the firm, aimed at acquiring inputs at the most favourable conditions'.

This definition explicitly includes the possibility that inputs may be less tangible than goods or services (f.e. knowledge), and acknowledges that purchasing may involve activities that are only indirectly concerned with ('aimed at') 'obtaining' inputs such as relationship building, and supplier development programs.

As part of the trend towards a more strategic perspective of purchasing, the field has seen a lot of new terms being introduced during the last decades; strategic sourcing, supply management, procurement, to name just a few. These terms are graphically represented in Figure 4.1.

Figure 4.1: Purchasing process and related definitions (* = USA, ** = UK)

Source: Van Weele, 1994.

Purchasing refers to six basic activities: specification, selection, contracting, ordering, expediting and evaluating (after-care). These activities form the basic building blocks in any purchasing process, be it that not all may be performed each time (f.e. in the case of repetitive transactions, 'straight rebuys'; Robinson *et al.*, 1967). In addition to purchasing, *procurement* encompasses storing, transportation, inspection of incoming goods, and quality control and assurance. *Buying* usually refers to those purchasing activities for which the specifications are already set.

The terms 'supply' and 'sourcing' refer to specific parts of the buying process. 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 appears to have a broader meaning to include receiving and storing deliveries. *Tactical purchasing* and *order function* refer to the first three and the last three steps of the purchasing process respectively. Ordering relates to the (operational) placing of orders against previously arranged conditions. Tactical purchasing comprises all activities that are necessary to arrange the supply conditions. Van Stekelenborg (1997: Ch 5) refers to tactical purchasing as 'initial' purchasing and distinguishes tasks like outsourcing, product design and demand planning.

This way of defining purchasing (or other related terms) places emphasis on the activities involved, rather than the people performing those activities; it perceives purchasing as a *function*. It is important to distinguish between the purchasing function and the purchasing department (cf. Axelsson and Laage-Hellman, 1991: 10). The purchasing manager co-ordinates the six basic activities mentioned in Figure 4.1, 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: 10). For example, top management might be involved in make-or-buy decisions (perhaps even excluding Purchasing), and Engineering is probably having contacts with suppliers regarding the design of new products. These activities are also part of the purchasing function. In other words, purchasing processes cut across the entire organisation. Even simple buying can take place without the intervention of the purchasing department.

In this study, we see purchasing in the first place as a *function*, and not as a department. The reason is that our analysis is primarily aimed at the level of *activities* related to managing supplier involvement in product development. Within the strategic view of purchasing, these activities are clearly part of the purchasing function, but that does not mean that they are the responsibility of the purchasing department. We have also made the choice to use the word *purchasing*. The first reason is that purchasing is the most widely used and most familiar term. The second reason is that it is sufficiently broad to capture all the relevant activities and decisions: buying, sourcing, and supply all have too narrow a focus for our research purposes, especially because they exclude the specification stage - a crucial phase in the context of product development. Of all purchasing activities, it is clear that the emphasis of this report will be on the initial purchasing activities. The remaining alternative, procurement, still has a connotation of the purchasing activities of public organisations, while this study exclusively deals with industrial firms.

After this examination of purchasing activities, we turn to the objectives or goals that have to be met in performing these activities: in other words, the 'roles' that have to be fulfilled.

4.2 The three roles of purchasing

The goals of purchasing have amongst others been discussed by distinguishing three different roles; a *rationalisation* role, a *structure* role, and a *development* role (Axelsson & Håkansson, 1984). The *rationalisation* role concerns purchasing's task to contribute to the firm's competitive strength by minimising total costs of production, logistics, prices of inputs, etc. More specifically this role comprises the following tasks (Axelsson and Laage-Hellman, 1991: 11-13):

1. Reduce *direct material costs* by, for example:
 - reducing prices by concentrating purchases to fewer suppliers; and
 - adapting the final product to reduce the supplier's production costs.
2. Reduce the *indirect material costs* by, for example:
 - reducing the need for incoming goods inspection; and
 - minimising operational costs of purchasing, f.e. by computerised order and invoice handling.
3. Reduce *internal production costs* by minimising, for example:
 - downtime/production-stops, by improving delivery performance; and
 - machining/assembling time, through adaptation of the supplier's product or the final product/production process.

Purchasing's network or *structure role* relates to handling the firm's supplier network, especially in terms of managing the degree of dependency of the firms on specific suppliers (cf. 'supply risk'; Kraljic, 1983). Purchasing can influence the structure of the supplier network, for example, by supporting newly established suppliers or existing but frail suppliers of goods important to the firm. 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:

- measures to increase, maintain or decrease the number of possible suppliers;
- measures to influence the standardisation of the product offerings of the firm's own suppliers, either to become more standardised or more unique; and
- activities to identify, screen and control changes regarding the development of the supplier structure.

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

- ensure that the technical competencies of suppliers are exploited in the firm's R&D processes, to ensure that the product development is adapted to externally accessible technology;
- generate suppliers' interest in developing products that the firm needs and wants;
- carry out development projects in co-operation with suppliers, together with other internal functions; and
- 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.

The three roles are complementary to each other, and partially overlapping. The rationalisation role focuses on matching the firm with suppliers in such a way that production and indirect costs are minimised, and the development role focuses on matching too, but now with the purpose of achieving synergetic effects in technological development. The structure role sets some conditions - restrictions - for the solutions that the other two roles may come up with. The rationalisation role can, for example, in the short run be favoured by a strategy that creates an unfavourable supplier structure in the long run. Considering costs, for example, it can be beneficial to concentrate all purchases of a particular item at one supplier. When doing so, the firm should be aware that it does not become too dependent on that supplier, otherwise purchasing has neglected its structure role.

Similarly, there are overlaps between the development role and the structure role. Developing a new component in close co-operation with one particular supplier, for example, could lead to a *de facto* monopoly situation for that supplier, which may be undesirable from the point of view of the structure role. Finally, there are potential overlaps or conflicts between the rationalisation and the development role too. For instance, an important element of the development role is that purchasing participates in the design-phase of new product development projects, but by choosing a design, construction methods, and, consequently, components and suppliers, the rationalisation role can also be affected in an important way. Suppliers that are excellent partners for technological co-operation, may be less suitable as a long-term source of supply, for example because of unfavourable cost structures. There are also issues where all three roles are overlapping. This can be seen when a firm starts to adjust the design of its final product, together with some of its suppliers, so that it can use some standard, 'catalogue' fixtures instead of customised ones, with the aim of saving costs and increasing the number of potential suppliers.

Evidently, the involvement of purchasing in the product development process does not only involve purchasing's development role, but also the rationalisation and the structure role. The weight of the different roles, and the extent to which there are potential conflicts between them, is dependent on the specific characteristics and motives of the development project or more long-term oriented effort at hand. If a development project is mainly aimed at adopting and implementing new technologies used by suppliers, then the emphasis is on the development role. In case a development project has as its prime target cost reduction, there is a combination of the rationalisation and the development role. When the focus is on standardisation, all three roles are present.

The concept of the three roles of purchasing is not explicitly used in the subsequent analysis and definition of purchasing involvement in product development. However, the notion that the involvement of purchasing in product development is not exclusively concerned with technical aspects, but also with commercial and structural aspects provides a useful background for a delineation of the issues this involvement has to focus on, which is the topic of the following section. That section also discusses why the three roles of purchasing are, in themselves, not sufficient as concepts for a deeper analysis and definition of purchasing involvement activities.

4.3 Defining purchasing involvement in product development

A first, global description of what purchasing involvement in product development is, can be deduced from the three general roles discussed in the previous section. This description would be:

'Contributing knowledge, taking part in managerial processes and participating in decisions with regard to product development, from a perspective of purchasing, i.e. striving towards optimal total product costs, well-balanced dependencies on suppliers, and an optimal technological match with suppliers'.

This description or definition acknowledges that the kind of activities within purchasing involvement may range from consultations to decisions: f.e. suggesting particular suppliers to development engineers vs. deciding the commercial terms on which the supplier should collaborate. Additionally, purchasing involvement encompasses 'taking part in managerial processes', which refers to tasks such as checking whether supplier development activities are still on schedule, etcetera. These various activities should be performed with due consideration of the general objectives of purchasing: optimal product costs, optimal supplier dependencies and optimal supplier technological match.

However, it is difficult to use this definition in identifying the more specific activities that constitute purchasing involvement in product development, which is the main research objective of this study (see section 1.2.1). In the first place, it is so broad that it provides too little focus for the identification of more concrete purchasing involvement activities based on the empirical studies reported in Chapter 5. In the second place, it may be rather difficult to use the three objectives (optimal product costs, supplier dependence and technological match) as selection criteria for distinguishing between activities that belong to purchasing involvement in product development and those who do not. The effects of the activities on the objectives are hard to measure, since regular purchasing activities that are not connected with product development affect those objectives too and isolating the different effects may not be possible. Moreover, the definition of 'optimal' is very company specific. Using the definition for identifying more specific activities in the case studies thus requires knowledge of each individual company's optimal product costs, supplier dependence and technical match.

Similar problems exist concerning the more specific objectives of supplier involvement in product development that section 3.3 has discussed: reducing product costs, development time and costs, improving product value and (long-term) access to supplier knowledge. In 3.5.3, it has been argued that the effects of supplier involvement can hardly be measured accurately, given that nearly each development project is unique. Additionally, each project may have different targets meaning that in one project development time is important and in another product cost. The effects of supplier involvement need to be evaluated in the context of the project's particular targets. In other words, the specific objectives of supplier involvement - which can be considered as the backbone of purchasing involvement - do not provide a practical means for distinguishing the more specific activities that constitute purchasing involvement in product development.

Another way of providing more focus regarding the essence or contents of purchasing involvement in product development, necessary to guide the identification of the concrete activities it encompasses, would be by defining the common characteristics of those activities. In other words; identifying what *kind* of activities does purchasing involvement consist of. One way of describing these common characteristics would be by means of the key processes that underlie this involvement. These key processes run through all purchasing activities in product development like a continuous thread. In Chapter 2, three processes have been identified as the key elements in product development: knowledge development, resource mobilisation and resource co-ordination. These processes provide a foundation for the key processes in managing the involvement of external suppliers. The question is how these general processes of inter-organisational product development translate into key processes specific for purchasing involvement.

4.3.1 Key processes underlying purchasing involvement in product development

Existing literature provides some definitions of the key processes underlying purchasing involvement, or rather supplier involvement, in product development. Bonaccorsi (1992: 35-37) talks about incentive, search and co-ordination as being the three key processes in structuring and managing supplier involvement in product development. In order to involve suppliers in product development, the manufacturer has to *create incentives* for two interdependent areas: the involvement in current development activities and the long-term alignment of technology strategies. To carry out development activities, suppliers have to invest in (at least partly) dedicated assets, which are at risk since development always carries some uncertainty. This incentive problem is closely related to the process of resource mobilisation.

By *search*, Bonaccorsi refers to the exploration, experimentation and testing of alternative technical solutions (1992: 36). In this context, Axelsson (1987: 156) stresses that a manufacturer should not only focus on the relationship with a certain supplier and the current relation with him, but at the same time survey the whole supplier network. Choosing collaboration partners, for example, should not be a static, one-off event but a process continuously fed by market research and other information. Too little attention to developments outside the relationships with current suppliers may entail the risk of getting 'locked-in' into obsolete technologies. This objective of keeping options open (c.f. the risk of technical lock-in; section 3.5.1) is at odds with the goal of incentive, which often requires dedication to a specific option, i.e. supplier. *Co-ordination*, finally, involves the synchronisation and mutual adjustment of development activities both in the short run, within a specific project, and in the long run in terms of research and development investments.

Håkansson and Eriksson (1993) use similar terms to describe the general processes of managing supplier involvement in product development. Based on large-scale empirical studies (Håkansson, 1989), and two additional case studies, they present four key issues in dealing with technological co-operation with suppliers, or, as the title of their article suggests, in 'getting innovations out of suppliers'. These are *prioritising*, *mobilising*, *co-ordinating*, and *timing*¹. *Prioritising* concerns the choices the manufacturer has to make how and where to invest his resources. This involves not only the choice of actual collaboration partners, but also the choice for a specific form and intensity of supplier involvement (Håkansson, 1989: 29). Companies have limited resources to handle supplier involvement, which means that companies have to set priorities regarding the technical areas or specific suppliers they want to work with. This aspect has been discussed in section 3.4, investigating the different forms of involvement. Without prioritising, supplier involvement may cost more time and effort than it saves.

Mobilising involves the mobilisation or motivation of suppliers to start working on a particular development. The mobilisation may involve suppliers themselves and their resources, or their other relationships ('networking'). This mobilisation involves what Bonaccorsi (1992) describes as creating incentives. Without mobilisation, suppliers may not be interested and willing to make the necessary commitments and efforts. *Co-ordinating* involves the adjustment and adaptation of development activities and resources between suppliers and the manufacturer. Without co-ordination, joint development will result in ill-fitting components, double work, incompatible technical solutions, etcetera. This need for co-ordination grows with increasing specialisation and the fragmentation of development activities. *Timing* is a special kind of co-ordination, which involves the co-ordination and adaptation of development activities and resources in time. Without timing, product development will suffer from unexpected bottle-necks, unnecessary delays, and missed deadlines.

These four processes - prioritising, mobilising, co-ordinating and timing - form the basis for our analysis of purchasing involvement in product development. They may serve as criteria for deciding which activities to add value to product development: if an activity does not contribute to or embody at least one of these key processes, it does not add any value. All purchasing activities in product development need to add value, i.e. make a useful contribution to the process or the result of product development. Table 4.1 lists some examples of activities that embody or constitute these different key processes.

¹ Actually, the authors use the words prioritising, mobilising, *synchronising* and *timing* respectively. We have chosen to replace synchronising with co-ordinating because of the potential confusion between synchronising and timing.

Table 4.1: Examples of the four key processes

key process	example
prioritising	<ul style="list-style-type: none"> selecting a supplier for the development of a specific component deciding how many resources (travelling expenses, hours) can be invested in managing the technological collaboration with a specific supplier
mobilising	<ul style="list-style-type: none"> promising a supplier a long-term production contract in exchange for its collaboration in the development of the component letting a supplier use the knowledge developed in the collaboration also for third party customers (after a period)
co-ordinating	<ul style="list-style-type: none"> having a packaging equipment and packaging material supplier adapt their respective new products to each other sharing development workloads between different suppliers according to their respective specialisations
timing	<ul style="list-style-type: none"> making sure that the internal R&D department delivers the basic technical requirements in time to the supplier so that the project deadline can be made introducing/developing a new final product just after a supplier of critical components has (autonomously) renewed its product

These four processes are, in our opinion, more detailed than the three objectives of incentive, search and co-ordination forwarded by Bonaccorsi (1992); only the objective of search is not covered. In essence, however, the process of search is not directly related to the actual management of supplier involvement. Search refers to the exploration, experimentation and testing of alternative technical solutions, and is primarily oriented towards investigating and maintaining different technical options. In our opinion, the experimentation and testing of alternative technical solutions is not a key task within the functional domain of purchasing. It is a task that lies much more in the domain of the design or development function. Therefore, we choose not to define this as an underlying process for purchasing involvement.

Apart from a definition or delineation of purchasing involvement in terms of underlying key processes, it may be helpful to distinguish the broad areas within product development processes that this involvement can be directed at. One of the shortcomings of the main body of existing research, as indicated in section 1.1.2, is its almost exclusive focus on activities in the context of (directed at) individual development projects. The following sub-section sets out to discuss other possible areas that purchasing involvement may be focused at, areas which have a more permanent, long-term character than development projects.

4.3.2 Areas of purchasing involvement in product development

We claim that three different areas or objects can be distinguished within purchasing's involvement in product development: (1) Projects; (2) Suppliers; and (3) Technologies. The three are closely related to each other, as they partly represent different levels of abstraction. Certain suppliers may be the primary source of a particular technology for the manufacturer. Likewise, individual development projects involve collaboration with specific suppliers. Nevertheless, the distinction between these different areas explicitly acknowledges that the activities regarding purchasing involvement in product development may take place within or be focused at *primarily* one of three objects or areas: either a project (a specific set of development activities in a specific period in time), a supplier (a permanent relation with the supplier, independent of any specific development projects) or a technology (a combination of knowledge and physical objects in a specific technical discipline, f.e. ceramics).

Each of the three areas has a different time-horizon, and each of them involves different kinds of activities and processes. This claim should be more fully sustained by the case-studies in the subsequent chapters. At this point, we will support our claim by arguing that each of the three areas is also emphasised by a different school or tradition of research. By combining the notions from these different schools one gets a broader and more complete understanding of purchasing's involvement in product development. The relations between the three different strands of research and the area of purchasing involvement is illustrated in Table 4.2.

Most of the research on purchasing's role in product development has focused on the area of 'Projects'. It is in this area that issues arise concerning the way product development is internally carried out and how this can be integrated with the development activities by suppliers. This implies a focus on the processes of co-ordinating and timing. The area includes activities like preparing, planning and co-ordination of product development activities of suppliers during a specific development project. These tasks have, per definition, a limited time-frame. 'Projects' is an area which is highlighted by research that has largely been published over the last decade, which is dominated by the perspective of the purchasing department, and predominantly Anglo-Saxon in origin (f.e. Burt and Soukup, 1985; Clark, 1989; Williams and Smith, 1990; Dowlatshahi, 1992; O'Neal, 1993; Birou, 1994; Hartley, 1994; Kamath and Liker, 1994; Mendez and Pearson, 1994; Peter, 1996; Ragatz *et al.*, 1997).

Table 4.2: Research strands and areas of purchasing involvement

area of purchasing involvement / authors	emphasis
Projects <ul style="list-style-type: none"> • Burt and Soukup, 1985 • Clark, 1989 • Dowlatshahi, 1992 • Birou, 1994 • Hartley, 1994 • Kamath and Liker, 1994 • Ragatz <i>et al.</i>, 1997 	<ul style="list-style-type: none"> • tasks of purchasing departments in new product development projects • effects of supplier involvement on the scope and performance of new automobile projects • purchasing tasks within development projects, differences between development and purchasing functions • influence of supplier involvement on project performance (cost, quality, product performance, development time) • quantification of benefits of supplier involvement and the identification of effective management techniques at the level of individual projects • different roles suppliers may have in development projects in terms of moment and intensity of involvement • most and least successful cases of supplier involvement with regard to project outcomes, managerial instruments used at project level
Suppliers <ul style="list-style-type: none"> • Bergman and Johanson, 1978 • Axelsson, 1987 • Bonaccorsi, 1992 • Håkansson and Eriksson, 1993 	<ul style="list-style-type: none"> • manufacturer-supplier interaction in product development • long-term access to supplier knowledge, joint development of new capabilities • structuring and managing supplier involvement in the long run • underlying managerial processes involved in getting product innovations out of suppliers
Technologies <ul style="list-style-type: none"> • Prahalad and Hamel, 1990 • Wheelwright and Clark, 1992 • Ford and Farmer, 1986 • Quinn and Hilmer, 1994 	<ul style="list-style-type: none"> • core competencies, resource allocation and outsourcing • technology planning and strategy, external acquisition of technological capabilities (long term) • contribution of materials function to make-or-buy decisions • core competencies and range of outsourcing options

The area of 'Suppliers' involves the permanent and long-term tasks of maintaining relations with suppliers in such a way that they contribute in an optimal way to the technological position and product development capabilities of the firm. This encompasses activities such as the maintenance of a preferred supplier base. The tasks associated with building and maintaining such relations with suppliers have to be carried out not only during development projects but also, and perhaps especially, *in between* projects. The area of 'Suppliers' has received most emphasis from research dominated by the IMP Group (section 2.3.2), who have traditionally focused at the more long-term interaction between customers and suppliers. This school of research is more (Continental) European in its origins, and is not dominated by a purchasing perspective but approaches the issue from different functional perspectives such as purchasing, marketing and product development (e.g. Bergman and Johanson, 1978; Axelsson, 1987; Axelsson and Håkansson, 1990; Bonaccorsi, 1992, Håkansson and Eriksson, 1993).

The area of 'Technologies' regards the division of work between the manufacturer and its suppliers regarding the development and improvement of specific technological knowledge and competencies. This involves what are often called 'Develop-or-Buy' discussions or decisions. Such a 'Develop-or-Buy' decision is actually more fundamental than the make-or-buy decision for production activities (or supporting services like cleaning and catering), since a decision to 'buy' a certain technology implies that the production activities using that technology have to be outsourced. When a manufacturer decides to maintain technological know-how in a certain area, it can still decide to outsource the production activities that use that know-how, if appropriate in a particular situation. In other words, the implications of a 'Develop-or-Buy' decision are longer-lasting. These decisions and problems are usually of such a critical importance to the firm, that besides purchasing and development, general management will be a key player. The purchasing function can contribute to Develop-or-Buy discussions mainly by identifying the availability of technologies in the supplier market. This area of 'Technologies' can be recognised as the third area of purchasing involvement in product development in research both in the area of strategic management and product development (e.g. Prahalad and Hamel, 1990; Wheelwright and Clark, 1992: 36) as well as in the area of strategic purchasing management or outsourcing (e.g. Ford and Farmer, 1986; Quinn and Hilmer, 1994).

Considering these three areas of purchasing involvement in product development, it is clear that they are closely related, and partially overlap (see Figure 4.2). For example, while in the area of Technologies, the division of technological responsibilities between the suppliers and the manufacturer is the central issue, this division is more or less taken as given in considering the two other areas. However, as Bonaccorsi (1992) points out, the areas are interrelated: the kind of technological specialisation, for example, is affected by the development of individual supplier relationships. Similarly, Projects is closely related to Suppliers since development projects can be seen as 'episodes' in the relationship.

This identification of three different main areas or objects within purchasing involvement in product development provides a conception of this involvement being not limited to contributing to the efficiency and effectiveness of single development projects. Additionally, we argue that the areas are closely connected and to a great extent focused on identical objectives: the key processes of prioritising, mobilising, co-ordinating and timing. These processes form a common basis for all of these three areas, in providing the general 'objectives' that the specific activities in each area should contribute to. However, just like supplier involvement, involving purchasing in product development is not without risks and problems.

Figure 4.2: The three areas of purchasing's involvement in product development

4.4 Risks

The most important risk of involving the purchasing function in product development is the potential conflict with the technical or development function of the firm. Discussing the relation between the purchasing and the development function, Van Weele (1994) argues that purchasing's task is to counterbalance as much as possible the technically oriented company functions such as R&D and product development. The buyer must regard specifications as a variable factor, and be able to challenge their content within his own organisation. Underlying this tense relation is a fundamental difference in orientation of the two functions. Dowlatshahi (1992) presents an interesting overview of these differences, as listed in Table 4.3.

Table 4.3 Purchasing and Development orientations

Purchasing orientation	Development orientation
1. Minimum acceptable margins of quality, safety and performance	1. Wider margins of quality, safety and performance
2. Use of adequate materials	2. Use of ideal materials
3. Lowest ultimate cost	3. Limited concern for cost
4. High regard for availability	4. Limited regard for availability
5. Practical and economical parameters, specifications, features and tolerances	5. Close or near perfect parameters, specifications, features and tolerances
6. General view of product quality	6. Conceptual abstraction of product quality
7. Cost estimation of materials	7. Selection of materials
8. Concern for JIT delivery and supplier relationship	8. Concern for overall product design

Source: Dowlatshahi (1992: 23)

It is clear that these differences in orientation may cause tensions or perhaps even conflicts in product development processes. Muschinski (1997) analyses the origins of this usually problematic relationship between the technical function and the purchasing function of the firm in product development. He argues that the tensions between the two became apparent in many companies when in the end of the 1960's, purchasing was disconnected from the production function and brought under the responsibility of the commercial functions of the firm. After that, the well-known division of work crystallised: purchasing should ensure the commercially advantageous supply of goods, while the engineers should be looking for technically optimal solutions. In the 1970's and 1980's, there was a growing realisation that purchasing does not only involve buying; a focus on price was replaced with a closer orientation on total costs. This also implied an active involvement in product development, since in that process a large share of total costs is determined. In that way, purchasing moved back into the originally exclusive realm of the technical function. Tensions between the two functions in product development processes have thus been 'pre-programmed'.

These tensions between the technical or development function and the purchasing function of the firm are natural and to some extent even positive. Both functions have their own tasks and responsibilities, and critical views of each other may provide the necessary balance and work in the company's best interests. However, the tensions may also reach a point where they are not productive any longer; some form of co-ordination and collaboration between the two functions is necessary. Bonaccorsi (1997) demonstrates that in order to exploit the benefits from early involvement of suppliers in product development, firms need to design and implement a truly integrated internal organisation. The benefits are dependent on the coherence of the internal integration of the purchasing and development function with the extent (moment) of supplier involvement. Later in this study, and especially in connection with the case studies in Chapter 7, we return to this important issue in more detail.

4.5 Summary and conclusions

After the two previous chapters that considered the product development process and the involvement of suppliers in that process, this chapter has investigated the involvement of purchasing in product development. After analysing purchasing in terms of the various definitions of its contents and tasks, we have described three fundamental roles of purchasing: rationalisation, structuring and development. The combination of these roles provides the background for purchasing's involvement in product development. In section 4.4, we have identified four key processes underlying the purchasing activities related to product development: prioritising, mobilising, co-ordinating and timing. Additionally, three different areas or objects for purchasing's involvement in product development are distinguished: Projects, Suppliers and Technologies. The four key processes cut across these three areas, and together they provide the conceptual basis for developing an integrated framework of purchasing activities with regard to product development. Finally, we have briefly reviewed some of the risks in achieving purchasing involvement in product development.

This concludes the Analysis part of the study, in which subsequently the product development process, the involvement of suppliers in that process, and the possible contribution or involvement of the purchasing function have been investigated. This has culminated in distinguishing two dimensions concerning purchasing involvement in product development: underlying processes and areas/objects. These two dimensions will be used in distinguishing specific activities constituting purchasing involvement. The identification of an integrated framework of such activities is the topic of the Design part of the thesis, which starts with the following chapter.

Design

Chapter 5

Nine Manufacturer-Supplier Relations

This chapter presents the empirical material forming the second phase of the research: case studies of product development collaboration in nine manufacturer-supplier relations across five different industries. The objectives of these case studies are: 1) to find out to what extent purchasing involvement activities can be adequately described and analysed in terms of the underlying key processes (prioritising, mobilising, co-ordinating and timing); 2) to identify possible differences between industries in terms of the occurrence and importance of the key processes and the main areas regarding purchasing involvement in product development (Technologies, Suppliers and Projects); and 3) to identify specific activities that can be seen to contribute to the key processes according to the different areas or objects.

The first section of this chapter describes the methodology and the criteria for selecting the industries and specific companies, and the case companies are briefly introduced. The second section draws a first broad comparison between the various relationships. In the sections 5.3 through 5.7, the case studies are presented according to the five different industries. After a brief introduction to the industry, each relationship is described from the perspective of both the manufacturer and the supplier. At the end of section, the relations are analysed in terms of the key processes in purchasing involvement in product development, as defined in Chapter 4: prioritising (choosing the areas and partners), mobilising (motivating the partners), co-ordinating (matching the joint efforts of all involved), and timing (planning and co-ordinating the efforts in a time perspective). The relations are also analysed in terms of the three areas distinguished before: Technologies, Suppliers and Projects. Section 5.9 concludes the chapter by reviewing the outcomes of the case studies in terms of the three objectives mentioned earlier.

5.1 Methodology and selection criteria

5.1.1 Methodology

The second phase in the research underlying the current study has consisted of interviews with pairs of manufacturers and suppliers in five selected industries, both in the Netherlands and Sweden. This phase has been designed to investigate manufacturer-supplier relations, and especially the technological collaboration taking place regarding the development of new products, across different industries. Within every industry and each country, two companies have been interviewed: a manufacturer and one of the suppliers it is collaborating with in product development. By interviewing both parties, we are able to analyse the role of the supplier and purchasing from both perspectives. This has been done deliberately, since one of the flaws in existing research, as mentioned in section 1.1.2 already, is the almost exclusive focus on the manufacturer's perspective on these issues (see also Hartley, 1994: 172).

The primary focus of the interviews has been on the relation and collaboration with the counterpart, but a number of additional business relationships have been investigated. In the case of a supplier, relations with four additional manufacturers have been considered and in the case of a manufacturer, relations with four additional suppliers have been reviewed. This resulted in information that can be used for placing the 'focal relationship' into its context, both for the manufacturer and the supplier. However, for lack of space these other relations are not explicitly described in this chapter but reserved for Appendix D.

The standardised interviewguide for the interviews is the same as the one used by a group of Scandinavian researchers to investigate ongoing business relations of industrial firms in general, as reported earlier (see section 3.1.1). The value of using this standard questionnaire for the current study, compared to a more focused questionnaire targeted on the specific research questions of the current study, is two-fold. First, it allows us to make use of this Scandinavian database, which provides useful insights into some of the general characteristics of manufacturer-supplier collaboration in product development. The second advantage is that it provides a useful method of investigating and describing the general situation and business environment of the company by means of a general section (the questionnaire is listed in Appendix A). This ensures a basic degree of comparability of the background material for the different cases. Issues of interest to our research, but not dealt with in the interviewguide, have been discussed in a semi-structured way alongside the interview guide.

The interviewees mainly included marketing or sales managers from the supplier side, and purchasing directors/managers from the manufacturer's side. In some cases, (additional) interviews have been conducted with general managers, R&D managers or senior purchasers responsible for individual suppliers. Interviews, roughly 40 in total, have typically lasted 2-3 hours. All interviewees have received feedback in the form of interview-reports and have given their approval for the case studies as finally presented in this chapter. Appendix C lists the interviews that have been held, while Appendix D contains descriptive data for the total group of manufacturers and suppliers and their supplier and customer relations, and background descriptions of each focal manufacturer and supplier, including information about the additional (mostly four) supplier or customer relationships.

5.1.2 Selection criteria

The five industries studied have been selected to reflect a variety in the type of production being employed by the manufacturer. The selection includes two manufacturers with large-series production, two with process production (to some extent combined with large-series production), and one unit production industry. In the first place, the choice to include manufacturers with different types of production has been made because of the almost exclusive focus on large-series manufacturers in hitherto available research in this area (see section 1.1.2). Hartley (1994: 19) even maintains that only in assembly process (i.e. large-series) industries supplier involvement in product development offers the opportunity for achieving a competitive advantage. Investigating different industries may provide some insight into the nature of supplier and purchasing involvement in product development in other industries. This is especially important since the research objective of the current study is to develop an integrated set of activities related to purchasing involvement in product development which is potentially applicable to a wide variety of industries and manufacturers. In the second place, research has shown that firms with different production types have different purchasing strategies and different characteristic problems (Håkansson *ed.*, 1982: Ch 4). These differences may also result in differences with regard to purchasing involvement in product development.

Therefore, a deliberate decision has been taken to select not only industries or production chains that have been studied intensively in the area of 'modern purchasing', and more specifically, supplier involvement in product development. One could say that the selection only includes two sectors that are more well-known in this respect, being the truck and telecommunications industry; both examples of large-series production industries. The reasons why these two have been selected are that they are considered to be technology-intensive (especially the telecommunications industry), and to have a purchasing function that is rather well developed¹.

¹ At least if we look at 'automotive' and 'micro electronics' in general, see Keough (1993).

Hence, we expect to find well-organised purchasing involvement in product development in these two industries, which then can be compared to examples from other industries. As examples of process production, we have taken manufacturers of plastic components and food & beverages producers. The latter actually employ a combination of process and large-series production. Finally, as an example of unit production, we have chosen the construction of power plants (diesel engines vs. steam and gas turbines)².

The choice to carry out case studies of both Dutch and Swedish companies, as discussed in Chapter 1, has been made not so much as to enable comparisons between the two countries, but rather to broaden our empirical basis and enable intra-industry comparisons. Within one country, it can be quite difficult to find more than one suitable company in the industries we selected, especially as manufacturer. A good comparison of the two countries has become even more difficult as we unintentionally ended up studying not only Dutch and Swedish companies.

Of the intended 20 interviews, 18 have been completed: efforts to interview a Dutch manufacturer-supplier pair in the plastic components business proved, in the end, unsuccessful. The case studies thus include relatively many Swedish companies, also because it was not possible/appropriate to interview a Dutch customer in the telecommunication industry. Of the 18 companies interviewed, 10 are located in Sweden (6 manufacturers and 4 suppliers), 6 in the Netherlands (3 manufacturers and 3 suppliers) and one each in Germany (D) and the UK (both suppliers). Interviewed companies are referred to as 'focal' companies. The type of focal companies are listed in Table 5.1 per production chain.

Table 5.1 Overview focal companies

production chain	manufacturer	supplier
trucks	truck producer S	oil cooler supplier S
	truck producer NL	injection system supplier D
telecommunication	mobile telecom system producer S	electronics supplier S
hardware	printed circuit board producer S	printed circuit board supplier NL
plastic components	plastic components producer S	chemicals supplier UK
	-	-
food & beverages	beer & beverage producer S	corrugated board supplier S
	dairy producer NL	tinplate cans supplier NL
power plants	turbine/power plant producer S	electrical installation supplier S
	diesel power plant producer NL	electrical installation supplier NL

In the truck industry, both focal manufacturers are truck producers and the focal suppliers produce components for the truck engine. The truck industry is especially 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 production volumes, quality criteria and the variety of parts. In the telecommunications industry, the focal manufacturers are a producer of (mobile) telecommunication systems and a printed circuit board assembly firm, coincidentally both from the same group. The focal suppliers are a producer of electronical components and a producer of printed circuit boards.

² Originally, a sixth, unit-production industry had been included: road construction. Road construction had been selected because explorative interviews showed that in utility and housing construction, collaboration with suppliers especially takes place within the field of logistics and materials handling (Wouters and Wijnstra, 1997). In the second place, studying road construction provided the opportunity to investigate the special characteristics of a government authority as being a partner in technological collaboration with suppliers. For various reasons, however, it turned out to be quite difficult to use the standard questionnaire in the interviews we had in this sector, and because of the restricted data, the analysis of the road construction industry would have been rather limited. Therefore, this sector has been excluded from the current study.

In the plastic components industry, the only focal manufacturer we studied produces components for the automotive sector and the supplier delivers a chemical compound. The focal manufacturers in the food and beverages industry are a producer of beer & beverages and a dairy producer. The suppliers are producers of packaging material; in the food industry, most product development takes place in packaging, driven to a great extent by environmental pressures. Finally, the focal manufacturers in the electrical power plant industry are producers of diesel-engine powered plants and gas turbine powered plants. Both focal suppliers deliver electrical modules and installation services. The power plant manufacturers build turbines and generators in unit production, but increasingly according to standard models. These standardisation efforts also involve technological collaboration with suppliers.

All descriptions (including company names etc.) pertain to the moment of (or period prior to) interviewing, which has been between Summer 1995 and Summer 1996. Most company figures regard either 1994 or 1995. Since turnover and other quantitative data are not of paramount importance in describing and comparing the different cases, the difference in years of 'observation' is unproblematic and not indicated further in the text.

5.2 Focal relationships

The case studies in this chapter concern 9 manufacturer-supplier relationships. However, only eight of them are 'complete' in the sense that we have interviewed both the manufacturer and the supplier. In the case of the relation between the Dutch printed circuit board supplier and the Swedish telecommunication equipment manufacturer, the situation was rather complicated resulting in an incomplete description of the relation. In section 5.5, this is discussed in more detail in order to explain why the relationship still provides an interesting case study. It means however, that only eight relationships are useful to compare on a number of key attributes, as summarised in Table 5.2. These are largely the same variables for which the supplier relationships from the Scandinavian database have been analysed (section 3.1.1).

Of the table, the first 6 rows regard descriptive variables such as type of product, the relative position and size of both parties in the relation. The 8 manufacturer-supplier relations mainly involve component suppliers that are either a single or dominating source, for which the manufacturer is most often one of several large customers. In four of the cases, the supplier is in terms of volume so important for the manufacturer that it accounts for more than 5 % of total purchasing volume. In half of the cases the supplier company is clearly smaller than the manufacturer, while in two cases the supplier is definitely bigger. Most relations are older than 15 years, but three are maximally 5 years old.

The following 8 rows regard the attributes identified before (3.1.1):

- intensity (the total number of people involved; the number of projects going on; the labour invested by both parties);
- balance (the initiator of the collaboration; the influence of both parties on the specifications of the product; the most active party in the collaboration); and
- formalisation (the existence and form of contracts; the existence of cost sharing arrangements).

In terms of *intensity*, most collaborations can be characterised as continuous, but seem to vary strongly in intensity with the total number of people involved from both sides ranging from 8 to 65, and the number of months invested annually by the two parties together ranging from a few to more than hundred. The relations in the large-series industries seem to be most intensive.

Regarding *balance*, the manufacturer seems to be the most likely initiator of the collaboration, while during the collaboration there is not clearly a single most active party. Roughly half of the relations are *non-formalised*, and in the others mainly project specific agreements are concluded. Cost sharing only takes place (to a limited extent) in the three relations in the large-series assembly process industries.

Even more interesting than a comparison between the different relations is to look at the different perceptions that the manufacturer and the supplier have of their collaboration. Only some general aspects are briefly discussed here; more specific analyses are presented in the respective sections for each individual relation, if appropriate.

Within each manufacturer-supplier pair, with only one exception, the manufacturer and the supplier have the same perception of the supplier's position. The manufacturer's position, however, is consistently perceived as more important by the supplier than the manufacturer himself indicates. For example, the manufacturer thinks it is one of several large customers, the supplier defines the manufacturer as a dominant or even single customer. This difference in perceptions arises mainly because the supplier has a more strict definition of 'product' and easily identifies a manufacturer as a single customer when the product is (slightly) customised. The problem is that this difference in perception may have an important influence on the collaboration process in terms of prioritising and mobilising. If for the supplier, the manufacturer is not comparable to other customers and the potential results of the collaboration such as, for example, an improved version of a component, cannot be used in other customer relationships because other customers demand completely different products, the supplier may have less incentives to collaborate with the manufacturer. If the manufacturer does not realise this 'exceptional' position, it may fail to put enough efforts into compensating or motivating the supplier directly, for example, by providing financial incentives.

Also with regard to the intensity of the collaboration, the perceptions differ markedly. In six cases, the supplier sees more people being involved in the relationship as the manufacturer. This is due to the fact that both parties, especially the supplier, see more people being involved from the counterpart than the counterpart sees itself. Apparently, the people from the manufacturer see their company's 'interface' with the supplier as more 'narrow' than the supplier sees it. This could be due to the fact that we have primarily been interviewing purchasing managers, who may not always identify the engineers involved from their company as key persons in the relation. Supplier representatives also tend to include more operational personnel than the manufacturer does.

Additionally, in six cases parties do not completely agree on the form of collaboration. In most of those cases, suppliers tend to see it more as a project-like collaboration while the manufacturer thinks of it more as a continuous process. This could be related to the relative time-perspectives that both parties have: suppliers would then have a shorter time-horizon than manufacturers. With respect to the balance in the relation, the supplier sees itself as being more active (also as initiator) than the manufacturer does, or at least equally as active. Only the Swedish truck and plastic component producers and the Dutch dairy producer see their suppliers as having a more important role than they see themselves.

Finally, suppliers constantly rate the collaboration as less formalised than the manufacturer: not only regarding general contracts (intellectual property rights, non-disclosure agreements) but also regarding cost-sharing arrangements. The purchasers interviewed at the manufacturer may have more consideration for (or knowledge of) the existence of such formal agreements than the marketing or general managers interviewed at the supplier.

Table 5.2: Attributes of the 8 collaborative manufacturer-supplier relationships

case attribute	truck producer S - oil cooler supplier S	truck producer NL - injection system supplier D	mobile telecom system producer S - electronics supplier S	plastic components producer S - chemicals supplier UK	beer & beverage producer S - corrugated board supplier S	dairy producer NL - tinplate cans supplier NL	turbine/power plant producer S - electrical installation supplier S	diesel power plant producer NL - electrical installation supplier NL
product position supplier*	component dominating (single)	component single	component dominating	semi-manufacture single	component one of several ones	component dominating	assembly / service dominating	assembly / service one of several ones
position master* (customer)	one of several large ones (single)	one of the smaller ones (single)	one of several large ones (dominating)	one of several large ones (dominating)	one of several large ones (single)	one of several large ones (single)	dominating among few ones (single)	one of several large ones (single)
share in total purch. volume	1%	3%	6%	1%	< 1%	13%	5%	6%
relative size supplier vs. manufact.*	1%	134%	8%	810%	6%	20%	38%	48%
origin relationship	1945	1963	1960	1961	1963	1940	1980	1974
nr people involved*	10 (17)	38 (25)	8 (65)	11 (19)	14 (25)	24 (27)	15 (13)	8 (12)
extent of collaboration	continuously and big (cont., not big)	one major project (cont. and big)	continuously, not big	continuously, not big	continuously, not big (one major project)	continuously and big (one major project)	continuously and big (one major project)	one minor project (one major project)
months annually invested **	6 (9)	36 (37)	1 (120)	1 (-)	- (-)	1 (-)	1 (-)	1 (4)
collaboration initiator *	manufacturer (both)	manufacturer	both	manufacturer (both)	both (supplier)	supplier (both)	manufacturer (both)	manufacturer
manufacturer involvement in techn. development of product*	very active /dominating (some involvement)	some involvement	none (very active /dominating)	some involvement	some involvement (very active /dominating)	very active (very active /dominating)	very active /dominating (some involvement)	very active /dominating
most active*	both (manufacturer)	manufacturer	supplier	supplier (both)	both (supplier)	both	manufacturer (supplier)	manufacturer (both)
degree of formalisation*	project specific agreements (none)	project specific agreements	none	long-term formal agreement... (none)	none	project specific agreements (none)	none	none
cost sharing	some sharing (each his own)	some sharing	some sharing (each his own)	each his own	each his own	each his own	each his own	each his own

All figures based on manufacturer's information, except *: answers for both parties are given if different, supplier answer (in italics) **: figures correspond to investments by manufacturer and supplier (in italics) respectively. ***: measured by turnover. -: no answer available.

With regard to the differences between the five industries, the following observations can be made:

- in the large-series industry cases within our sample, the collaboration is relatively intensive and formalised, and by both parties seen as a continuous process;
- in the unit-production industry cases within our sample, the collaboration is mainly dominated by the manufacturer, and little formalised;
- in the process industry cases within our sample, the collaboration is relatively little dominated by the manufacturer: the supplier is relative to the other cases more active.

These differences between the three kinds of industries are discussed more deeply in section 5.8.

What becomes especially clear from this first comparison of the focal relationships is that supplier and manufacturer often have a different perception or interpretation of what the characteristics of the collaboration are in terms of intensity, balance and formality. This may affect their behaviour in the relationship, and the possibilities for and outcomes of the key processes of prioritising, mobilising, co-ordinating and timing. This is one of the aspects that will be considered in the subsequent analyses of the individual focal relationships.

5.3 Relations between truck manufacturers and component suppliers

The case studies in the truck industry involve the relation between the Swedish truck manufacturer Scania and its engine cooler supplier, Valeo, and the relation between the Dutch truck manufacturer DAF Trucks and its injection system supplier, Bosch. The truck industry faces an entirely different market than the passenger car industry. It deals with industrial (business-to-business) customers, which place totally different demands on their vehicles than individual consumers do. Reliability, durability and operating costs are key issues in the truck market, versus comfort, styling and price in the passenger car market. An additional difference with the auto industry is that the manufacturers in the truck industry are usually much smaller in terms of sales volume. This means that their position vis-à-vis suppliers that operate in both industries is relatively weak. DAF Trucks, for example, has relatively little bargaining power in terms of volume when dealing with major international suppliers. The situation is slightly different for Scania, which is much larger than DAF Trucks, but in general, truck assemblers are less powerful than auto manufacturers. In the area of technological co-operation, this could mean that the customers are less dominating than usually is the case in the car industry.

Both Scania and DAF Trucks are focused at the market for heavy trucks (Gross Vehicle Weight of 16 tonnes or more). 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 place³. Another way is by standardisation by means of standard modules, something especially Scania has always been known for.

Technological development in the industry is currently driven to a large extent by environmental demands from national and supra-national authorities like the EU, and efficiency demands from customers, of which transport companies and fleet owners are the most important. Fuel economy, emission and noise levels are important parameters. Both Scania and DAF Trucks seem to be giving more and more attention to the collaboration with suppliers in product development (see Ahlberg, 1995; Ode, 1995; Van Dongen, 1995; Adriaans, 1996; Jacobs, 1996).

³ In 1997, DAF Trucks has been taken over by the American truck manufacturing group Paccar, one of the aims being cost reductions through economies of scale, among others involving combined purchases.

5.3.1 Focal relations

Scania and Valeo Engine Cooling

The manufacturer's perspective

Scania has been buying oil coolers from Valeo Engine Cooling (or its predecessors) since around 1945. In terms of volume, this specific Valeo company⁴ is just a small supplier to Scania, yet a important source for this specific product. The package includes six different types of normal oil coolers and a (more expensive) brake retarder cooler. Basically, an oil cooler consists of a system of channels, put in a case or box of iron or aluminium. To achieve a certain cooling capacity, there are two main variables: the length of the cooler and thus the channels, and the amount of channels. All products are fully customised: the amount of channels, length, required temperature performance, the place of the fittings, shape and size of the outer casing, etc. These specifications are mainly dependent on the engine specifications, and therefore largely determined by Scania. If an oil-cooler does not function, the whole engine does not work. It is, however, not considered by the customers as a strategic part, as it usually can not give the truck a competitive edge over the competitor's product: it is not a 'differentiator'.

Still, Valeo and Scania have been co-operating closely both in product and process development. This has involved different types of normal oil coolers, and the development of the brake retarder cooler, which is a special Scania product. The retarder cooler was developed in co-operation with Valeo, because it closely resembles normal oil coolers that Scania was already buying from Valeo. The brake-retarder is a device that makes it possible to brake on the engine instead of on the disc brakes, which otherwise frequently need to be replaced. Development was started around 1990, and the retarder was introduced to the market in 1994. Initially, it was only sold to a limited selection of customers as Scania wanted to introduce it carefully, but for 1995, a large increase in sales was expected. The brake-retarder is highly appreciated by end-users, as it reduces operating costs. Apart from the development of the retarder cooler, technical co-operation has involved areas like new materials, and efforts to make optimal use of the space inside the engine reserved for the cooler.

The co-operation with Valeo has grown over the years. This has been caused by the increased need for control and reduction of engine temperatures, due to the demand for greater engine power and the growing need for a balanced engine performance (necessary for exhaust gas reduction). Scania would like to see the development time of new coolers being reduced, implying less room for 'trial & error' as is custom today. In bringing the development of oil coolers to a higher level, it is not Scania's intention to decrease its own expertise in this field: to the contrary, it feels it has to increase its knowledge in order to maintain a fruitful dialogue with Valeo. Currently, Scania has a group of 7 development engineers working on engine features like coolers, generators and transmission.

The co-operation is formalised only to a small extent with the general purchasing agreements covering confidentiality aspects. Specific tooling is fully owned by Scania, which means that Valeo is not allowed to sell the specific oil coolers in the aftermarket⁵. Scania prefers its suppliers to make its development costs clear and not include them totally as costs in the product unit price. In addition to specific tooling, Scania pays also for development in the form of (expensive) prototypes. Collaboration in process development has consisted of Scania's consultancy work regarding quality control issues (free of charge).

⁴ Valeo is a large French automotive component conglomerate, and several of their companies are supplying Scania.

⁵ The aftermarket for spare parts is in many industries the most profitable market, also for truck manufacturers.

Despite these co-operation projects, Scania argues that its trucks only contain Scania coolers: that the coolers are manufactured by Valeo is not a unique selling point. This even applies to the brake retarder cooler: some customers may demand a brake retarder, developed by Scania, of which the Valeo cooler is just a part. Scania thinks it is the dominating partner in the collaboration, although this may vary during the project, and mostly takes the initiative to start a new project. The development of new coolers takes place when Scania is developing a new engine. Scania thinks it has helped Valeo develop one step further, as it has been demanding features that were not commonly available at that time. The brake retarder cooler is not something that can be easily sold to other customers (even if Valeo was allowed to do so), but the knowledge it has built up in developing it can certainly be an argument in attracting other customers.

The supplier's perspective

Despite Scania being Valeo's single biggest customer, with a share in total sales of several tens of per cent, Valeo's collaboration with Scania in product development is not very different than in the case of other customers. In all cases, the projects can be big or small, and are almost continuously going on. As for most of Valeo's customers, the extent of the co-operation has remained largely the same during the last five years. In total, Valeo has 5 people working full-time on R&D for its five most important customers and the group of minor customers: this implies an average of 10 months annually per customer. There is no formal organisation of the co-operation projects: everything is based on trust and mutual commitment, and there are only some 'exclusivity' agreements. Apart from developing a new product, like in the case of the brake retarder cooler, the goal of the technical collaboration can also be the standardisation of a range of products that a particular customer buys.

In the co-operation, Valeo sees itself as the most dominant party as regards the technical competencies. The final specifications of the product are the result of the customer's engine specifications, and Valeo's ideas and suggestions. With regard to the managerial side of the projects however, the driving force is usually the customer: "they have pushed us more than we push them".

DAF Trucks and Robert Bosch

The manufacturer's perspective

Bosch supplies DAF with fuel injection equipment, starters and dynamos, brake parts and some hydraulics. In terms of volume, it is one of DAF's major suppliers. 'Kraftfahrzeugausrüstung 5' (K5) is the Bosch division that delivers 'Einspritzsysteme für Dieselmotoren', and the most important division to DAF. Robert Bosch in total is almost 15 times as big as DAF Trucks, and even K5 is bigger than DAF itself. For injection equipment, DAF has contacts with three Bosch plants, and several development groups. At Bosch, development activities are strongly vertically segmented into basic research, product development, and application development.

Apart from the injection system on one engine type that DAF buys externally, Bosch is DAF's only fuel injection supplier. Fuel-injection systems are called 'components' in DAF terminology; (often multiple-part) products that are highly standardised, and designed by the supplier (see Box 3.2). The electronical parts of the product are much more customised, and customers pay a high price for that. Also the actual tuning/application of the products is adapted to the individual customer. For example, the actual output of an injection system can easily be adjusted with a regulator cap. In these 'component' markets, suppliers try to avoid all sorts of customised versions of their product, and the customers have only a limited knowledge of the technologies involved. Such a market requires a very different purchasing behaviour than markets for customised (DAF design) items like cast iron products, where the customer also has a much deeper understanding of the technologies involved.

Bosch, for example, listens to the demands and wishes of DAF, and then goes to the next customer, listening to their demands and wishes. Finally, they retreat and develop a 'one for all' solution, which is sometimes a compromise between all the demands they are faced with. The product itself is technically speaking a perfect product, but it may not exactly meet the wishes of DAF and/or any other customer.

In the design of the core product (the mechanical part), Bosch pays most attention to the demands of the 'Groß-Kunde', although DAF is sometimes one of the first to test a new product. Bosch gives little information about its other customers, but says DAF is a relatively important customer. Despite its relatively small size, DAF Trucks still has a market share of around 10 % in the European heavy truck market, which makes it an interesting customer. At the same time, DAF is also one of the few small customers that develop and build their own engines, which is a very interesting aspect for Bosch. Still, DAF suspects it does not account for more than a few percent of Bosch's total sales of injection systems. Having Bosch as a supplier of fuel injection systems does not directly mean that DAF sells more trucks, but one clear sales advantage is that Bosch has a world-wide service network.

Some 15 to 20 people from DAF have frequent contacts with Bosch. Most frequent topics of discussion are development collaboration, the delivery of prototypes, and logistical matters. There are frequent technical meetings and 3-4 meetings annually to discuss a specific product group in all its aspects. Once-twice a year, there is also a 'Tagung' where delegations from both companies will discuss the major issues that have been identified before as requiring special attention. This can be, for example, new development projects or after-care of particular products in the end-market. Additionally, there are 'Vorentwicklungstreffen' where engineers from both companies meet to discuss potential development projects. The responsible purchaser does not always participate in those, but is present when a project proposal is to be accepted and the costs and the appropriation of the results have to be discussed, and decisions have to be made regarding the purchases of raw materials for tests. Finally, DAF and Bosch have engineering meetings every 4-6 weeks (or even several times per month) to discuss more daily issues.

At the moment, Bosch and DAF have two main development projects regarding alternative injection systems. DAF has encouraged Bosch to continue the development of one of the new systems, which should become available around the year 2000. The other system is being developed in such a way that it is possible to use the system without major engine re-designs. This development has also been heavily promoted by DAF, and should become available in 1997-8. Within these developments, DAF does not always aim at a DAF-specific solution: at one moment, it has agreed on a redesign of the electronics so that another customer of Bosch can use it as well. As a development is seldom being pursued exclusively for DAF, it almost never pays any development costs to Bosch, which always wants to sell the product to other customers as well. The exception regards injection equipment with electronic controls, where some application costs are involved because of tailor-made software. The risk of leakage of information from a development project to other customers is limited by the use of non-disclosure agreements, and an industry tradition of maintaining confidentiality.

The extent of co-operation between the two firms has increased substantially the past few years. Earlier on, Bosch would have the equivalent of one full-time engineer working for DAF, while the figure is now closer to 2 full-time equivalents. The main reason for the increase are tighter environmental regulations. DAF itself puts a similar or higher number of full-time equivalents per year in the development of fuel-injection systems and their interaction with the rest of the engine, not even taking into account the time spent on peripheral issues like flow-swirls in fuel.

The supplier's perspective

DAF is one of Bosch's smaller customers for injection systems. But even as a small customer, DAF is not unique to Bosch: there is also for example Liebherr, a producer of construction equipment, which is quite similar. But as a development partner, DAF is quite valuable to Bosch, as it gives reliable information and places great confidence in Bosch.

With DAF, there is a wide pattern of contacts with all different kinds of people, but at the same time the whole range of contact-points is very well organised by DAF. The responsible purchaser acts as a kind of co-ordinator, and attends nearly all meetings: another prime contact is an engineer at R&D. At Bosch' side however, only 6 people are involved (2 sales persons, 1 engineer, 2 quality people, and 1 located at DAF for quality issues) while the corresponding number for other customers is 10 or even 15. The high number for other customers is mainly due to more intensive technological co-operation, and the larger number of varieties involved and factories delivered to. Face-to-face meetings with DAF take place 2-3 times a month, compared to weekly with some of the other customers.

It is interesting to compare the relation with DAF Trucks to the relation with a Swedish customer of Bosch. At this Swedish truck manufacturer, the purchasers have more technical knowledge than at DAF, but internally the teamwork is not so well organised. Purchasing, for example, really has to 'push' engineers with regards to pursuing and managing co-operation projects. This may partly be caused by this manufacturer's considerably larger size than DAF.

5.3.2 Discussion

Prioritising

Prioritising by the manufacturer actually takes place on two levels: first, specific products are targeted for development, second, specific suppliers are chosen to carry out this development in collaboration with the manufacturer. While these decisions may not always be that clearly separated and taken in this order in practice, it may be useful to make this distinction analytically. In the two case studies, both products, oil coolers but especially injection systems, are essential for engine performance, which makes it important to collaborate with suppliers of these products. The number of working-months invested by both manufacturers in the collaboration (see Table 5.2) compared to their other supplier relations is quite high. However, it should be noted that this labour mainly concerns internal engineering and development work, not so much communicating with and managing the supplier. The function of the products obviously entails a great deal of technical activity, but not necessarily jointly with the supplier.

Considering the choice in both cases for the specific suppliers to work with, it should be pointed out that both relations go back several decades and involve also (nearly) single sourcing; in other words, for the truck manufacturers these suppliers were a convenient (perhaps even logic) choice. For the supplier, prioritising primarily involves a consideration of the need for and returns on investments in specific customers. For Valeo, the volume involved clearly gives high priority to working with Scania. The opportunity to collaborate in the development of the brake retarder cooler, and subsequently applying that knowledge in other products and/or for other customers may have further attracted Valeo. Bosch may give somewhat less priority to collaborating with DAF Trucks, as demonstrated by the relatively low amount of time spent on DAF compared to other customers. However, this can be explained by DAF's limited size; if the time spent is related to the transaction volume involved, then the relation is actually quite intensive.

It is interesting to note that the intensity of the collaboration is rated higher in one case by the supplier, and in the other case by the manufacturer (Table 5.2). Valeo thinks the collaboration is not as intensive as Scania argues it to be, which is probably due to the fact that Valeo has other, similar customer relations. Scania rates the collaboration as intensive because it is more intensive than its other relations.

Mobilising

In the case of the Swedish relation, the collaboration involves a rather small supplier that is quite dependent on the truck manufacturer in terms of turnover. Keeping Scania a satisfied customer is thus of vital importance to Valeo. Nevertheless, Valeo estimates that in nearly all its customer relations the manufacturer accounts for over half of the driving force in the relation, and Valeo for the rest. They would like the division to be the reverse, 40-60. This lack of aggressiveness is probably due to the fact that the relationships have been there for a long time, and that the people at Valeo feel rather secure about their continuation. In other words, it seems like Scania has to do more mobilising than would be expected based on their importance to Valeo. In that sense, Scania does not seem to have a much stronger position vis-à-vis Valeo than DAF has vis-à-vis Bosch.

In the relation between DAF Trucks and Robert Bosch, the supplier even seems to be the more powerful party in terms of size and volume. Bosch's prominence or even dominance in the market for injection systems has undoubtedly limited the need to collaborate with individual customers. For a long time, the salesman mentality of 'one for all' solutions has been facilitated by the strong position Bosch has. However, Bosch's dominance in the industry seems to be decreasing as truck manufacturers are increasingly collaborating on injection development with other partners than Bosch, such as Lucas or Caterpillar. Bosch is now increasingly obliged to pay more attention to the demands of individual customers.

Still, DAF Trucks has managed to establish a close and intensive collaboration with the German company. The collaboration between Bosch and DAF is more intensive than between Scania and Valeo, which is obviously dependent on the more complex character of injection systems compared to oil coolers but also enabled by the fact that the Bosch-DAF relation involves a much larger purchasing volume. Moreover, one could say that in the last few years, DAF has been successfully 'stimulating' (mobilising) Bosch. This is demonstrated by the fact that the truck manufacturer has managed to encourage the supplier to continue with two projects it would otherwise have abandoned all together. Despite its relative small size, DAF is often among the leading customers in terms of technological development, although technically speaking, it is not always the most demanding customer. Although DAF Trucks thinks it is more special to Bosch than Bosch says it is, it seems to compensate for its relatively less important position by the efficient and relatively simple way it can handle technical collaboration with a supplier. On the other hand, Bosch sometimes claims that it puts a disproportionate amount of time in the collaboration. DAF answers to this by maintaining that it is entirely logical that, relative to its volume, DAF requires more time than bigger customers since it is at least as active in technical development.

In DAF's opinion, its relative small size in the industry is in general not a problem for developing specific products. This is demonstrated by that it even develops and produces its own engines. For suppliers, DAF's small size can even be an advantage, implying a limited number of layers in the organisation, which makes communication easier and faster, and the organisation more flexible. A supplier has to communicate with only 3 to 4 engineers at the Dutch truck manufacturer while at other major truck manufacturers, this could easily be 10 people. As a result of that, suppliers can, for example, easily and quickly organise field tests together with DAF for their new or improved products.

Co-ordinating

In the two focal relations, we have seen few explicit elements of co-ordinating the development activities of the different parties concerned. This may partly be due to the fact that we have not explicitly considered the research & development taking place internally at the truck manufacturers in the field of either oil coolers or injection systems. No extensive co-ordination with the development activities of other suppliers seems to take place, at least not by the manufacturer, but this may be related to the fact that both manufacturers develop their own engines. We only have seen that Bosch itself has close contacts with other suppliers of engine components regarding technical development, but it is unclear whether this takes place also in the specific case of DAF Trucks. Both manufacturers neither seem to intensively co-ordinate development activities between first and second tier suppliers (in this case Valeo and Bosch and their respective suppliers). This is probably not necessary because both products are not complex sub-assemblies. On one or two occasions however, Scania has set up a direct development collaboration with second-tier suppliers for the cases or panels around the oil-cooler. The specification of these cases and panels are only determined by the engine dimensions, and can largely be determined by Scania.

Timing

In both cases, we have seen that technological collaboration is going on more or less continuously, but that the actual development and introduction of a new type of oil cooler or injection system is determined by the moment a new engine is developed (or revised). The timing of collaboration is obviously mainly decided by the truck manufacturer.

Interestingly, for Valeo the main difference between the technological collaboration with different customers regards the timing of a project. Technically, the oil coolers are not very different: it is mainly a matter of dimensions. Nowadays, each truck manufacturer wants to have a new cooler when it is developing a new truck model, but when two or more truck manufacturers could align their introductions of new models it would be possible to standardise the coolers, which would have a significant effect on costs. Ultimately then, there could be a standard oil cooler for every engine size. This standardisation should not be impossible as it does not involve a strategic component in the whole truck. Valeo has suggested this idea of co-ordination and standardisation to some customers, but it is very difficult to get it through. Since the different model introductions take place at intervals, each customer wants to take the development a little further.

In conclusion, the two relationships involve considerable collaboration in technological development though not especially intensive; at least not for the supplier. The main issue for both manufacturers seems to be mobilisation; how to encourage and motivate the supplier to develop those products that it needs and wants, and in the right time.

In terms of the three areas, Technologies is not a main issue, as both manufacturers have been outsourcing the products and (most of) the development involved already for a long time and do not seem to be contemplating a change in that strategy. Projects also seems less an issue, presumably because development activities both at Bosch and Valeo can be carried out relatively independent from those at the manufacturer. This perception may be influenced by the fact that in these two cases, no development engineers have been interviewed. The area of Suppliers seems to be the most dominant one, as in both cases the main issue for the manufacturer regards the ongoing relationship with the supplier. Especially DAF Trucks seems to be focusing most on constantly communicating with Bosch, and 'getting innovations out of the supplier'. This ties in with the prevalence of the mobilisation issue.

One final observation in that context is that both manufacturers' near-single sourcing strategy may be closely connected to product development collaboration: it seems highly unlikely that especially Bosch would consider investing as much as it does in DAF when it would only supply half or even less of the current volume. On the other hand, it is unclear what the effects would be if both Scania and DAF would establish a second source: would this increase the incentives for more collaboration faster ('stimulus' factor) then it would reduce the resources needed for it ('market room' factor)? This debate has not been resolved for the relation between innovation and market position in general (Scherer and Ross, 1990: 630-660) and there is no evidence for making a substantial claim in the specific case of supplier position. Our finding that the intensity of technical collaboration is the highest for supplier relations that involve single source suppliers (section 3.1.1) does not necessary imply a causal relation between the two. Neither does it exclude the possibility that this intensity is due to the insistent prompting and urging by manufacturers, for which they have relatively more resources in case of a limited number of suppliers, rather than the suppliers' intrinsic motivation.

5.4 Relations between telecommunication hardware manufacturers and component suppliers

The case studies in the second industry involve the relation between the Swedish telecom equipment manufacturer Ericsson Radio Systems and its transistor supplier, Ericsson Components, and the relation between the Swedish printed circuit board (PCB) manufacturer, Ericsson Radio Systems 'Kumla', and its Dutch PCB supplier, Cityprint. Actually, it is only possible to speak of one *complete* focal relation. In the case of the Dutch supplier, Cityprint, it has been very hard to find exactly the unit or factory within the Ericsson corporation that was dealing with this PCB supplier. This is due to the fact that the organisation of the procurement and supply of PCBs is very complex within Ericsson. Finally, we interviewed Ericsson's PCB factory and supply centre within the business area Radio Systems (BR) in Kumla (S). Unfortunately, this factory had no *direct* dealings with the Dutch supplier. Still, both 'Kumla' and Cityprint are discussed here since they still show us interesting aspects of collaboration in product development.

The liberalisation of telecommunications markets and the associated internationalisation in both the operator and hardware markets have led to an increased diversity in the relations between the actors involved. 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. Traditional national supplier / national operator 'development-pairs', like in the case of Ericsson - Telia in Sweden, increasingly face or are replaced by other combinations of actors that co-operate in technological development. The new operators often have smaller organisations, and do not possess the necessary resources to do a lot of product development on their own. More than their predecessors, they look at the hardware manufacturers for ready-made solutions which can be implemented quickly. More and more, hardware manufacturers are therefore forced to focus more on application and systems knowledge, which means that they have to take resources from other areas. This leads to more intensive technological co-operation with suppliers, as they need to take over some of the competencies related to specific components and technologies the manufacturers previously had.

Figure 5.1: Changing positions in the telecommunications industry

5.4.1 Focal relations

Ericsson Radio Systems and Ericsson Components

The manufacturer's perspective

Ericsson Radio Systems (ERA), which manufactures base stations for mobile telephone networks, buys RF power transistors from sister company Ericsson Components. Radio frequency (RF) power transistors are small hybrid components⁶ that amplify the radio signal transmitted from a radio base station. They are made of different layers of silicones, gold wire bonding and a ceramic cover. In 1990, the RF Power Transistor business centre was established when the only supplier Ericsson Radio had at that time for power transistors was bought by Motorola. Radio Systems felt it would otherwise become too dependent on Motorola as a supplier of these critical radio frequency power components, since it acted also as a competitor in mobile telecom equipment. It was logical to include the production of RF power transistors in the Microelectronics division of Ericsson Components, as it was closely related to that division's other products, and Components had already been producing silicones for a long time.

Radio Systems still uses Philips and Motorola as additional suppliers. External suppliers cannot afford the 'luxury' of being afraid of information leaking from Ericsson Radio to Components: if they would stop sharing information on their products, Ericsson may just shift to other suppliers. In specific cases, however, Radio Systems and an external supplier may sign a non-disclosure agreement.

The supplier's perspective

In total, Ericsson Component's RF power transistors business centre has roughly 100 customers. In 1994, the unit has started to sell externally, and it has already a substantial marketshare. The biggest customer by far is Ericsson Radio Systems, taking roughly half of turnover. The relation between the two Ericsson companies is strictly commercial - there is no 'forced in-house shopping' - but due to the ownership connection, the companies will usually inform each other about the background to certain demands/choices, more than in the case of independent companies. Although the business area Ericsson Radio systems consists of different units that produce different kinds of radio base stations based on different technical standards, most of the R&D and engineering is carried out at the business area level, and consequently there are many contacts at the business area management level. Other contacts involve the engineering and purchasing departments of the different business units within Radio Systems.

Since Ericsson Radio is the first and biggest customer, most of the power transistors are tailored to its needs and demands. Ericsson Radio is also a very demanding customer, which is on the leading edge of technological development, and therefore the external customers have no problems in 'following' the developments in that sense.

⁶ Hybrid components consist of Integrated Circuits and micro-electronic parts.

The external customers buy versions that are more standard, or based on the versions sold to Radio Systems. If an external customer decides to place a large lot-order, then a specific design may be engineered for that occasion. Engineering work for a new version, however, does not take a very long time.

Although it is possible to speak about standard power transistors to some extent, not two transistors from two different suppliers are the same. Therefore, because most customers want to have at least two alternative suppliers, their engineers usually make two different designs as far as the interfaces with the transistor are concerned when developing a new radio base station. Actually, there are only interfaces between the power transistor and the Printed Circuit Board (PCB) that all the different components are mounted on and this is designed by Radio Systems itself, not by another supplier. Consequently, a transistor supplier needs to contact the customer, and have its newest product ready at a specific time-slot; if two other suppliers have already been successful in contacting the customer, the supplier is too late. New versions may, however, also be introduced during the life-time of a specific radio base station type; the customer may consider switching to a new supplier, or there may be demands for slight quality improvements or cost reductions.

Ericsson Radio Systems 'Kumla' and Cityprint

The manufacturer's perspective

'Kumla' is the in-house printed circuit board factory of the Ericsson business area Radio Systems (BR), responsible for the procurement and supply of all PCB's to BR. Nearly all of the PCB's used in the business area are bought by Kumla. Kumla does not (yet) supply to external customers. Of the total volume, the majority comes from external suppliers and a small part is produced internally at Kumla. Internal production regards mainly proto-types, first series and small series of complex multi-layer PCB's. Kumla provides different services for the internal Ericsson customers:

- build a small bufferstock, and decrease lead time through its expertise about supplier(market)s and its own short lead times;
- (re-)packaging and minor assembly work;
- keep tracing & tracking records of all products it buys.

In 1992, the business area headquarters in Stockholm was about to close Kumla: the factory was losing money, and had very long lead-times. Kumla got 12 months to get into the black again. At that time, the factory was producing all kinds of PCB's. A decision was made to outsource most of the production and to concentrate on the production of the most complex boards. In 1996, Kumla has been starting to show profits but still it has to show its unique benefits, otherwise it will be outsourced.

In dealing with external suppliers, Kumla will not ask for exclusive Ericsson-designs. On the other hand, many PCB-designs are customer specific in itself. Ericsson does try to stay 2-4 months ahead of the competition, and therefore proto-types and first-series are produced in-house. This is also done to check for the design's suitability for large-scale production. This is important with an eye to later production-yield, and thus product costs. The costs for a specific board can vary from a few guilders for a PCB in a mobile phone, to hundreds of guilders for a board in a base-station. Especially with the large-volume/cheap boards it is important to achieve a high production yield. For example, by taking away some millimetres of the delivery board (the frame which holds the PCB) large amounts of money can be saved. Suppliers offer a lot of suggestions regarding the production of PCB's, for instance that the dimensions of (assembly) holes in the board be increased. Through that specific suggestion, Ericsson could choose from more suppliers (less precision needed) and became thus more flexible.

Suppliers, since they largely perform the same activities as Kumla's in-house production, are important sources for information on production technology. When Kumla bought new electrical testing machines, for example, it asked some suppliers for advice. This happens also vice versa. Also in the case of production problems, it has happened that Ericsson sends engineers to suppliers and vice versa.

The supplier's perspective

Cityprint is a producer of printed circuit boards⁷. During the last few years, the company has increasingly focused on the production of PTFE PCB's, and moved away from producing ('old-fashioned') FR4 PCB's. PTFE is a Teflon material, and the key characteristic is that the material itself is part of the functionality of the PCB: the functions of components that are otherwise put onto the board, are now integrated into the board itself. PTFE is very suitable for high-frequency radio equipment, and has been widely used in military equipment. Gradually, new applications are introduced, like in mobile telecommunication or traffic management. New applications are hard to develop, both technically and commercially since PTFE is a very expensive material, which makes it not so suitable for consumer products. The high price also means that production yield is very important, and this yield is primarily determined by the design of the board. The more the customer has discussed the lay-out of the board with Cityprint, the more the available production knowledge is used in designing the board and, consequently, the higher the production yield. Extensive and early communication on the board lay-out is far more important for PTFE boards than for FR4 boards, because FR4 has no functionality on its own. Many customers, however, treat PTFE boards in first instance as a normal board, and tend to disregard the need for more precise specifications and the greater possibilities for variety.

On average, PCBs account for some 15 % of total costs of the customers' final products, but this share can vary from 2 to 30 percent. All PCBs produced by Cityprint are 100 % customer-specific. To many customers, Cityprint is increasingly giving advice regarding dimensioning, materials, and assembly processes/finishing (that the PCBs go through at the customer). Technical co-operation with Cityprint gives customers in the first place a PCB that is easier to assemble or process in their own production. It does not result in increased sales or new markets. Cityprint delivers PTFE PCBs to Ericsson Radio for mobile telephone base stations. Compared to the other customers, Cityprint has been giving little advice to Ericsson, mainly because it is a rather simple product with a relatively low unit-price.

5.4.2 Discussion

Prioritising and mobilising

The fact that Ericsson set up internal production of RF power transistors when it felt becoming too dependent on competitor/supplier Motorola implies that this component is a rather important element in the final product of Radio Systems. By having the opportunity and choosing to work with an in-house supplier, Radio Systems benefits from an open exchange of information and the first opportunity to use newly developed transistors. The benefits of the collaboration for the supplier do not accrue to some external supplier, but to another Ericsson company. The benefits in terms of expertise may be substantial because of Ericsson's supposedly leading position in mobile telephone systems.

Despite the fact that the component is rather critical, the collaboration is not very intense (see Table 5.2), at least not from the manufacturer's point of view. The large difference in the time spent on the collaboration by both parties is clearly a demonstration of the fact that the relation does not really involve joint development.

⁷ In 1996, the company has been renamed 'The 5M Company'.

It is rather 'arm's-length' development carried out by the supplier on conditions set by the manufacturer. The manufacturer even sees itself as not being involved at all in the technological development of the product: that Components sees this differently has more to do with Radio's size (relative to Components itself and its other customers) and its setting the (functional) specifications than with its active involvement. From the point of view of the supplier, Components, it is clear that collaboration with Radio Systems gets high priority, both because of this manufacturer's technical expertise, which makes Components attractive to external customers, and because of its sheer commercial importance.

Since there is actually no relationship, it is difficult to present an analysis of the Kumla-Cityprint case. However, the descriptions of the two companies show that selling and buying PCB's is a complicated process at Ericsson Radio. Actually, the in-house producer functions as a sort of buffer between the internal customers and the external supplier. This may provide a lot of benefits to those internal customers in the form of extra services, but it definitely makes the situation for external suppliers rather complicated. This is especially true for small and relatively new suppliers, but even for Cityprint which has been dealing with Ericsson Radio for the past 7 years.

It makes it especially hard to get through to the engineers working on the specifications for the boards, and this can be problematic as it is important in the case of PTFE PCB's to have early and extensive communication with these engineers in order to establish optimal specifications. There is no substantial information about the opinion of the internal customers on this matter, but having an internal supplier which has such an important 'gate-keeper' position with regard to external suppliers may hinder or even prevent intensive collaboration between internal customers and these suppliers - especially when, as seems to be the case, the in-house and the external supplier are competing to some extent. While Cityprint is currently only supplying a relatively simple PCB which requires little collaboration, further extension of the relations may be hampered in this way. In other words: as a supplier, Cityprint is definitely facing a mobilisation problem in establishing itself as a collaboration partner, mainly caused by the fact that Ericsson does not seem to make a clear choice between keeping PCB expertise in-house or 'buying' it externally.

Co-ordinating and timing

As mentioned above, 'joint development' would be overstating the level of collaboration between Radio Systems and Components: the supplier develops, rather independently, the new transistor on the basis of specification from the manufacturer. Extensive co-ordination of development work between the two parties does not seem to be necessary, also because there are relatively few interfaces with other components. Therefore, the case also shows little evidence of co-ordination of technical development with other suppliers. Neither is any vertical co-ordination taking place; RF power transistors are relatively simple components which means the supplier only uses raw materials and semi-manufactures suppliers. Components does not seem to have extensive collaboration with these suppliers, which ties in with earlier observations that, generally speaking, technical collaboration with these kinds of suppliers is not so frequent and intensive as with component and assembly suppliers (see Figure 3.3).

In terms of timing, it has been noted that RF power transistor suppliers need to have their new products available precisely when manufacturers are changing the design of their base stations; in other words, for major (but not all) product innovations, there exists a certain 'window' determined by the manufacturers. Most of the technical development is related to the production equipment that is used in processing the silicones, and developing a new process takes roughly 18 months. As long as such a process has been developed before the 'window' opens, the supplier is on the safe side, since developing or engineering a new transistor usually takes no more than a couple of weeks.

Summarising, both cases seem to be dominated by the process of mobilisation: in the relation between Components and Radio as rather unproblematic, and in the Kumla-Cityprint case as a major problem for the supplier.

Viewed in terms of the three areas, the area that dominates both cases is Technologies. For the RF power transistors, this is reflected in Ericsson apparently considering this technology as a core competence, for which it cannot risk to be dependent on external suppliers. For PCB's, Ericsson has several plants, which, however, supply to the another business area (BX; public telecommunication) and produce more simple PCB's than Kumla. Unlike in BR, PCB's are not a core product/competence in the BX area, and therefore this production will be outsourced in the future⁸. We have seen that this decision has been close for Kumla too, and it seems like the question whether to keep this competence in-house has not yet been definitely resolved.

5.5 The relation between a plastic components manufacturer and a semi-manufacture supplier

In the plastics industry, we have only been able to study one focal relation: between a Swedish component producer and a British supplier of semi-manufactures. In this industry, there is a limited number of major producers of intermediate products, such as plastic granulates, which are all global players. Some of these buy their raw materials from other (petro-) chemical companies, others possess 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 plastic component producers, 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 also affects technological collaboration patterns.

To study technological co-operation in more detail, we have chosen to focus on the production of (engineering) plastic components which, for example, are used quite intensively by the car industry. There is considerable technological development in this area, caused, for instance, by increasing demands on recyclability and weight-reduction. The development of these plastics takes place in close collaboration with component customers. DSM Polymers, for example, has developed new plastics for car bumpers in close co-operation with Peugeot and Renault. An interesting aspect of this kind of co-operation is that it often stretches over more than two levels in the supply chain, as the (intermediate) plastics component manufacturer is usually involved as well (see also Hyun, 1994).

5.5.1 Focal relation

Perstorp Components and ICI Polyurethanes

The manufacturer's perspective

Perstorp Components makes 'acoustic' components for the automotive industry, which have the primary aim of reducing noise levels inside the car. Most important products are dashboard insulations - heavy mats made of minerals and plastics, with a layer of felt or foam - that isolate the motor from the passenger compartment, and bitumen parts glued to the roof to reduce noise from rain and wind. Perstorp also makes, among others, roofliners for trucks and plastic panels for car doors.

⁸ In March 1997, Ericsson announced these PCB factories will be outsourced to SCI Systems and Soletron.

ICI is Perstorp's single source for poly-urethane foam (PU). Purchasing volume amounts to a few million NLG, and the relationship exists since 1991. The formula for this foam is more or less specific for Perstorp (with an English sister company buying the same recipe), and the two companies have been co-operating closely in the field of technological development. Compared to Perstorp's other supplier relationships, this one involves the most technological collaboration and the companies have even signed a formal partnership agreement. The co-operation started with a set of functional specifications from Perstorp, and ICI made a 'new' formula based on these demands. The development did not involve a huge amount of work; mainly some testing and laboratory research. Since 1991, the recipe has been changed twice. Today, technological co-operation takes the form of small improvements in product and process. It is likely that ICI supplies a similar or even the same recipe to suppliers of other car producers, but not to another supplier of Perstorp's important customers Volvo or Saab, although this is not formalised. Selling to other Volvo or Saab suppliers would also mean some cannibalisation of ICI's sales to Perstorp. Developments are also taking place in a special kind of foam that is a little heavier than normal PU foam. Besides for separating different layers of plastic or steel, this foam can also be used as a weight replacing the bituminous parts that are now being used, which could provide important cost savings.

The partnership agreement does not include provisions on prices, but it does specify minimum levels in terms of product performance. An evaluating audit takes place every quarter. Perstorp tries to conclude similar agreements with suppliers of plastic granulates aiming at a larger commitment from their side, but these suppliers are rather reluctant because of the many other (potential) customers they have. Perstorp would like to develop closer collaboration in three areas: logistics / material flow, R&D, and marketing / prices. In that way it may be able to stand stronger vis-à-vis the car manufacturer, for example, when it comes to price increases. The lack of intensive co-operation so far has also been caused by the fact that in the past, Perstorp has often bought standard granulates at the stock market and has not really been building supplier relations.

Often Perstorp is more or less stuck in the middle between very big suppliers and very big customers. In the case of some other semi-manufactures that Perstorp buys, such as granulates and carpet, the automotive customer co-operates directly with Perstorp's suppliers. For visible plastic parts, the colour (styling) and temperature resistance (safety) of these semi-manufactures is rather crucial, and the car producer is therefore closely involved in the development of these products. The suppliers of granulates and carpet supply the same products to other component manufacturing companies, which in their turn sell to the same automotive customers as Perstorp. Often, the automotive customer has no strong preference which plastic components producer it is supplied by. The material suppliers are spending a lot of efforts to 'get into' the final customer's development and purchasing operations, for which they can draw on their often considerable size and resources. Actually, three of the supplier relationships that have been analysed are not Perstorp's own choice (see Appendix D, 6.1). A carpet supplier has really been forced upon Perstorp, while two granulate suppliers are 'approved' by one of its customers. Having a limited number of approved granulate suppliers is a way of reducing the costs of trial and error involved in finding the exact production parameters for getting the right products. Even when there are clear specifications, a particular grade and colour of granulate is not exactly the same for two different suppliers: some production parameters always have to be adjusted. By just approving just two or three suppliers, the car manufacturer reduces the costs and risks of long trial runs of its components⁹.

⁹ Generally, one could say that when an input is easily specified, the final customer will only place demands on Perstorp in terms of grades and qualities of the inputs; when the product is very difficult to specify, the final customers will even tell Perstorp which supplier it should buy from.

ICI, however, has no direct contacts with final customers regarding the products it delivers to Perstorp: this is mainly due to the fact that the technical properties of the foam are only influenced by Perstorp's production operations, and because the foam is not visible for the automobile customer.

The supplier's perspective

Perstorp Components is a minor customer to ICI. Collaborative product development is predominantly driven by fine-tuning to the production process, and the demands by the final customers. For Perstorp, ICI makes prototypes (free of charge) because Perstorp has no facilities on its own to do this. However, especially in Germany, it is common practice that PU producers charge their customers for this service. With Perstorp Sweden, there are now 2 major projects going on: one in weight reduction, and one in the development of the special new foam.

Through the years, ICI has become more selective in which customers to sell to. In the automotive sector, ICI is mainly focusing its efforts on the car manufacturers and their major first-tier suppliers. ICI usually tries to have one component supplier per car manufacturer as a customer, but sometimes more. If ICI is selling to component manufacturers that deliver to a less successful car producer, it does not pull out directly. But it will mean that it will fight less for orders, put less development effort into the relation, and it is also less likely to start up a relation with a not so successful car producer. Normally, the car manufacturers change suppliers of components only when they introduce a new car model, especially with regard to seats - one of the major applications of PU foam. Therefore, ICI closely monitors the introduction plans; with 5 years life-time on average, and some 5 models, it means that a car manufacturer introduces a new model each year. Consequently, ICI and the final customers are almost constantly developing new products together.

With the car manufacturers, ICI usually works on the new model some 2 years ahead in a sort of Early Supplier Involvement arrangement. Before it enters the ESI stage, ICI is sometimes already certain of getting the business finally. In other cases, however, there will be even competition in the ESI trajectory, like in the case of the 1997 Toyota Carina, or when Ford developed a new component production method. In the latter case, three suppliers were involved. In the end, the business was split between ICI and one other supplier. With component suppliers, there is no continuous product development collaboration: it goes more in waves. Normally, ICI will be involved by the component supplier some 6 months before the model's market introduction.

5.5.2 Discussion

Prioritising and mobilising

Perstorp does not buy a huge amount of polyurethanes: the money involved is in fact less than in its other four supplier relationships that have been considered. Nevertheless, the relationship with ICI is judged to be most collaboration-intensive. This may have to do something with the fact that in the case of granulates and carpets, these suppliers rather collaborate directly with Perstorp's customers. In the case of polyurethanes, the technical properties of the product are more determined by Perstorp's demands based on its production operations than by the automotive customer's demands regarding styling and safety. In this perspective, Perstorp's efforts in working with ICI could be the result of a 'negative' choice: the suppliers of other products do not want to co-operate with a component producer, but focus on the final customer instead. We have seen that Perstorp is trying to chance that situation although, hitherto, not very successfully.

Perstorp is neither a major customer for ICI, and it is clear that although it seems like a smooth co-operation, it is certainly not one of the most intensive ones for ICI. Slightly different than in Perstorp's opinion, there does seem to be direct co-operation between ICI and automotive customers. The reasons for ICI are the same as for other raw material/semi-manufacture producers: in this way it can influence the automotive customers to demand specifically that their products be used by the component suppliers ('market-pull'), and direct contacts may speed up the development process. Obviously, Perstorp is competing with powerful 'competitors' in mobilising its suppliers for technical collaboration. It seems to put its priorities where it believes to be in a better position to mobilise suppliers, due to fewer 'competing' parties. Even in this case, however, the supplier (ICI) deals directly with the manufacturer's customers (the automotive customer).

In spite of all the problems that have been discussed, final customers could be an important instrument for Perstorp to motivate or mobilise its suppliers for technological collaboration. If it has a strong position at car manufacturers to which the raw material/semi-manufacture supplier has few other channels, it can be in a good position (as 'gate-keeper') to draw attention and resources from its suppliers, also in technical development. A complicating factor in this industry can be that there are not very many different suppliers to choose from, and that pressure - also because of the relatively small size of most component producers - can be difficult to exercise¹⁰. In deciding which component supplier will be involved in the development project of a new car, the automotive customers put emphasis on the piece price the suppliers think they can achieve, the development time they need, and the resources these suppliers have in terms of technology. Perstorp has, for example, an acoustics laboratory, which can be a valuable asset.

The slightly different perceptions of the collaboration are also reflected in the fact that Perstorp sees itself as the initiator, while ICI thinks both parties fulfilled that role. In contrast, Perstorp sees ICI as the most active party while the supplier itself perceives also here both parties as equally active. ICI also sees the relationship as less formal than Perstorp. All these differing views, which by the way are not causing apparent conflicts, may be related to the fact that the collaboration and the relationship as a whole is still rather young.

Co-ordinating and timing

In the case, there is little evidence of explicit co-ordination by Perstorp between the development activities together with ICI and other development activities. Presumably, the characteristics of polyurethane are not largely dependent on or influenced by other materials such as granulate. For the granulates and some other materials, however, there is a strong division of development activities between raw material (or semi-manufactures) supplier, component manufacturer and automotive customer. These different development efforts seem to be co-ordinated mainly by the automotive customer.

The moment of introducing new products is largely determined by the manufacturer's customer, the automotive industry. The material supplier is keen to know the timing of the automotive customer's new model introductions so that it can plan and focus its collaborative efforts accordingly. Both the material supplier and the component manufacturer may be involved very early on in a development project at the automotive customer: in some cases even 5-6 years before market introduction, but increasingly less in advance because of shortening time-to-market.

¹⁰ In 1996, Perstorp Components has been acquired by Collins & Aikman. Scaling up the size of component producers is probably one of the underlying arguments (see Appendix D, 6.1).

In the case of the Volvo 850, for example, Perstorp became involved 6 years before the car was actually introduced in the market. In another project, the Volvo S/V 40 produced by NedCar (NL), development lead time was extremely short: just one year. On average, however, Perstorp is involved some 3-4 years before the actual market introduction.

Summarising, also this case seems to be dominated by the process of mobilisation. Other than in the previous cases, however, the manufacturer does not have to compete with other manufacturers in 'getting attention' from its supplier, but rather with its own customers. In terms of the different areas, the dominant area seems to be Suppliers: embedding the collaboration in, and using it for, an increasingly stronger relationship.

5.6 Relations between food & beverage manufacturers and packaging suppliers

The case studies in the fourth industry, food and beverages, involve the relation between the Swedish beer and beverages producer Pripps Bryggerier and its corrugated board supplier, Munksjö Förpackningar, and the relation between the Dutch dairy producer, Friesland Dairy Foods, and its supplier of tins, Thomassen & Drijver-Verblifa.

In the area of food and beverages, most product development is taking place in packaging. While the contents may undergo some change in formula, or become available in new variations, these innovations seem less important, less evident and less frequent than the innovations in packaging material, forms and designs. One interesting aspect of packaging is that different materials or forms of packaging can often be each other's substitutes: milk, for example, is (in the Netherlands at least) sold in plastic and glass bottles, and different sizes of carton packages. Producers of food and beverages shift from the one alternative to the other, or combine them, depending on the preferences of final customers and equipment capacity. All forms of packaging primarily have the same function, and final customers base their preference on issues like user-convenience, appearance and (increasingly) environment friendliness, and (usually) do not have any technical preference for any specific packaging material. All together, this implies that the degree of freedom in packaging innovation is quite large. At the same time, product life cycle considerations are quite important: how easy can the new packaging be handled in the filling process, how does it fit within the marketing strategy, and what are the demands from downstream logistical operations (f.e. retail) with regard to weight, size and robustness? Many internal and external parties are involved in and at least affected by packaging development. These characteristics - a large number of alternatives, and many conditions - not only apply to the direct packaging material of the products, but also to transportation, distribution and 'presentation' packaging like pallets, trays and wrappings. Furthermore, technical collaboration between food producers and packaging suppliers is interesting because, in general, the two groups have distinctly different technical competencies.

The level of concentration and internationalisation seems to be increasing in this sector too: not only food and beverage producers are more and more becoming international conglomerates, but especially the suppliers of packaging like cans and glass are getting bigger and fewer. This leads to situations where, also because of relatively high transportation costs for packaging, customers can only choose between two or three potential suppliers. On the other hand, packaging for food and beverages often has distinctly national or cultural aspects. Beer in Sweden is primarily sold in cans, while bottles are far more popular in the Netherlands. Coffeemilk and coffeecream in the Netherlands is usually put in glass bottles, and in carton packagings in Sweden.

5.6.1 Focal relations

Pripps and Munksjö

The manufacturer's perspective

Munksjö is Pripps' major source for corrugated board trays, on which beer cans are distributed and put in the shop. Compared to the other supplier, Munksjö is a somewhat smaller company, and it has been more aggressive and active in approaching customers. At Pripps, it has been successful in taking away business from the other supplier and in 1995, Munksjö supplied roughly two-thirds of Pripps' need for corrugated board. This volume (equalling a few percent of Munksjö's total sales) is expected to increase in the near future. The trays delivered to Pripps are fully customised (design and printing), and come in different versions for the different sorts of beer. There are some general standard norms for these kinds of products, but Pripps is such a big customer that it can afford to buy special varieties.

Corrugated board has seen price increases up to 40 % in the period between Summer 1995 and the beginning of 1996 and this considerably increased the speed of product development. Basic aim for nearly all product development related to packaging, is to reduce the necessary amount of material. Pripps used to have only one type of tray, for 24 either 33 cl or 50 cl cans. This was very convenient for planning and production, but Pripps would save a lot of material costs if the 33 cl tray were made lighter, which is possible due to the lower weight of the cans. A new, lighter '33 cl' tray has been developed in close co-operation with Munksjö. Specifications for corrugated board are primarily functional, not technical: the tray should comply with 'transport' requirements (be able to take the weight of 24 cans in different conditions), and should be suitable to be handled by packaging machines at certain speeds. Within those functional requirements, suppliers are free to come up with new ideas and solutions. A unique element is that the new tray is made of 100 % recycled fibre: Munksjö has actually pioneered the usage of recycled fibre corrugated board in Sweden. The introduction of the new trays has been rather gradual; customers must still be able to recognise the tray, and the people in distribution and transport must learn how to handle the more 'fragile' trays.

The supplier's perspective

The relation with Pripps started in 1992, when Pripps was looking for an additional supplier of corrugated board. It had been doing business with another supplier for more than 20 years, but was rather unsatisfied with their performance. At that time, the average price Pripps was paying for a tray was substantially above the price that Pripps' purchasing manager wanted to have. The board being used was of a very heavy quality, and Munksjö proposed to substantially downgrade this. Both parties agreed that Munksjö would sell Pripps the function of putting beer cans on a tray, and that technical specifications would follow from this function and not form a goal in itself. Test runs with the new trays were done in Pripps' brewery in Bromma, but problems arose due to old packaging machinery. Therefore, further trials were done in the Gothenburg brewery, which has machinery from another supplier. This supplier was also involved in the development of the new trays, especially in the discussions regarding the speed at which the trays should be processed.

The technicians at Pripps were quite reluctant to decrease the paper quality of the trays, because they suspected it would cause problems especially when packing and storing the trays in warehouses and shops. Munksjö visited a number of warehouses and shops, and concluded that the proposed new quality was sufficient. Besides downgrading the paper quality, Pripps and Munksjö are also working on reducing the height of the rim of the tray. Simultaneously, the two companies are investigating the possibilities to decrease the number of different designs printed on the trays and the number of colours that are used.

Other breweries are very interested in these developments, but although there is no exclusivity agreement with Pripps, Munksjö is determined to work and solve all problems with Pripps for another 2-3 years before it will turn to other customers too.

Compared to other relations, the same number of people is involved from Munksjö's side: 2 from customer service, 1 each from the development and quality departments, and the sales manager. However, from the side of Pripps some 20 people are involved: purchasing, production (2 sites), plant managers, marketing, and public relations. This is an extremely high number compared to the other customers, where usually 2-3 people are involved. The co-operation is expected to have substantial results: at the moment Munksjö is only supplying the trays for cans in six-packs, but in the near future it will also supply other trays leading to an estimated doubling of sales volume for 1996.

Friesland Dairy Foods and Thomassen & Drijver-Verblifa

The manufacturer's perspective

Friesland Dairy Foods (FDF) buys different kinds of tinplate cans from supplier Thomassen & Drijver-Verblifa (TDV): cans for sweetened condensed milk, and cans for milkpowder and baby food. Small cans a.o. for condensed milk are produced in-house. Together with TDV, FDF has been working to reduce the amount of material used in the can by making the ends and sides thinner, and to develop lower cans. This process has been going on more or less constantly since 1990.

Since recently, the two companies are also working together on a new can design. This development has been triggered by the introduction of a re-usable plastic container by one of FDF's main competitors. The origins, however, go further back. In 1992, FDF's purchasing department had organised a presentation by FDF's other can supplier, for internal customers. The supplier and the purchasing department suggested several ideas regarding a new can for infant milk, but the internal customers - marketing and product managers from one of FDF's business units - were not enthusiastic, and the ideas were put aside. In 1995, a competitor introduced its new container, and the marketing people changed their opinion. Since that time, the marketing, purchasing and packaging development departments at FDF have been co-operating closely with TDV to develop a new can. In December 1995, the first prototype became available and TDV and FDF considered signing a non-disclosure agreement. Then, the project seems to have come to a standstill, and during 1996 nothing much seems to be happening. In March 1997, a new meeting between FDF and TDV takes place, and the project is stopped. FDF claims that the original design does not comply with the demands made by the retail sector regarding size and dimension¹¹, that it entails too large investments in packaging lines and is not that positively received in consumer tests. However, different alternatives are still being considered, and FDF and TDV will jointly do some tests.

The supplier's perspective

In 1995, TDV was already doing some general research into reusable cans when FDF came to TDV with the request to develop a new can. TDV has had mostly contacts with the marketing people of the responsible business unit of FDF regarding this development. The marketing people are not actively involving other FDF people, like Purchasing and Development. More than at other customers, this co-operation project has been important for TDV in order to prevent the substitution of the metal can by another form of packaging. When the original design was opted out in March 1997, TDV did not have any firm intentions to discuss the design with other potential customers. However, as they believe they will be able to sell it in other segments they are now trying to get the model protected (by establishing intellectual property rights).

¹¹ In the Netherlands, the retail sector - and especially market leader Albert Heijn - demands that all packagings and the batches in which they are distributed are 'collomoduul', i.e. based on a standard pallet size.

For TDV, this is the customer relationship with the most people involved from the customer side, which has to do with FDF's rather complex organisation. It is also due to the greater variety of technical issues discussed with FDF.

5.6.2 Discussion

Prioritising and mobilising

Corrugated board, or rather trays, for Prippts is an important area to develop new cost-effective solutions, since it is a product that the final customer is not paying for but which is still necessary for logistical reasons. Also because of the developments with regard to six-packs that have led to reduced demands on the strength of trays (see below), corrugated board has become an important product for technical development. For Prippts, Munksjö is an interesting collaboration partner because of their ability to produce 100 % recycled corrugated board, which would give Prippts a favourable 'green' image. Another aspect must have been that a successful collaboration with Munksjö would put pressure on Prippts' other corrugated board supplier and perhaps encourage (mobilise) it to increase its efforts towards Prippts. For Munksjö, the co-operation with Prippts was *the* opportunity to become an important supplier to this big customer and, indeed, it quickly replaced the other supplier as the most important source for corrugated board. Although it seemed that the other corrugated board supplier had more or less been neglecting Prippts, Munksjö continuously had to overcome the vested interests of this supplier at different departments at Prippts. In that way, it has learned to lobby quite intensively.

In the case of the collaboration between FDF and TDV, the trigger clearly was the introduction of a new can by one of FDF's most important competitors, although ideas for a new can had already been brought forward three years earlier, by another supplier. Since this specific can is used by the customer for a relatively long period, its appearance and convenience is an important factor and the design and development of the can therefore has considerable interest from the side of FDF. The reason why, especially in 1996, this project has not progressed to any great extent is at least partly due to 'external' events such as a possible acquisition of FDF's activities in baby food by the competitor mentioned earlier¹². That the project finally has been terminated, at least in its original form, is mainly based on considerations regarding marketing and production (at FDF) rather than development and purchasing aspects. For TDV, it has already been indicated that the specific motive for this collaboration is the prevention of substitution by another packaging form, and the perspective of selling this can to other customers in the future. Now that it has become apparent that FDF will not function as a 'lead user', TDV needs to look for other potential collaboration partners. It seems unlikely that because of the 'failure' TDV will decrease its overall efforts towards FDF, as TDV cannot afford to lose such an important customer.

Co-ordinating and timing

Some co-ordination takes place in the co-operation between Prippts and Munksjö in the sense that other suppliers are also involved or consulted, as illustrated by the involvement of the packaging equipment supplier. However, this involvement has not consisted of a great deal of development activities in itself, but rather of discussions regarding the technical possibilities of the existing equipment. For corrugated board, the moment of technical collaboration with customers is closely related to the moment a customer is planning to buy new packaging equipment.

¹² This acquisition would be part of a larger 'exchange' of a range of dairy activities, but has not been effectuated in the end.

These moments are therefore closely monitored by Munksjö. Furthermore, one can speak of co-ordination between the development collaboration with Munksjö and with the supplier of six-packs. Munksjö has started to supply the trays for the beer cans that are also packaged in six-packs (meaning that there are four six-packs on a tray), since in that case it is relatively easy to use a lighter quality board because of the bearing capacity of the six-pack. Pripps uses special six-packs that have been developed in close co-operation with another supplier, prior to the co-operation project with Munksjö (see Appendix D, 7.1). Here we see clear elements of timing different development collaborations. In the collaboration between FDF and TDV, there are no explicit elements of co-ordinating and timing.

Summarising, both cases involve a supplier that has been very active and motivated to collaborate with the manufacturer: one, because of the prospect of becoming an important supplier, the other because of potential dangers from substitutes. Again, just like in the relations Scania-Valeo and Perstorp-ICI, there are substantially different opinions on who is the most active in the collaboration (see Table 5.2), but also on the extent of the collaboration. While Pripps sees the collaboration basically as a joint effort, Munksjö clearly sees itself as the most active partner. TDV, however, sees its customer FDF as more active than it sees itself. Both suppliers also see the manufacturer as having a more dominant role in the overall technical development of the product involved than the manufacturer thinks it has.

As mentioned earlier, some of these differences are obviously related to the fact that both sides have different things to compare with. Pripps will compare the collaboration with Munksjö with the relations it has with, for example, can, PET bottle and sugar suppliers, while Munksjö compares Pripps with customers like ice-cream and plastic bag factories. The same applies to FDF and TDV. On the other hand, the companies may see the relation as they *want* to see it. TDV, for example, may see FDF as more active than it really is because it needs to justify its own efforts. Why co-operate with a long-time customer, if that company is not pushing you to do so? Why both suppliers see the collaboration as a major project, while the manufacturers see it as a continuous process remains unclear: it would have been more logical, i.e. in line with the previous observations, if they would have perceived it as a more continuous process than the manufacturers. A possible explanation could be that suppliers, usually being smaller companies, have a shorter time horizon, as has been hypothesised in section 5.2.

The dominant area in the Swedish relation seems to be Suppliers : embedding the collaboration in, and using it for, a growing relationship. In the Dutch relation, Projects is the main, problematic, element it seems: how are development projects internally managed, and how do suppliers and purchasers become involved at the right time and to the right extent.

5.7 Relations between power plant manufacturers and sub-assembly/service suppliers

The cases in this final industry involve the relations between the Swedish producer of power plants, ABB Stal, and its supplier of electrical gear, ABB Installation, and between the Dutch contractor for diesel engine power plants, Stork Wärtsilä Diesel Projects, and its electrical gear supplier, Holec Projects.

Within electrical power plants, there is a large variety both with respect to the size and purpose (for example, output delivered to the public grid or to an industrial plant) and the technology involved in relation to the fuel input (f.e. coal, water, gas and diesel). ABB Stal primarily produces (parts of) power plants that are used for power (and sometimes also steam) generation at industrial plants by means of gas or steam turbines: customers can be found in electricity intensive sectors, like the paper and pulp industry, refineries and chemical plants.

The Dutch manufacturer produces diesel engine power plants, which are used in power plants at a great variety of locations, especially where the infrastructure for electricity generation and distribution is still under development.

In general, the industries for these two types of power plants are rather mature with well-developed technologies. They are also well-internationalised and concentrated industries, with in the gas turbine sector some five major competitors and around 15 competitors in the diesel engine segment, while the segment for steam turbines is somewhat less concentrated. Despite the fact that the industry is a typical example of a project-based, or unit-production industry, many manufacturers are increasingly trying to standardise the basic 'building blocks' of their final product, like the turbine, the diesel engine or the electrical switches and installation work. This is clearly demonstrated in the collaboration in the two focal relations.

5.7.1 Focal relations

ABB Stal and ABB Installation

The manufacturer's perspective

ABB Stal produces (parts of) complete plants for power and heat production to industry and utilities, like advanced steam and gas turbines, and combined power and heat plants (co-generation). Sister company ABB Installation is its most important supplier of electrical installation work and switches. Main part of the purchases from Installation regards switching gear and electric cubicles, while 10 % involves installation work. Contracts with regard to switchgear are renewed annually, and contain clauses about lead-time reduction, cost reductions, and other special activities. For electrical installation work, the conditions between each customer project differ and Installation has to make a new offer for each project. A supplier since 1980, Installation has become more competitive since 1993 when the co-operation has been intensified. Until some years ago, Stal was using five different suppliers but due to increasing turnover, it was forced to co-operate more closely with its suppliers and therefore chose to reduce the supply base to two suppliers.

Special software for the design and cost calculation of a new installation has been developed to improve the quality of the information exchange with Stal, and to speed up the quotation process vis-à-vis final customers. This must result in more efficient communication not only between Stal and Installation, but with the final customer as well. Regarding electrical installation work, Stal has contacts with two Installation offices, headquarters in Västerås and the regional office in Norrköping. Stal wants to have more/only direct contacts with Västerås, but for that it was necessary that contacts became more efficient; otherwise all application engineers in Västerås would be busy working for Stal. This has also been the main motive for the development of the software, initiated mainly by Stal and developed by Installation. Installation can now use this software as a unique selling point in dealing with other customers too. The introduction of the software should also reduce the amount of application engineers involved in the relationship to roughly five. Purchasing should then only be involved in negotiating the contracts, and supporting the process.

Opposed to installation work, which is unique for each customer project, switchgear is rather standardised. It is very important for the performance of the total turbine, and all changes in the design of the turbine set lead to design changes in the switchgear. It is therefore produced as one of the last items in the turbine production process, which makes lead-time reduction an important issue. Stal has now made some changes in its internal material/production flow also in order to enable lead-time reduction for the items supplied by Installation.

Standardisation has taken place mainly with regard to electrical circuitry; nowadays, only 8 different types are being used, while this figure used to be around 50.

The supplier's perspective

Stal is Installation's only customer in this industry; there are no competitors in Sweden. However, Stal tries to be Installation's overall most important customer, and in that sense there are competitors. Especially in relation to Stal, Installation has been very active in developing the already mentioned software tool, Center Pro, which makes it possible to 'design' by computer the switchgear and electrical circuitry based on the customer demands and calculate prices. In a sense, it is an advanced pricelist. By doing this by means of a computer, the design and drawing of these components of the generator/turbine set has become easier and quicker.

For Stal, it means that is able to speed up the quotation process vis-à-vis potential customers. This is very beneficial, since usually only 1 in 10 quotations is successful. It saves a lot of time, which makes the preparation of unsuccessful quotations less costly. When the design has been made, and the quotation is successful, the programme can be used directly in producing the specific turbine set. After the order from Stal is confirmed, Norrköping sends its Center Pro files by electronic mail to Västerås, where it is then translated to their own files. From that document, a bill of materials is prepared.

In 1993, Installation regarded this software as something that could be given to customers, so that they could work with it themselves. Only in specific cases, Installation has special versions of the programme for user/customers that take into account their standard preferences, like in the case of a paper company. In the case of Stal, their standard preferences regarding the design of electrical circuitry have been built into a program, resulting in a 'Center Pro - ABB Stal version'. One of the difficulties is that Stal is still having problems with standardising the options it offers to its customers. Whenever a project does not comply with Stal's normal standard designs, technicians will be involved to devise specific solutions, and the quotation process will take longer time. But already, prices for the electrical installation work and switchgear have dropped considerably because of the easier design procedures.

Still, apart from special projects like the Center Pro introduction, the relation with Stal is not very time-consuming. All in all, the co-operation between the two companies is neither difficult nor troublesome; they are quite familiar with each other and their respective products. It is more about 'picking' solutions, then on really developing them.

Stork Wärtsilä Diesel Projects and Holec Projects

The manufacturer's perspective

Stork Wärtsilä Diesel Projects (SWD) installs diesel engine power plants, and Holec Projects (HP) delivers switching gear and electrical installation work, together called the 'E-package'. Over the years, HP has got more and more responsibilities from SWD: the power output has grown, SWD wants to work in a more modular way, and the final customer increasingly demands a 'black box' product. This is because the character of the final customer has changed; in many countries, due to privatisation, there are now Build-Own-Operate-Transfer customers, that build a power plant not as public utility, but as an investor. These customers have no knowledge of and interest in technology, and leave more to the supplier or a supervising engineering contractor. This development is similar to what is happening in the telecommunications industry (see Figure 5.1).

Design

Most of the technological collaboration between the two companies has been focused at standardisation. In that context, SWD and HP are, for example, discussing the design and selection of new medium-voltage switching gear. HP wants to start co-operating more closely, standardising on the basis of individual projects. This applies especially to the E-package of a new engine type.

The supplier's perspective

HP is SWD's main supplier when it comes to major projects. For smaller projects, SWD uses two other suppliers. With regard to the specifications of the products, the final customer has less and less specific demands (see the trend towards standardisation). In joint projects, SWD is usually the main contractor towards the final customer. SWD sets all the basic specifications, and from time to time HP will make suggestions regarding mostly minor design or layout changes. Compared to other customers, SWD puts much emphasis on delivery time.

Normally, there are some 7 people from HP, and 4 from SWD involved in this relation. At HP, this regards the project manager, a sales person, an expeditor and some engineers. At SWD, this involves the project manager too, a purchaser and two technicians. Technical discussions are closely co-ordinated by the project manager from SWD. For a new engine type, there are plans to make more standardised solutions for the E-package. This is a quite strong common tendency, because clients increasingly demand short delivery times. The Automation department of HP has been doing quite some work to work on standardised solutions for the control software. One of the successful joint projects is an installation project in Honduras in 1994/5 when, for the first time, HP installed an integrated package of monitors and controls that made it possible to remotely monitor the plant. Until then, SWD had been buying the controls, monitors and peripheral equipment from separate suppliers, putting it together themselves. The remote control function was an entirely new feature, and the value added generated by HP was therefore substantially increased. Both parties were pleased with the outcome of the project, but despite a substantial evaluation report, there has not been a follow-up of the project. HP is allowed to sell the basic solution to other customers, but the software will have to be re-developed substantially. Spin-offs of the project may occur in visual monitoring systems for power distribution substations.

In general, the relation with SWD has given HP a lot of experience in fast deliveries and working with high power outputs, and thus useful reference projects. For SWD, the co-operation has also resulted in good references, the possibility to use HP's name as a sales argument, and faster delivery times for total projects. SWD has been talking to HP about introducing a preferred vendor agreement, and in 1995 HP was nominated as a preferred vendor for the electrical part of diesel power plants with engines of the new type. Activities for standardisation for the E-package of these diesel power plants had already been started in 1994 by the two companies. HP has been working on this standardisation with a team consisting of the people that had been dealing with the Honduras project. In 1995, however, business remained well below the level forecast by SWD. HP then decided to continue the standardisation process later when some more projects would have been realised. In HP's opinion, SWD has not really been investing in the relationship; purchasing decisions are still very much project-based. HP is prepared to start co-operating more closely and to standardise, but only on the basis of individual projects.

In 1996, together with a management change at SWD, there has been a radical change in strategy. SWD has decided to do all electrical engineering themselves and to buy all components directly from manufacturers. This means that there is no more need for doing business with HP, despite all previous co-operation.

5.7.2 Discussion

Prioritising and mobilising

In both cases, the supplier that the manufacturer has chosen to work with seems a rather logic choice. Installation is Stal's most important supplier for switchgear and installation work, a sister company, and located nearby. It is also a rather important supplier relative to Stal's total purchasing volume (see Table 5.2). HP is not that dominant as an E-package supplier to SWD but still, because of the large volume involved and its relatively nearby location, the most natural partner. For Installation, the motives for working with Stal are at least partly related to the fact that it is the only customer that manufactures turbines (OEM customer), which means that the drive for standardisation and rationalisation of the bidding and engineering process is stronger than in the case of other, less 'regular' customers, for example a steel mill. Consequently, the customer's demand for and interest in standardised E-packages and tools like Center Pro is greater. Additionally, the fact that the relation regards a sister company has the advantage of being a relatively open test-ground for the further development of the software tool. In other words, both Installation and Stal have strong motivations for this collaboration, and it seems like the mobilisation of both parties has not been problematic. Only, Stal sees itself as the more active partner while Installation considers it more like a joint effort. Again, this is most likely due to the different reference material they have. As Installation has less collaboration with other customers, it is more likely to see an effort by itself as 'large'. Stal has intensive collaboration with other suppliers too and may rate Installation as less active than others (see Appendix D, 8.1).

For HP, as an OEM customer SWD is one of the few customers it can have a more permanent and stable relationship with, and therefore one that provides good opportunities for product development collaboration, apart from the fact that it normally is one of HP's more important customers in terms of volume. During the collaboration, however, it became apparent that it is not always easy to mobilise a supplier for technological collaboration when the level of business remains below expectations. In some sense, and this may be very typical for project-based industries and especially standardisation projects, one can speak of the 'chicken or the egg' dilemma: first put efforts in co-operation in order to promote business, or first get more business in order to promote co-operation. In this case, it seems that the manufacturer preferred the former approach and the supplier the latter one.

Ultimately, the collaboration has been put to a complete stop due to a change in strategy at the manufacturer. It is not entirely clear whether this could have been prevented by a more fruitful collaboration between the two companies, but it seems rather unlikely since the new strategy originates from the Finnish owner of SWD, and applies to all of its operating companies. During the collaboration, there have been more instances of different perceptions. The Honduras project, while highly valued by HP, is not a very special or interesting project in the eyes of SWD. The remote control feature was certainly not going to be a standard feature since it was very costly. The rest, the control and monitoring unit, was also being produced by another supplier, and at a lower price. Besides, after some time SWD introduced its own monitoring systems, and external purchases of these systems therefore decreased. Concluding, it is fair to say that SWD and HP have had very high expectations of the collaboration, but that it has failed due to different perceptions of the results and different ideas on how to embed the collaboration in the overall relation.

Co-ordinating and timing

In both cases, little has been found with regard to co-ordination in time and content between each of these collaborations on the one hand and other co-operative developments on the other hand. Obviously, both projects fit within the manufacturers' general efforts to increase the level of standardisation and making the bidding process more efficient, and are co-ordinated in that sense. In hindsight, however, the SWD-HP collaboration is an example of bad timing: starting to intensify collaboration with a supplier two years before these activities are brought in-house. It is uncertain, however, to what extent this shift in strategy could have been foreseen. It is interesting to observe that in both cases, the goal of the collaboration has been the standardisation of the products involved and rationalisation of project related engineering activities. In other words, the parties collaborate in the long-term oriented development of tools and products to reduce the need for short-term collaboration in engineering for each specific transaction. The effect of such collaboration is that the production technology involved in the relation between the manufacturer and the supplier increasingly comes to resemble small-series technology rather than unit production.

Summarising, both collaborations are basically focused at standardisation, and therefore show many similar characteristics. Mobilisation, at least in the SWD-HP, has clearly been the main problem. Of the three areas, Suppliers seems the most central one in both cases. The software development and the standardisation of E-packages both serve to permanently improve communication, and to rationalise the bidding and installation process. In the Dutch case, Technologies also plays a major role as the recent 'make' decision has demonstrated.

5.8 Conclusions

In this final section of the chapter, the results of the case studies are assessed in terms of whether their objectives have been achieved, as discussed in the introduction to this chapter: 1) to find out to what extent purchasing involvement activities can be adequately described and analysed in terms of the underlying key processes (prioritising, mobilising, co-ordinating and timing); 2) to identify possible differences between industries in terms of the four key processes and main areas (Technologies, Suppliers and Projects) regarding purchasing involvement in product development; and 3) to identify specific activities that can be seen to contribute to the key processes according to the different areas or objects. The achievement of the first two objectives is discussed in this section. The third objective is the topic of the following chapter.

5.8.1 Key processes

The case studies demonstrate that the concepts of prioritising, mobilising, co-ordinating and timing can be used to describe and analyse supplier-manufacturer collaboration in product development. As the descriptions have illustrated, most of the activities performed in connection with this collaboration can be related to these key processes. More importantly, the problems and successes in each of the nine collaborations can be interpreted in terms of activities related to one or several of the key processes. This supports the claim that the four key processes are essential 'ingredients' in successfully managing supplier involvement in product development, and thus should form the basis for purchasing involvement in product development.

The case studies also demonstrate that the key processes are applicable to supplier-manufacturer collaboration in product development across a fairly broad range of industries. This indicates that the processes of prioritising, mobilising, co-ordinating and timing are rather universal. Elements of most processes can be found in nearly each case; take timing, for example. The cases in the large-series production industries have shown interesting examples of the importance of timing. Both in the case of oil coolers and injection systems, new products are only incorporated when the engine is being renewed. New RF power transistors are introduced in connection with a new base station. In the case of large-series production, usually heavy investments are made in production and assembly equipment and production efficiency is an important goal. Changes in components may require new investments and cause disruptions in the normal production flow, and should therefore be carefully selected and planned. Introducing new engine coolers, injection systems or power transistors not only when the final product is going through a development project, but as soon as they have been developed by the supplier, may require intermediate changes in other components that are just too costly. Therefore, large-series production manufacturers put heavy emphasis on the co-ordinated incorporation of new components into their final product. But also in the other industries, timing is taking place. In the case of corrugated board supplier Munksjö, we have seen that the moment of technical collaboration with customers is largely determined by the installation of new process equipment. In the Perstorp - ICI collaboration, but even more in the development of granulates, timing takes place between different levels in the supply chain: raw material supplier - component manufacturer - automotive customer. Also the processes of prioritising, mobilising and co-ordinating can be found across the different industries.

Summarising, the four key processes seem to apply to supplier-manufacturer collaboration in product development across different industries. This means that for a further elaboration of the activities regarding purchasing involvement in product development, it is useful to start from these processes.

5.8.2 Differences between industries

The second objective of this series of case studies has been to study the influence of the various types of production on purchasing involvement in product development in terms of the underlying key processes and the main areas. We have argued that the four key processes seem to apply to different industries, but it is possible that one specific process is more important in some industries than in others.

Håkansson (*ed.*, 1982: Ch 4) argues that, given the high degree of inflexibility of mass-production technology, the characteristic problems in that case concern ensuring stable relationships with suppliers to create security, and balancing this against identifying and incorporating new technical developments. This balancing of new technical developments with a relatively stable and inflexible production flow could be reflected in an emphasis on the issue of *timing*. Given their dependency on raw materials and process equipment, the characteristic purchasing problem of firms with process production involves balancing security of supply against the freedom to change suppliers. This regards both raw materials and process equipment (Håkansson (*ed.*), 1982: 265-267). One of the dominating aspects of technical collaboration in process-production industries, could consequently be the key issue *co-ordinating* development collaboration between material suppliers and equipment suppliers. Finally, characteristic problems in firms with unit production technology, given the emphasis on assembly and customisation, are: (a) obtaining and handling the external capabilities to develop, design, and produce critical and complicated components, and (b) obtaining and handling efficient external production resources for more simple components (Håkansson (*ed.*), 1982: 193). Additionally, it seems reasonable to expect that the main issue in technical collaboration in these industries involves *mobilisation*, as unit production industries usually have a less regular demand and production process which makes it difficult to constantly maintain and 'vitalise' supplier relations.

However, our analysis of the 9 cases results in the conclusion that for all industries, mobilising is the dominant process. The cases have shown that suppliers and manufacturers may have very different interpretations of the character of their relation in terms of intensity and balance (see section 5.1 and Table 5.2). This may result in incorrect estimates of the importance of the collaboration to the counterpart and the extent and importance of its own efforts, which may especially hinder the mobilisation process. Nearly all cases have demonstrated this, except Ericsson Radio-Ericsson Components: the only 'in-house' relation we studied. While it does not seem to prevent a collaboration to be effective and stable, it does imply that mobilisation - which is apparently very important - often is a difficult and potentially inefficient process. Both parties in the collaboration could make the collaboration more transparent and more efficient if they would pay more attention to the other (development) relations the counterpart has, and place the focal relationship in that context. By doing that, they would better be able to understand what the relationship means to the counterpart and to use that knowledge in creating or emphasising the right incentives. Summarising, in terms of the key processes, the case studies show less differences than expected based on the industries they are selected from. Therefore, the tentative hypotheses we formulated regarding the dominance of specific key processes based on the work of Håkansson ((*ed.*), 1982) are to be rejected.

Apart from the key processes involved, the cases may differ in terms of the relative importance of the three main areas regarding purchasing involvement in product development: Technologies, Suppliers and Projects. In two of the four large-series production case studies (Scania-Valeo and DAF Trucks-Bosch), Suppliers seems the dominant area while in the other two (Ericsson-Ericsson and Ericsson-Cityprint), Technologies plays a main role. In two of the three process-production case studies (Perstorp-ICI and Pripps-Munksjö), Suppliers is dominant again while in the third case (FDF-TDV), Projects is emphasised. In the two unit-production cases, Suppliers seems the most important while in one of them (SWD-HP), Technologies also forms an essential aspect in the relation. Obviously, in our case studies there is no clear relation between the type of production and the area of purchasing involvement that is the most dominant. Only with regard to unit-production, Suppliers seems to be crucial in 'all' cases but not exclusively so.

The overall conclusion would be that there is little difference between purchasing involvement in product development in different industries, neither in terms of the underlying key processes, nor with regard to the main areas of that involvement. One possible explanation for this may be that the concepts of key processes and areas of involvement have too little distinctive abilities. In other words, they are so broad that they cannot capture the differences between the different cases. This has, however, also a positive effect as indicated in section 5.8.1: purchasing involvement and possible problems and successes seem to be adequately described and analysed in terms of the key processes across a variety of industries.

An additional possible explanation for finding little differences between different industries is that we may have selected the wrong parameter to differentiate between the case studies. The selection of industries with different production types has been based on the notion that this leads to differences in purchasing behaviour and thus in purchasing involvement in product development. Instead, the selection of cases might have focused on research and (product) development characteristics. Perhaps, selecting case studies to cover a variety of industries in terms of innovation characteristics would have shown larger differences regarding purchasing involvement in product development between various industries. For this purpose, we could have used the taxonomy of Pavitt (1984). This taxonomy takes into account the 'similarities and differences amongst sectors in the sources, nature and impact of innovations, defined by the sources of knowledge inputs, by the size and principal lines of activity of innovating firms' (Pavitt, 1984: 343, quoted in Oerlemans, 1996: 198). This issue deserves further attention in future research (section 9.5).

Finally, it should be noted that our perception of the cases may be somewhat biased. We have taken a rather 'strategic' angle to the collaboration by mainly interviewing purchasing and marketing *managers*. If instead mainly purchasers, sales representatives and development engineers would have been interviewed, our observations would probably have focused more on operational issues and on processes such as co-ordinating and timing. Since we have interviewed similar managers for each of the nine relationships, the possible perceptual bias is consistent across all cases. It should also be emphasised that our description and analysis of the different relationships concerns specific periods. Had we not included, for example, the recent 'make' instead of 'buy' decision in the SWD-HP case, Technologies would have not been classified as an important area in that relation. In other words, the period included in the analysis of a relationship may affect what is regarded as its important aspects.

The final objective of these case studies has been to identify specific activities that contribute to or realise the four key processes, according to the three main areas. This is the topic of the following chapter.

Design

Chapter 6

Developing a Framework of Activities

In this chapter, the focus is on developing a framework of activities that constitute purchasing involvement in product development, as described in our first research objective. First, however, section 6.1 briefly discusses different perspectives or conceptions of strategy and organisational decision making in order to indicate which perspective lies behind our framework. In section 6.2, the first version of the framework is developed by identifying, based on the case studies in Chapter 5, specific activities that contribute to the four key processes underlying purchasing involvement. These activities are grouped together according to the three different areas or objects previously identified. In section 6.3, a second series of ('mini') case studies of Dutch manufacturers and their ways of managing purchasing involvement in product development leads to distinguishing different 'levels of responsibility', ranging from strategic to operational. When comparing the different levels of responsibility with the areas previously identified, a substantial overlap becomes evident which leads to the integration of the two aspects in a second version of the framework, in section 6.4. Additionally, these new case studies demonstrate that purchasing involvement in product development goes beyond managing supplier involvement, which leads to the identification of a fifth underlying key process. However, the different activities and management areas from this generic framework may not be equally important for all kinds of firms, and not all firms may equally be capable of performing the activities, depending on the presence of so-called driving and enabling factors. Section 6.5 briefly introduces these driving and enabling factors. Finally, section 6.6 contains the summary and conclusions of this chapter.

6.1 Perspectives on strategy and decision-making

The main objective of the current study is to develop a framework of activities that constitute purchasing involvement in product development. These activities range from making decisions at a specific point in time with respect to a particular issue to more or less continuously supporting or managing an ongoing process. Before developing this framework of activities, however, it is appropriate to review, if only briefly, some of the different perspectives on strategy and organisational decision making. This enables us to indicate which ones lie at the basis of the framework of activities, which may be useful in understanding the framework as a whole and the particular definition and wording of the specific activities.

First, consider the concept of 'strategy'. One popular textbook definition of strategy reads:

"A strategy is the pattern or plan that integrates an organization's major goals, policies and action sequences into a cohesive whole. A well-formulated strategy helps to marshal and allocate an organization's resources into a unique and viable posture based on its relative internal competencies and shortcomings, anticipated changes in the environment, and contingent moves by intelligent opponents."

(Quinn, 1980: 3, emphasis added)

Strategies can be formulated at different levels; for example, at the corporate, the business unit and the functional level (Stoner and Freeman, 1989: 202-203). What may be a 'tactic' for the corporate managers may be a 'strategy' for the purchasing manager. In that perspective, the framework of activities regarding purchasing involvement in product development may be seen as a potential strategy, at least at the level of the purchasing and product development functions.

The framework of activities should integrate goals (achieving the key processes of prioritising, mobilising, co-ordinating and timing) with policies and action sequences into a cohesive whole, marshalling and allocating the organisation's resources (see, for example, Chapter 3). The intended framework of activities is rather a strategy than a policy or programme since it does not specify rules or guidelines concerning the *limits* within which the actions should occur or a step-by-step *sequence* of actions.

There are, however, a number of definitions of what a strategy actually is besides the 'plan' or 'pattern' from definition by Quinn (1980). Mintzberg (1987) presents five definitions of strategy:

- as plan - a consciously intended course of action;
- as ploy - a manoeuvre to outwit an opponent;
- as pattern - a pattern in the behaviour of a corporation, even in hindsight;
- as position - a means of locating an organisation in the 'environment'; and
- as perspective - a way of doing things, like organisational culture or character.

The definitions of strategy as plan or as a pattern, which seem the most popular conceptions, can also be related to the distinction between *intended* and *realised* strategy. The difference between the two is the combined effect of only some intended strategies being actually realised by the organisation as *deliberate* strategies, and some non-intended or *emergent* strategies being imposed on the organisation (Mintzberg, 1987). In reality, each strategy can be placed on a continuum from wholly deliberate to totally emergent, where viable strategies combine elements of both (Mintzberg and Waters, 1985: 270; Weggeman, 1995: 72).

By its very nature, the framework of activities developed in the current study mainly has the character of a *plan* or intended strategy. It is formulated as a rather prescriptive set of actions, in the form of a kind of meta-strategy for achieving and giving form to purchasing involvement in product development. Individual organisations may use the framework of activities to develop their own strategy by taking into account their specific context, for example, in terms of driving and enabling conditions or factors (see section 6.5 and Chapter 8). However, the framework of activities does have some aspects of strategy as a *pattern* as well. As indicated in Chapter 1, the framework is being developed by identifying and selecting those specific activities actually being performed by companies investigated in our case studies, and which contribute to one or more of the key processes of prioritising, mobilising, co-ordinating and timing. In other words, based on an actual pattern of activities, be it for different companies together, a general framework of activities or strategy is inferred.

At a more detailed level, the formulation of the individual activities, ranging from specific decisions to continuously managing certain processes or a combination of the two, one implicitly adopts a particular view of organising and organisational decision making. At this point, it seems appropriate to indicate briefly which view or model underlies the current study. Daft (1986: 354-375) discusses four major models of organisational decision-making processes:

- the systems analysis model;
- the Carnegie model;
- the incremental decision process model; and
- the garbage can model.

The systems analysis model implies a rational approach to organisational decision-making processes, stressing the systematic analysis of a problem followed by choice and implementation in a logic step-by-step sequence. The Carnegie model (f.e. Cyert and March, 1963) argues that organisational decisions are reached through alliances of different management coalitions within the firm, rather than by the firm acting as a kind of single entity possessing all relevant information. Coalition-formation is necessary for reconciling often ambiguous and inconsistent organisational goals and for overcoming the limitations individual managers face in terms of bounded rationality. The third model of organisational decision-making, the incremental decision process model, places strong emphasis on the notion that major organisational decisions are usually a series of small choices that combine to produce the major decision. Finally, the garbage can model (Cohen *et al.*, 1972) does not treat the decision process as a sequence of steps beginning with a problem and ending with a solution. Decisions are rather the outcome of four independent streams of events within the organisation (of problems, solutions, participants and choice opportunities) which makes the pattern of organisational decision-making a random, 'garbage-can'-like phenomenon.

Daft (1986: 369-371) argues that each of these four decision models applies to a specific situation in terms of the existing uncertainties or internal disagreement with regard to a) the organisational goals, and b) the means to achieve those goals. The garbage can model applies to situations where both goals and means are highly uncertain, and the systems analysis model applies to situations where both goals and means are relatively certain. The Carnegie model of decision-making can be used in situations where only the goals are highly uncertain, and the incremental decision process model can be used when only the means are highly uncertain.

For our intended framework of activities, we have chosen to adopt the rational or systems analysis approach to organisational decision-making processes. This means that we assume that both the goals and means of purchasing involvement in product development are relatively certain, otherwise the rational approach to decision making would not be appropriate. This assumption may, however, be disputed. The goals of purchasing involvement in product development seem relatively certain: contributing to a number of key processes (prioritising, mobilising, etc.) and, ultimately, maintaining access to technological knowledge of suppliers and achieving reduced development time and costs, reduced product costs and increased product value. As indicated in section 4.4, however, one of the main risks with regard to purchasing involvement in product development is formed by the often inherent differences and tensions between the purchasing and product development function of an organisation. These differences may even imply that there is no agreement on the goals of purchasing involvement in product development. Maybe, the purchasing manager values different goals than the product development manager.

Also the means may be uncertain, when there is either little knowledge and understanding or little agreement about how to achieve the goals. Even within the specific activities that will be identified in our framework, there is considerable latitude in terms of the different ways of executing that activity. Additionally, it may not be clear to what extent each activity contributes to the final goals, which makes it difficult to choose, if necessary, between different activities when, for example, there are limited resources. Despite these possible uncertainties with regard to the goals and means, the framework of activities will be defined and formulated on the basis of a rational approach to decision-making processes. This is mainly related to the fact that the framework of activities is to be presented as a normative plan or strategy to achieve the goals of prioritising, mobilising, co-ordinating and timing. The framework of activities places strong emphasis on what kind of activities should be performed rather than on the means (specific actions) by which they should be realised or on how to create internal consensus regarding the goals. Consequently, the description and wording of the various activities may seem somewhat 'mechanistic'.

In the final Chapter 9, we return to this issue and briefly discuss the possible benefits of adopting other views of organisational decision-making in further developing our framework of activities.

6.2 Initial framework

Within the overall involvement of purchasing in product development, three areas or objects have been distinguished at which this involvement may be focused: Projects, Suppliers and Technologies. Projects focuses on managing or contributing to product development projects; activities with a limited time-frame. In the area of Suppliers, the focus is on permanently maintaining supplier relationships with the objective of supporting and improving the product development capabilities of the firm. Technologies is concerned with the respective specialisation of the firm and its suppliers regarding the development of technical knowledge and competencies. This distinction of different areas or objects is crucial to this study, as one of the shortcomings of existing research on purchasing involvement in product development is its almost exclusive focus on the *short term* activities within specific projects (section 1.1.2).

In this section, specific activities within each of the three areas are discussed. The case studies in Chapter 5 have provided examples how the key processes of prioritising, mobilising, co-ordinating and timing are handled for each of the different areas. By reformulating these examples into more general activities, a general framework is developed that can be applicable to different companies. Each of the three areas with its specific activities is discussed in the following sections, going from the long-term to the more short-term areas.

6.2.1 Technologies

The first area, Technologies, encompasses one activity: determine which technologies to keep/develop in-house, and which ones to outsource to suppliers. This issue has played an important role in several of the case studies on supplier-manufacturer collaboration. In the case of Ericsson Radio - Ericsson Components, the 'develop' decision taken by Ericsson as a whole led to the establishment of in-house development and production of RF power transistors, and consequently the relation between the sister-companies. The Kumla (or rather, Ericsson Radio)-Cityprint relation is also affected by develop-or-buy policies. The SWD-HP relation has evaporated because of a new 'develop' decision. Essentially, the 'Develop-or-Buy' decision involves *prioritising* the technological areas the manufacturer will spend his internal resources on.

The activity of 'determining' which technologies to keep/develop in-house and which ones to outsource sounds rather decisive, but actually encompasses other related, more continuous activities as well such as identifying the technologies relevant to the firm, and analysing their relative 'value'. Thomas (1994) argues that the value (to the manufacturer) of a given technology can be assessed in terms of the availability of the technology, its stability and the level of dependence. The availability of the technology defines the range of suppliers from which it can be obtained, while the stability relates to its stage of development or maturity. The level of dependence defines the reliance of the purchasing firm on that technology for its competitive position (*cf.* Pralahad and Hamel, 1990). The higher the level of availability and stability, and the lower the level of dependence, the greater possibilities to 'Buy' the technology, i.e. leave the development to suppliers. Analysing the availability of technologies in the supplier market may be one of the core contributions by the purchasing function in the whole process of 'determining which technologies to keep in-house'.

The resulting 'Develop-or-Buy' decisions may indicate for different technologies (for example, metal casting or plastics injection moulding) what the manufacturer's involvement in technical development will be, ranging from only setting functional specifications to fully determining the detailed technical specifications. Such a 'Develop-or-Buy' decision is actually a more fundamental decision than the make-or-buy decision for production activities (or supporting services like cleaning and catering), since a decision to 'buy' a certain technology implies that the production activities using that technology have to be outsourced too. When a manufacturer decides to maintain technological know-how in a certain area, it can still decide to outsource the production activities that use that know-how, if appropriate in a particular situation. In other words, the implications of a 'Develop-or-Buy' decision are longer-lasting (Ford and Saren, 1996).

The outcome of a Develop-or-Buy decision is closely related to the extent of supplier involvement in a development project for the products that involve these technologies. However, many companies have determined their Develop-or-Buy policy only to a very limited extent. This often leads to lengthy discussions at the beginning of (and sometimes even during) development projects especially between purchasers and development engineers as clear guidelines what to outsource and what not are missing. By determining beforehand which technologies to keep or develop in-house and which ones to leave to suppliers, and to which degree, a manufacturer may save time and effort at the start of a specific development project. It should be noted, however, that a clear Develop-or-Buy policy does not mean an inflexible policy. The policy could indicate, for example, apart from 'black' technologies that should always be bought and 'white' technologies that should always be developed internally, certain 'grey' areas where a decision should be based primarily on the specific context of a particular project.

Obviously, there are more options than 'totally buy' or 'totally develop' a certain technology. A manufacturer may choose to maintain some basic expertise in a certain technological area, leaving the specialist capabilities to the supplier. In that way, the manufacturer can still evaluate and discuss (to some extent) the technical proposals of the supplier, and monitor technological developments in the supplier market. An example can be found at DAF Trucks, which still maintains expertise in injection systems although it relies heavily on the specialist knowledge of Bosch, and the same applies to Ericsson Radio in Printed Circuit Boards. Quite often, however, the two partners in a collaboration have very different opinions regarding the character of the relation. This applies also the level of manufacturer involvement in the product's technical development (see Table 5.2), which indicates that the parties often do not agree on the extent to which the manufacturer has outsourced the development of the product involved. In general, this may lead to misunderstandings or problems, for example, in the area of compensation and intellectual property rights when parties can not agree on the investments or resources they put into development.

6.2.2 Suppliers

The second area, Suppliers, regards the permanent and long-term activities of maintaining relations with suppliers in such a way that they contribute in an optimal way to the innovative capabilities of the firm. How a manufacturer deals with a supplier in an ongoing relationship affects the willingness and opportunities of that supplier to participate in a particular development project. For instance, at one of the manufacturers discussed in Chapter 5, a supplier once indicated that it had decided to offer its new products no longer to the manufacturer in question but rather to other customers, because it felt mistreated by the manufacturer in its constant and exclusive focus on price. In other words; collaborative projects were hampered by the character of the ongoing relationship.

On the basis of the case studies in Chapter 5, four activities can be distinguished within the area of Suppliers:

- Target suppliers for collaboration;
- Motivate suppliers to develop products the firm needs;
- Exploit the capabilities of suppliers;
- Co-ordinate the development activities of different suppliers.

The first activity in building and maintaining collaborative supplier relationships concerns targeting collaboration partners, which is mainly a matter of *prioritising*. Perstorp has targeted ICI (even formally) as a collaboration partner, apparently because it thinks this supplier will be the most interested in co-operating with a component producer based on the technological characteristics of the product. DAF has targeted Bosch as a collaboration partner because injection systems are such an important component in its trucks, and Bosch is a leading company in that field. This targeting of collaboration partners is not the same as deciding which suppliers are going to be involved in a specific development *project*. In the first place, the kind of collaboration that the manufacturer wants to maintain with these suppliers may not be related to a specific internal development project. A great deal of technological collaboration takes place outside the framework of a specific project, and has a more permanent character. Examples are the different collaborations that Scania and DAF Trucks have with suppliers that are more focused on basic research than on the development of a specific truck or part model (see Box 3.1).

In the second place, manufacturers may want to maintain relationships with a greater number of innovative suppliers for a specific product than they are going to involve in a development project. They may want to have several suppliers in their supplier base to choose from for a specific development project. In that way, they do not become as dependent as they would when always collaborating with one specific supplier. Dyer and Ouchi (1993) argue that this is what some manufacturers aim at with their supplier-assistance programs. On the other hand, maintaining collaborative relationships with a large number of suppliers is not easy, and not for free. One of the motives behind the pervasive trend of reducing the number of suppliers is exactly to better benefit from the technological knowledge of the remaining ones (Burt and Soukup, 1985; Womack *et al.*, 1990; Gadde and Håkansson, 1993).

When targeting suppliers for technical collaboration, manufacturers may first target a type of supplier, or rather: a type of inputs. Chapter 3 has dealt extensively with the characteristics that determine a product's suitability for supplier involvement. In addition to that, Axelsson (1987: 150-166) emphasises that in targeting suppliers for collaboration, attention should be given to technological areas that may be of interest in the future. The selection of partners should therefore be based on the company's long-term technological strategy, and its expectations regarding future technological developments. Following that, the manufacturer has to consider which specific supplier it wants to collaborate with¹. Major aspects to consider in that respect are the supplier's technological and organisational capabilities. Ardon and Van Weele (1994: 73-76) present a detailed checklist of criteria for the evaluation of potential co-operation partners on those aspects. But apart from the capabilities of the supplier, it is important to consider the supplier's willingness or interest in collaboration, as in the case of ICI-Perstorp. The potential for mobilising a supplier, its 'mobility', is one of the key issues in establishing a collaboration that produces results and is efficient in terms of benefits vs. resources invested. This brings us to the second activity.

¹ As suggested before, the two decisions may not always be taken strictly separately. For example, a specific supplier may propose to start collaborating on a new component without the manufacturer previously ever having considered focusing on that component.

The second activity, motivating or getting suppliers interested in developing (parts of) products that the customer firm needs or wants, clearly involves *mobilising*, but also *co-ordinating* and *timing*. To get a supplier interested primarily implies mobilising his resources; in listening and adapting to the manufacturer's needs and wants, the supplier has to consume some of its resources. One possibility for the manufacturer to mobilise the supplier's 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). In a sense, it implies that the manufacturer has to present itself as a kind of *supplier* to its supplier - of unique benefits (Leenders and Blenkhorn, 1988; Kornelius and Wijnstra, 1996). In the case of DAF Trucks, for example, we have seen that it is able to mobilise Bosch: not so much on the basis of the business volume involved, but rather on the basis of its openness and swiftness in sharing information and technical feedback. Ericsson Radio's leading position in the field of mobile telephone systems is a strong mobilising factor in the collaboration with Ericsson Components. Co-ordinated technical capabilities is also a key element in this motivation process. If the manufacturer has some knowledge or expertise the supplier can gain access to through the collaboration, and which is relevant to him, it is easier for the manufacturer to engage the supplier. Scania's expertise in brake retarders is very interesting for Valeo, since it thinks it can leverage that expertise in relations with other customers too. Stork Wärtsilä Diesel's experience with high power-outputs made it an attractive partner to Holec Projects, since it expected to benefit from this experience in future projects with other customers.

Finally, getting suppliers to collaborate also requires timing, because the resources that companies control are generally limited. When a supplier has a lot of other things going on, it may be very difficult to involve it in (substantial) technological collaboration. On the other hand, if the manufacturer manages to pick the right moment (perhaps just through sheer luck) a supplier may be especially keen on collaborating. FDF's desire to develop a new can, for example, coincided nicely with TDV's efforts to preclude any further substitutions of their products by other packaging forms.

This motivating of suppliers may also entail what is called 'supplier development'. In return for, and to enable and generate suppliers' commitment and collaboration in product development, manufacturers help these suppliers from time to time; just like companies such as Motorola and Honda do (Van Weele and Rozemeijer, 1996: 76-80). This assistance may be related to quality matters, equipment selection and automation, but also to more managerial aspects (see Dyer and Ouchi, 1993: 57). Scania, for example, has given substantial technical and managerial support to a small supplier of simple metal plate parts. This support is part of Scania's strategy to increase the responsibilities of suppliers in product development, and this specific supplier has been one of the pilot-projects. In our experience, however, few companies realise that the sometimes drastic increase in their demands on suppliers in terms of product development capabilities often needs to be paralleled by some form of assistance to suppliers in order to help them make the transition. Such assistance may be especially needed in industries where suppliers only recently are starting to get a bigger role in product development.

The importance of motivating a supplier to participate in technical collaboration is often underestimated because most practitioners and researchers usually see manufacturers as being more powerful than suppliers, thus being able to 'demand' or even force their suppliers to collaborate (f.e. by threatening to withdraw business). The case studies in Chapter 5 have clearly shown that this is not always the case, and even if it would be possible for manufacturers to force their suppliers to collaborate, it is questionable whether this is a more productive avenue than the motivation approach, especially in the long run.

The third activity, exploiting the technological competencies of suppliers, also entails *co-ordinating* and *timing*. Naturally, all collaborations, also those of the cases in Chapter 5, involve some exploitation of the supplier's technical capabilities, usually in areas decided by the manufacturer. In the case of DAF-Bosch, the manufacturer even convinced this large supplier to continue with some developments that otherwise would have been dropped. But instead of having the supplier develop products the manufacturer needs, 'exploiting' also refers to letting the manufacturer adapt to the capabilities of its suppliers. Exploiting, in that context, means that the customer does not ask its suppliers to develop certain products which it needs for its new end products, but rather that the customer firm closely watches and analyses the capabilities of its supplier, and adapts to that by building a new product around the component or material developed by the supplier. This strategy can be especially effective when a customer is faced by large, powerful or very innovative suppliers. In our case studies, an example is Pripps exploiting Munksjö's existing capabilities in making corrugated board from 100 % recycled fibre, and using that to promote its own image. An even stronger example comes from a Dutch fruit juice producer that was able to enter a completely new distribution channel after it had been introduced to a completely new form of packaging by a supplier. This way of exploiting opportunities and technical capabilities by a 'reversing of roles' can be a very fruitful approach in creating new products².

However, managing suppliers with regard to product development does not only entail activities directed at individual supplier relations. One of the central notions in the Network Approach (section 2.3.2) is that relationships between companies cannot be considered in isolation as relationships influence one another (c.f. Håkansson and Snehota (eds.), 1995; Anderson *et al.*, 1994). When a supplier and a manufacturer co-operate to develop a new product, for example, the supplier may have to place new demands on its relationship with one of its own suppliers. In managing (or studying) collaborative relationships with suppliers, these kind of 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 needs to consider the larger supplier network. This will involve *horizontally* co-ordinating the development capacities and efforts of suppliers delivering different components to the customer firm, and *vertically* co-ordinating development activities between different tiers of suppliers. This co-ordination primarily involves elements of *co-ordinating* and *timing* in order to create the best conditions for collaborative product development (Håkansson and Eriksson, 1993: 30).

In the case of plastic components, as we have seen in the case of Perstorp Components, automobile manufacturers often have direct technological collaboration with the suppliers of raw material such as granulates and resins regarding temperature resistance and colours. One of the case companies introduced in the following section (6.3), ASM Lithography, a Dutch producer of wafer-steppers (used in producing micro-chips), actively works with different tiers of suppliers in product development. In the development of lenses for example, discussions not only involve Carl Zeiss, the supplier of the lenses, but also Zeiss' supplier of glass, Schott. Obviously, lenses are such a critical part in the stepper that ASM wants to have direct contacts with this second tier supplier. Actually, both vertical and horizontal co-ordination also have to be performed within the more limited time frame of specific development projects, and since most of the case studies in Chapter 5 provide better illustrations in that context, these co-ordination activities are discussed in more detail under the area of Projects.

² It also puts the traditional purchasing process (see Figure 4.1) in a new perspective: it does not always have to start with an internal customer specifying its demand, it could very well be initiated by an external supplier specifying its supply.

6.2.3 Projects

Within the area of Projects, three activities can be distinguished on the basis of the case studies:

- determining which suppliers to involve, at which moment, and to what extent,
- co-ordinating development activities of different suppliers, and
- co-ordinating internal development activities with those of suppliers.

The first activity, determining and timing supplier involvement, involves all four key issues of *prioritising*, *mobilising*, *co-ordinating* and *timing*. It is similar to the Suppliers activity of targeting suppliers for collaborative product development, be it now in the context of a specific project. Again, the choice has to be based on the supplier's capabilities and 'mobility', but additionally on the supplier's availability at that specific moment. Chapter 3 has been dealing with the issues involved in this activity. It discusses different basic forms of supplier involvement, distinguishing between the moment and the extent of involvement. It deals with the moment of involvement within the project as being dependent on product characteristics such as complexity, costs and development risk. The extent of involvement is related to the supplier's capabilities (and capacities) and the manufacturer's develop-or-buy strategy.

The issue of which supplier to involve in a project becomes especially relevant when the manufacturer has several suppliers for a specific product. It is not a given fact, however, that only one supplier will be involved for each product. Especially in the automotive industry, it seems common practice in a development project to involve two or three suppliers in the form of a 'Design Contest', the losing supplier becoming, for example, a secondary (or back-up) supplier for that model (Dyer and Ouchi, 1993: 57). We have seen examples of this in the case of ICI, and its collaboration with car manufacturers. In our case-studies, the manufacturers were not co-operating with another supplier directly in parallel to the collaboration we studied. Since technological collaboration takes resources, manufacturers have to balance the costs and benefits of involving more than one supplier (Bonaccorsi and Lipparini, 1994). The choice of involving one or more suppliers also depends on other factors, such as the manufacturer's overall purchasing strategy (single vs. dual or multi-sourcing, see Jonsson, 1997), and the number of available suppliers in the network and their relative technological capabilities.

The second activity concerns horizontally and vertically co-ordinating development activities of different suppliers, as discussed under the area Suppliers, but now within the time frame of a specific project. Horizontal co-ordination, for example between the development activities of a mechanical parts supplier and an electronics supplier, is quite common; almost every product contains parts supplied by more than one supplier, and innovations in the product often affect more than one part. The collaboration between Pripps and Munksjö involved some co-ordination with an equipment supplier, and Bosch collaborates even directly with other engine component suppliers. Also in some other development projects of new packagings we studied at FDF, which are usually not so complex technically speaking, several suppliers are usually involved - for example, a bottle supplier, a cap supplier, a supplier of crates - and their efforts needed to be co-ordinated closely.

Vertical co-ordination between the development activities of so-called first tier suppliers and their (second tier) suppliers seems to be widely practised by the manufacturers in the electronics and auto industries (Kamath and Liker, 1994; Hines, 1994), as demonstrated by the Perstorp-ICI case mentioned earlier. In general, however, co-ordinating the work of different suppliers during product development seems to be a difficult activity. Scania has experienced this in one of the other relations we studied, where suppliers were unwilling to co-operate because of their fear of having to disclose strategic information or knowledge.

Also for DAF Trucks, 'early multiple-supplier involvement' in product development is a complicated and difficult issue, requiring special management attention (Jacobs, 1996; Van Dongen, 1995: Chapter 8).

It is important to observe that it is not always and exclusively the manufacturer that carries out this horizontal and vertical co-ordination of development activities; suppliers may carry out this co-ordination (partly) by themselves too. Horizontally, suppliers may co-ordinate their efforts directly with each other, with only limited ('arms length') involvement of the manufacturer. This happens especially when the suppliers know each other well, for example through operating in the same kind of 'consortia' vis-à-vis a manufacturer. Millen-Porter (1996) reports that Caterpillar, producer of utility vehicles and engines, encourages suppliers of components that are part of the same sub-system to co-operate in joint development. The motive for Caterpillar bringing three suppliers together is to get a complete working system, in an efficient way³.

But also in vertical co-ordination, the manufacturer may leave it to its first tier supplier to co-ordinate its development activities with those of second tier suppliers. This is one of the main reasons of having a tiered supplier structure in the first place⁴. Within the tiering structure it is the responsibility of each tier to manage and communicate with the level below (cf. Nishiguschi, 1987; Hines, 1994; Burt and Doyle, 1993). When a manufacturer does choose to deal directly with second or even lower tier suppliers, it is usually because it regards a crucial product technically (ASM Lithography) or financially speaking, or because suppliers do not have the skills to undertake this co-ordination. Chrysler applies this multi-tier approach not only in product development but also in quality improvement and cost reduction programs under the name of Value Chain Mapping (Van Weele and Rozemeijer, 1996: 54).

The third activity in the area of Projects concerns the co-ordination of development activities of suppliers with those of internal departments of the manufacturer. This activity centres around *co-ordinating* and *timing*. The case studies did not consider the development activities going on internally at the manufacturer in great detail. What has become clear, however, is that this need for co-ordination is not always that strong: in the collaboration between Ericsson Radio and Ericsson Components, there was no real 'joint' development taking place. In the collaboration between DAF Trucks and Bosch, however, there seems to be much more co-ordination taking place between the development activities since DAF spends a lot of time too in R&D on injection systems and their interaction with other parts of the truck engine. The need for co-ordination of development activities seems therefore closely related to the form of supplier involvement, as discussed in section 3.4. When development work is being carried out equally by the manufacturer and the supplier, the co-ordination is likely to be the most intensive.

³ A project focusing on combustion improvement involving a piston supplier, a piston ring supplier and a cylinder liner supplier even received a Caterpillar Annual Quality Initiative award.

⁴ First tier suppliers are usually considered to be the most active in technological development together with the final assembler, as only they are able to make the necessary investments in personnel, design systems, testing facilities and R&D (Kamath and Liker, 1994). Lamming (1993), however, argues that the roles in the supply chain cannot always be that clearly defined. Instead, Lamming makes the distinction between indirect and direct suppliers, and first tier and second tier supplier. Direct suppliers are always first tier suppliers, but the reverse does not apply. In his definition:

'First-tier suppliers are those that integrate systems for direct supply to the assembler, or have a significant technical influence on the assembler while supplying indirectly. Second-tier suppliers are those that supply components to first-tier firms for integration into systems, or provide some support service, such as metal finishing, etc.' (Lamming, 1993: 188). According to this definition, plastic granulate suppliers are first-tier suppliers, although they supply indirectly. Still, Lamming also makes a distinction between first and second tier suppliers when it comes to innovation: first tier suppliers undertake 'pro-active' innovation, while second tier suppliers mainly innovate in response to customer-identified problems or only develop products on the basis of customer ideas (1993: 221-237).

Table 6.1 lists the three different areas each with its specific activities as they are related to one or more of the key issues.

Table 6.1: Initial framework

Areas	Activity	Key processes
Technologies	<ul style="list-style-type: none"> • Determine which technologies to keep/develop in-house and which ones to outsource to suppliers (Develop-or-Buy) 	P
Suppliers	<ul style="list-style-type: none"> • Target suppliers for technological collaboration • Motivate suppliers to develop products the firm needs • Exploit the capabilities of suppliers • Co-ordinate development activities of different suppliers ('horizontally' and 'vertically') 	P M,C,T C,T C,T
Projects	<ul style="list-style-type: none"> • Determine which suppliers to involve, at which moment, to what extent • Co-ordinate development activities of different suppliers ('horizontally' and 'vertically') • Co-ordinate internal development activities with those of suppliers 	P,M,C,T C,T C,T

*: P=prioritising, M= mobilising; C= co-ordinating; T= timing.

After this first version of the framework of activities constituting purchasing involvement in product development, we now turn to the second series of case studies which have led to some amendments to this framework.

6.3 Mini-cases of 9 Dutch manufacturers

The second series of empirical studies underlying the current study consists of 9 'mini' case studies carried out in co-operation with a working group of the Dutch Association for Purchasing Management (NEVI). Purchasing managers from different companies - some of which had a name as being 'best-in-class' in the field of the involvement of purchasing in new product development in the Netherlands - have been invited to present a short case study of their respective companies, which have then been analysed to identify the major issues in new product development from the perspective of the purchasing function. This resulted in an overview of current practices in various Dutch companies, and the identification of a number of key issues (Wijnstra and Van Stekelenborg, 1996; Botter and Wijnstra (eds.), 1996).

In section 5.8, it has been indicated that our descriptions of the case-studies of manufacturer-supplier collaboration in product development may have been biased towards the more *strategic* problems due to the fact that mainly purchasing *managers* have been interviewed. Interviewing operationally responsible purchasers would perhaps have resulted in focusing at more operational problems. In these mini-cases, the main sources of information are again purchasing managers. This should, however, not form a problem in terms of perceptual bias since the main purpose of these mini-cases has been to identify current practices and the main issues in managing purchasing involvement in product development. Purchasing managers are likely to be the persons with a relatively good overview of these issues. Additionally, the mini-cases have not sought to establish which area is the most problematic or deserves the most attention, but are rather meant to provide an overview of the various important areas together.

The companies studied in these mini-cases are:

1. Philips Medical Systems -	a producer of	medical equipment;
2. Fokker Aircraft		aircraft;
3. Océ-van der Grinten		copiers and drawing room equipment;
4. Rank Xerox Manufacturing (Nederland BV)		copiers;
5. ASM Lithography		wafer steppers;
6. Fluke Industrial		test and measuring instruments;
7. Hollandse Signaalapparaten		radar systems;
8. Philips CE Hasselt		laser-optic modules; and
9. DAF Trucks		trucks.

Two of the companies, Philips Medical Systems and DAF Trucks, are also studied in one of the two other phases of the empirical research. At most of the companies, additional interviews or students' projects have been carried out to complement the information provided in the working group (see Appendix E for details). Still, however, these companies and their ways of managing purchasing involvement in product development have not been studied very intensively, and hence the label 'mini-cases'. Therefore, there is no use in discussing them at length, for example, in order to compare how the different companies handle a specific issue. The most important result of these case studies, and the main purpose of presenting them here, concerns the identification of various 'levels of responsibility' within purchasing involvement in product development.

6.3.1 Results: five levels of responsibility

One of the central notions resulting from the mini-case studies is that activities related to purchasing involvement in product development are being performed at different levels in the organisation. Purchasers and development engineers discuss the design of a new product, and monitor the progress a supplier is making in developing a specific component for that product. Purchasing managers and perhaps some of their colleagues from R&D periodically meet with important suppliers to evaluate ongoing business and discuss potential future developments in terms of new technologies. Purchasing directors develop guidelines for their department's responsibilities and tasks in product development projects, and general management may consider to outsource research and development regarding a specific technology to suppliers. This notion has led to distinguishing a number of 'levels of responsibility' within purchasing involvement in product development, ranging from operational to more strategic responsibilities. These levels are:

- specification responsibility;
- operation responsibility;
- preparation responsibility;
- structure responsibility; and
- policy responsibility.

At the first level, purchasing's involvement in product development involves a design or rather *specification responsibility*. This refers to assisting in the actual development of the new product as far as supplier materials/components/assemblies are concerned by considering issues that should be taken into account from a purchasing perspective (e.g. technology availability, new technological developments in supplier markets, capacity constraints, production (im-)possibilities, lead time and cost consequences). A further distinction can be made between 'restrictive' activities, aimed at *limiting* the number of alternative specifications, and 'extending' activities, aimed at *increasing* the number of alternatives (Erens and Van Stekelenborg, 1993).

The second level, *operation responsibility*, refers to tasks like the planning and co-ordination of development activities of suppliers *during* a development project; preparing and starting such a development project is regarded as a *preparation responsibility*. The fourth level, *structure responsibility*, includes activities related to the management of a base of preferred development suppliers. Unlike the three previous levels of responsibility, these activities are not project-specific, but targeted at permanently having a supplier (infra-)structure available, which may be 'activated' when a specific project comes up. Finally, *policy responsibility* regards the formulation and communication of guidelines and policies regarding the role of the different internal departments and suppliers in product development. This policy responsibility may form the basis for the four other areas of responsibility.

Together with this distinction of five levels of responsibility, the mini-case studies also resulted in identifying an additional key process underlying purchasing involvement in product development.

6.3.2 Results: one additional key process

Until now, we have been talking about four key processes underlying purchasing involvement in product development, originally defined by Håkansson and Eriksson (1993) (section 4.3.1): prioritising, mobilising, co-ordinating and timing. These processes have been quite useful to describe and analyse the case studies on manufacturer-supplier collaboration in product development (Chapter 5), and in developing the first version of a framework regarding the activities constituting purchasing involvement in product development. Increasingly, however, it has become clear that these key processes - and thus the specific activities based on that - are related to managing supplier involvement rather than purchasing involvement.

The mini-cases have clearly demonstrated that purchasing involvement is more than only managing supplier involvement, as reflected in the specification responsibility. The essence of the difference between purchasing involvement and managing supplier involvement regards the collection and dissemination of information before or in parallel with the actual involvement of suppliers. Part of this relates to what has previously been introduced as 'search' (Bonaccorsi, 1992: 36): the exploration of alternative technical solutions. In section 4.3.1, it has been argued that the experimentation and testing of technical solutions is not a key task within the functional domain of purchasing, but rather within the domain of the product development function. However, what does form part of purchasing's responsibility in product development is the identification and first exploration of technical solutions provided in the supplier market. O'Neal (1993: 6) describes this process quite aptly:

"As marketing is scanning the environment for unfulfilled needs, and R&D is developing/ acquiring new technology, purchasing is actively acquiring, assimilating, digesting, and sharing information on new and forthcoming supplier developments."

These are activities not directly related to managing supplier involvement, but which take place prior to (and in parallel with) selecting and working with particular suppliers, like carrying out market research, evaluating different alternative component designs in terms of availability and costs. We label the underlying process for these kind of activities '*informing*', referring to both acquiring and sharing information. With this addition, the involvement of purchasing in product development can be seen to rely on *five* key processes: prioritising, mobilising, co-ordinating, timing and informing. This amounts to an adaptation of Håkansson and Eriksson's original conceptualisation.

Consequently, a basic definition of purchasing's involvement in product development would be:

"acquiring and sharing (technical) information about supply markets and individual suppliers for product development purposes, and co-ordinating collaborative product development between supplier(s) and manufacturer".

In the following section, the first version of the framework that has been developed in section 6.2 is being revised based on the two notions from the mini-cases; a variety of levels of 'responsibility' with regard to purchasing involvement activities and a fifth underlying key process.

6.4 Revised framework

At this point, two dimensions have been identified along which a distinction can be made of the different activities within purchasing involvement in product development: objects or areas and levels of responsibility. On close inspection, however, these dimensions seem to overlap to a considerable extent. Therefore, the revised version of the framework integrates the two dimensions (see Figure 6.1).

Figure 6.1: Integrating the areas and levels of responsibility

Combining the three areas or objects from our initial framework and the five levels of responsibility, it is possible to distinguish four different management areas: Development Management, Supplier Interface Management, Project Management and Product Management. Development Management combines the previous area of Technologies and the level of policy responsibility. In a sense, it includes activities that set the stage for the other areas of purchasing involvement in product development. The area of Supplier Interface Management combines the area of Suppliers and the structure responsibility, involving the permanent and ongoing management of supplier relationships. Project Management integrates the area of Projects and the preparation and operation responsibilities, including activities like preparing, planning and co-ordinating product development activities of suppliers during a specific development project, which per definition have a more limited time-frame than the activities within Supplier Interface Management.

Within Project Management, a distinction can be made between Project Planning (before the project's start) and Project Execution (during the project) activities. Both Project Planning and Project Execution mainly encompass activities in order to enable and support the development *process*. In addition to that, however, there are activities that are not primarily concerned with the process of developing the product, but rather with the new product itself: these are grouped into the area of Product Management. This final area refers to what has previously been called specification responsibility. Note that Product Management, in our definition, is essentially different from what is referred to as product management in the general marketing literature. There, it is used to refer to cross-functional management of a range of products, including developing long-range strategies and, for example, preparing marketing plans and sales forecasts. In that sense, it is similar to the term brand management (Kotler, 1991: 690-691). We use the term Product Management to refer to those activities regarding purchasing involvement in product development that are directly aimed at (the design or specifications of) the new product.

The other notion from the mini-case studies, the existence of a fifth key process, can easily be combined with the four key processes of the initial framework. It can be seen as an additional variable in the same dimension. The revised framework concerning purchasing involvement in product development then consists of *four management areas* and *five underlying key processes*. In the following sub-sections, specific activities within each of the four areas are presented and discussed, also in terms of their relation to one or more of the five underlying key processes. Many of those activities have already been identified in the context of the initial framework, and are therefore not discussed in detail. Only the 'new' activities, obviously many of which are related to the process of informing, are presented more extensively, among others by referring to examples from the mini-case studies.

6.4.1 Development Management

The first area, Development Management, encompasses four activities:

- Determining which technologies to keep/develop in-house and which ones to outsource to suppliers;
- Formulating guidelines for the involvement of suppliers in product development;
- Formulating guidelines for purchasing related activities of internal departments in product development; and
- Communicating policies and procedures internally and externally.

The first activity, determining which technologies to keep/develop in-house and which ones to outsource to suppliers, has already been discussed extensively in relation to the initial version of the framework, as the main activity within the area of Technologies (section 6.2.1).

Apart from such Develop-or-Buy decisions or issues, Development Management involves determining guidelines for supplier involvement and the purchasing related activities of internal departments within product development. These guidelines can indicate what the manufacturer expects from suppliers and what suppliers may expect from the manufacturer regarding product development, for example in terms of communication, documentation and compensation. The guidelines may also indicate the responsibilities and activities of different internal departments regarding purchasing related activities in product development, since the different activities need not be the domain of the purchasing *department*. Some activities can be carried out by people from the Development department, depending on their expertise and experience. In essence, these guidelines should indicate how, when and by whom the activities in the three other areas - Supplier Interface Management, Project Management and Product Management - are carried out.

Primarily, these external and internal guidelines can be seen as instruments for *co-ordinating* and *timing*. They should handle the interdependencies between the different activities and processes involved - in content (co-ordinating) and in time (timing).

Finally, without effectively communicating these guidelines, clearly a case of *informing*, it may be difficult to create understanding and acceptance for the role and involvement of suppliers and the different departments in product development. Guidelines can provide a constructive basis for discussing problems in the development process, and serve as a reference in possible competence conflicts. It is important to communicate these guidelines also to suppliers. Suppliers also benefit from clear guidelines with regard to their responsibilities and those of the departments at the manufacturer: they can adapt their strategy and ways of working to the demands of the manufacturer, and know who to turn to with specific problems.

One of the mini-case companies, Océ-van der Grinten, has developed a policy for supplier involvement in the form of a portfolio approach in distinguishing and managing different supplier roles in product development (see section 3.4.5). This policy also provides guidelines regarding the responsibilities and tasks of departments such as purchasing and product development. Appendix G contains a similar set of guidelines that we have developed for Philips Medical Systems, which is discussed further in section 7.4. At Philips CE Hasselt, one of the main reasons why purchasing is not structurally and intensively involved in product development seems to be a lack of guidelines and policies (Yeh, 1996).

6.4.2 Supplier Interface Management

Within the area of Supplier Interface Management, it is possible to distinguish five main activities:

- Monitoring supplier markets for technical developments;
- Pre-selecting suppliers for product development collaboration;
- Motivating suppliers to build up/maintain specific knowledge or develop certain products;
- Exploiting the technical capabilities of suppliers; and
- Evaluating suppliers' development performance.

The first, monitoring supplier markets with regard to technical developments, including the abilities of specific suppliers, is a basic activity that is instrumental to build up technological competence (*cf.* Axelsson and Laage-Hellman, 1991: 83). Market research is a quite common activity within purchasing and exists in different forms (Van Weele, 1994: 97-106), but here we explicitly refer to market research that is targeted at technical aspects. This excludes research that is, for example, meant to find a more competitive supplier for an existing standard product. It does include pro-active, continuous research with the aim of identifying suppliers and/or technologies that may be relevant for the development of new products. It is thus also opposed to ad-hoc research (Van Weele, 1994: 100) in the frame of a specific development project, like a quick scan that seeks to identify an alternative supplier for a specific new component. The key process involved clearly is *informing*.

Within the mini-case companies, we have actually seen few clear examples of this monitoring of supplier markets. Only Rank Xerox and Océ-van der Grinten explicitly indicate this as one of the purchasing responsibilities within product development. Many of the case companies agree it is an important issue, but few have clear guidelines on, for example, how and how often it should be done. Usually, market research seems to be done in the ad-hoc mode without a clear (long-term) plan. At the time when the mini-cases were being conducted, Philips Medical Systems was in the process of giving market research a more prominent place within the job description of its initial purchasers.

The second activity concerns pre-selecting preferred suppliers for collaboration in product development. This is the same as 'target suppliers for collaboration', one of the activities in the initial version of the framework in the Suppliers area. Also the third activity, motivating suppliers to build up or maintain specific knowledge and develop certain products, and the fourth activity, exploiting the technological competencies of suppliers, have been discussed within the initial framework (see section 6.2.2).

The fifth and final activity concerns evaluating supplier performance with regard to product development. In order to keep the preferred supplier base updated, this performance has to be assessed periodically, based on the experiences in product development projects. This assessment will take place mainly at the level of the development *process* at the supplier, for example in terms of adherence to deadlines, reliability and quality in communication and documentation. To some extent, the assessment can also take place at a *product* level, for example by reviewing the quality and cost of previously developed parts compared to the original objectives. The methods involved are a combination of objective methods such as vendor-rating on quantitatively measurable aspects and more subjective methods such as personal assessments by engineers and purchasers (see Van Weele, 1994: 228-229). Assessment methods specifically targeted at product development performance, however, seem to be developed only recently. The case companies provide no specific illustrations of this activity, but many companies feel there is need for this and also for new assessment methods to carry it out. Alfrink (1997) contains a recent (prototype) example from Philips Medical Systems.

Having an up-to-date base of suppliers for different products and technologies that can perform development activities for the manufacturer makes the selection of suppliers to collaborate with in a specific project more efficient by reducing the need for searching and rating suppliers. Ericsson Radio's plant in Kumla works with such a list of preferred suppliers, and so does Philips Medical Systems' XRD business unit (Van Stekelenborg, 1997: 123-124; see also section 7.4). In fact, many companies use so-called shortlists or pre-qualified suppliers, but the criteria do not always include specific considerations of the supplier's ability to collaborate in product development. Ericsson, however, includes aspects such as supplier profitability and number of training hours in its assessment of suppliers, since it argues these have a positive effect on the supplier's investment possibilities and innovative performance.

Supplier Interface Management does not include the horizontal and vertical co-ordination of development activities of different suppliers, as in the Suppliers area of the initial version of our framework. On reflection, the examples from the case studies in Chapter 5 used to illustrate this activity concern activities within the context of specific projects rather than some sort of permanent process (see also 6.2.2). Also in the mini-cases, the kind of co-ordination between different suppliers that does take place is mainly related to specific development projects. Permanent vertical and horizontal co-ordination of suppliers' development capabilities may be very costly and time-consuming, and not as important as co-ordination within a specific project. Therefore, this activity has been reserved for the area of Project Management.

6.4.3 Project Management

Within the area of Project Management, two specific sub-areas may be distinguished: Project Planning and Project Execution. Planning activities are performed at the start of a development project, while execution activities are performed during a project.

Project Planning

Project Planning entails four main activities:

- Determining specific Develop-or-Buy solutions;
- Selecting suppliers for involvement in the development project;
- Determining the extent ('workload') of supplier involvement; and
- Determining the moment of supplier involvement.

The first activity regards project-specific develop-or-buy decisions. These have previously been discussed under the heading of Development Management as a long-term activity, but need to be considered also in the context of specific projects. The company may have a Develop-or-Buy policy, but this will not always automatically imply which decisions should be taken at the project level, for example because the component involved incorporates a totally new technology not yet considered, or because the project needs to meet a tough deadline which means that the manufacturer cannot undertake all development work it usually undertakes. Just like within the area of Development Management, it primarily involves *prioritising*. The other three activities have previously, in the initial version of the framework, been discussed as one single activity in the area of Projects. The first of these, selecting suppliers, similar to the Supplier Interface Management activity of pre-selecting suppliers, has been discussed most extensively in section 6.2.3, and therefore the attention is focused at the other two activities.

Determining the extent ('workload') of supplier involvement, is closely related to the first two activities in Project Planning. It is related to decisions on Develop-or-Buy issues; these decisions will not only involve 'totally buy' or 'totally develop' options, but also intermediate solutions (see 6.2), and thus give an indication of the required extent of supplier involvement⁵. It is also closely related to the process of selecting the supplier; the kind of workload that the manufacturer wants to give to a supplier will influence the criteria used in supplier selection. Conversely, the kind of supplier that is available, and ultimately gets selected may limit the workload a manufacturer can give to the supplier. Not in all industries, manufacturers can choose from a range of qualified suppliers that have substantial internal development resources. Ultimately, a previously taken 'buy' decision may have to be reconsidered when it becomes apparent that no appropriate supplier is available. This determining of supplier workload is mainly a matter of *prioritising* and *co-ordinating*, as it essentially involves choosing and co-ordinating between involving supplier and internal development resources.

⁵ The Develop-or-Buy decision and the decision on the extent of supplier involvement are so inextricably related that they could be seen as essentially the same. However, it is appropriate to separate them since the Develop-or-Buy decision is often taken prior to supplier selection.

The fourth and final activity in Project Planning involves determining the moment of supplier involvement. Chapter 3 has discussed this moment of involvement as being dependent on product characteristics such as complexity, costs and development risk, as opposed to the extent of involvement which should be based on the supplier's capabilities (and capacities) and the manufacturer's develop-or-buy strategy. Determining this moment, or more precisely: differentiating between different moments for different suppliers, contributes to using the manufacturer's resources for managing this supplier involvement as efficiently as possible and to supporting the development process' progress (see section 3.4); in other words, it is about *prioritising* and *timing*.

Project Execution

While the Project Planning activities are primarily carried out during the initial phase of a development project, or even prior to that, Project Execution involves activities *during* the project. It encompasses four main activities:

- Co-ordinating development activities between suppliers and manufacturer;
- Co-ordinating development activities between different first tier suppliers;
- Co-ordinating development activities between first tier suppliers and second tier suppliers; and
- Ordering and chasing proto-types.

The first three activities are the same as those identified in the first version of the framework, in the area of Projects (which did not yet differentiate between planning and execution activities). The fourth, new activity concerns co-ordinating prototyping and production start-up. The co-ordination of the design and delivery of prototypes is very important for a successful development project (Wheelwright and Clark, 1992), and a good performance of suppliers in this context is often crucial (Kamath and Liker, 1994).

6.4.4 Product Management

With regard to actually assisting in the development of the new product, i.e. directly contributing to the specifications of the new product, the activities can be categorised into 'extending' and 'restrictive' contributions to the new product development process. Restrictive activities are aimed at limiting the number of alternative specifications, while extending activities are aimed at increasing the number of alternatives (Erens and Van Stekelenborg, 1993; see also Dowlatsahi, 1992). The activities encompass:

Extending activities:

- Providing information on new products and technologies being developed or already available in supplier markets; and
- Suggesting alternative suppliers, products and techniques that can result in a higher quality of the final product.

Restrictive activities:

- Evaluating designed parts in terms of availability, makeability, lead-time, quality, and costs; and
- Promoting standardisation and simplification of designs and parts.

In the first place, Product Management involves providing information on new products and technologies that are available or being developed in the supplier market. This is an activity that is especially relevant in the first phases of a development project. Somewhat later during the project, after the first options have been reviewed, Product Management involves suggesting alternative suppliers, product and technologies in order to achieve a higher product quality. Both these 'extending' activities are closely connected to the activities in the area of Supplier Interface Management, especially the monitoring of supplier markets.

Knowledge about alternative technologies and the capabilities of specific suppliers is crucial for being able to add value to product development: a 'centralised locus of control with respect to the flow and exchange of technical information' (Williams and Smith, 1990) is an advantage for becoming involved in the product development process.

Suggesting alternatives is closely related to the third activity: evaluating product designs in terms of availability, makeability, lead-time, quality, and costs. This involves informing internal departments about various suppliers' (in)abilities to meet specifications, giving information about costs, performance, market availability, quality and reliability of particular components (Burt and Soukup, 1985). Finally, Product Management includes finding and proposing other parts that have more common specifications, in order to gain efficiency and purchasing leverage. Part standardisation and simplification 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).

These four activities are part of the range of purchasing related activities within product development, and thus belong to the domain of the purchasing function. However, they can also be carried out directly by suppliers themselves (see section 3.2), but especially for those suppliers that are not (yet) directly involved in a development project, the purchasing function can act as a kind of 'window' on their technological capabilities. All these four activities involve the key process of *informing*, while suggesting alternatives and promoting standardisation and simplification also involve *prioritising* and *mobilising* as they essentially concern choices between different options, and trying to convince or motivate various functions (such as Research and Development, or Production) to choose certain options. These activities are especially prone towards exposing or generating the kind of conflicts identified in section 4.4.

Hollandse Signaalapparaten, the manufacturer of maritime radar systems, provides a good example of these extending and restrictive Product Management activities. For some 20 groups of components, the company employs teams of purchasers and development engineers, so-called Article Specialists. The specialists have to give their permission to development engineers that want to design a new component, by signing a request for the introduction of a purchase item ('Aanvraag Introductie Koopdeel, AIK'). Based on their experience, technical expertise and market information, the Article Specialists may agree on the specifications and propose the appropriate supplier, or suggest a different design so that available suppliers can meet the specifications. Alternatively, the Specialists may reject the request and refer the engineer to the company's list of standard purchase parts if they think the costs of designing and producing a new part outweigh the benefits, while an existing component can do the job too (Cuijpers and Wijnstra, 1996).

As an overview, Table 6.2 presents the revised framework with the four different areas of purchasing involvement in product development each with its specific activities, and the underlying processes.

Table 6.2: Revised framework

Areas	Activity	Key processes*
Development Management	<ul style="list-style-type: none"> Determining which technologies to keep/develop in-house and which ones to outsource to suppliers Formulating policies for the involvement of suppliers Formulating policies for purchasing related activities of internal departments Communicating policies and procedures internally and externally 	P C, T C, T I
Supplier Interface Management	<ul style="list-style-type: none"> Monitoring supplier markets for technical developments Pre-selecting suppliers for product development collaboration Motivating suppliers to build up/maintain specific knowledge or develop certain products Exploiting the technical capabilities of suppliers Evaluating suppliers' development performance 	I P M, C C I
Project Management	Planning: <ul style="list-style-type: none"> Determining specific Develop-or-Buy solutions Selecting suppliers for involvement in the development project Determining the extent ('workload') of supplier involvement Determining the moment of supplier involvement Execution: <ul style="list-style-type: none"> Co-ordinating development activities between suppliers and manufacturer Co-ordinating development activities between different first tier suppliers Co-ordinating development activities between first tier suppliers and second tier suppliers Ordering and chasing proto-types 	P P,M,C,T P,C P,T C,T,I C,T,I C,T,I C,T,I
Product Management	Extending activities: <ul style="list-style-type: none"> Providing information on new products and technologies being developed or already available in supplier markets Suggesting alternative suppliers, products and technologies than can result in a higher quality of the final product Restrictive activities: <ul style="list-style-type: none"> Evaluating product designs in terms of part availability, makeability, lead-time, quality, and costs Promoting standardisation and simplification of designs and parts 	I P,M,I I P,M,I

*: P= prioritising, M= mobilising; C= co-ordinating; T= timing; I= informing.

The table presents the four management areas and the concerning activities as if they are separated, but this is not the case. Apart from the different management areas being connected to each other in terms of sharing (some of) the same underlying processes, the activities are, in many cases, also directly linked to each other. Already in section 4.3.2, it has been indicated that the different areas of purchasing involvement are closely related to each other. The supplier involvement policies developed within the context of Development Management, for example, are connected to the Project Planning activities of determining the extent and moment of supplier involvement in a specific project. The market monitoring activities within Supplier Interface Management are closely related to (being able to contribute useful input to) Develop-or-Buy discussions, be it long-term within the context of Development Management or within a specific project in the area of Project Planning. Similarly, Product Management activities such as suggesting alternative suppliers, products or technologies are closely intertwined with Supplier Interface Management activities such as market monitoring and motivating individual suppliers to develop specific knowledge or products. In fact, Supplier Interface Management plays a central role as all other areas draw upon this area. While it may be possible, for example, to have Development Management without Product Management, although the latter will normally be a result of the former, Supplier Interface Management is hard to do without. These close relations between the different management areas are illustrated in Figure 6.2.

Figure 6.2: Interrelations between the four management areas

The revised version of the framework forms the achievement of our first research objective: developing an integrated framework of purchasing activities related to product development (see section 1.2.1). However, the idea in developing this framework is not that each firm is or should be performing *all* of these activities all the time. In reality, different firms may or should emphasise different activities, and may not equally be capable of performing the activities. Therefore, the second objective of the current study has been defined as 'developing preliminary insights regarding the application of the framework of activities in terms of factors influencing the need and the possibilities to carry out the activities'. These factors are the so-called driving and enabling factors. The insights are 'preliminary' since the study focuses only on a limited number of driving and enabling factors. These are introduced in the following section.

6.5 Driving and enabling factors

The framework of activities has been developed by taking different elements from literature (the key processes and the areas of purchasing involvement) and specific examples of activities from two series of case studies. In that sense, the framework is rather eclectic, combining different building blocks from different empirical and 'theoretical' sources. However, it is likely that of the different activities in the framework, not all are equally necessary or *important* in all situations. In other words, there may or may not be particular *driving* factors present in a certain situation. It is also possible that specific activities are important, but not or less *possible* to carry out due to a lack of *enabling* factors. One important aspect of driving factors is that within the context of purchasing involvement in product development, they are given. One does not change, for instance, company size, just to improve purchasing involvement. Enabling factors, on the other hand, can be manipulated - they are a 'decision variable' - within the context of supplier and purchasing involvement.

6.5.1 Driving factors

As driving factors we have chosen to focus on the following four aspects:

- company size, measured in turnover;
- production type or technology;
- the overall dependence/reliance on suppliers measured as purchasing share in turnover; and
- the importance of product development, measured as R&D expenditure related to turnover.

Prior research, to our knowledge, has not investigated the impact of driving factors on the extent of purchasing involvement in product development. Hartley (1994: 143-149) comes closest to investigating driving factors. She studies a) the newness and the technical complexity of the product under development, and b) the urgency of the development project and the need for supplier input. These are hypothesised to have an impact on 'buyer's management techniques', including:

- early timing of supplier involvement;
- increasing supplier roles in design;
- frequent communication; and
- direct communication between technical personnel of the supplier and the manufacturer.

However, neither the newness and complexity of the developed product nor the urgency of the project were significantly related - i.e. an important motivator or driving factor - to the use of these techniques. Only the need for supplier input, measured by the need for the unique skills of the supplier and the importance of its component to the final product, could explain the extent of the use of the different management techniques. The latter findings confirm what has been said earlier, in Chapter 3, about the factors determining the moment and extent of supplier involvement.

At the same time it is clear, however, that Hartley (1994) focuses nearly exclusively on managing supplier involvement, which according to our framework is only one part of purchasing involvement. Additionally, she focuses on driving factors *specific to an individual development project*. The interest in our study lies with more *permanent* driving factors inherent to the manufacturing company, since many of the activities concerning purchasing involvement are not limited to a specific project. Therefore, the research by Hartley provides us with little direct starting points for considering the driving factors for purchasing involvement as defined in the current study. Because of the lack of prior research, the four driving factors have been selected primarily on the basis of general notions of the relation between purchasing and product development. They are *hypothetical* driving factors.

Company size has been selected as the first possible driving factor, primarily as an indicator of overall organisational complexity. The more complex an organisation, the more important it may become, for example, to develop and communicate guidelines for supplier involvement. If an organisation is small, the few people concerned may simply agree on doing things a certain way, without labelling and communicating it as guidelines or policies. Additionally, the larger and the more complex an organisation, the more likely it is that development projects involve a variety of internal departments and external suppliers. Co-ordination of development activities between the manufacturer and the supplier, and between different suppliers, may hence become an increasingly relevant activity.

However, company size could also be seen as an enabling factor. For example, as companies grow bigger, departments get bigger with more opportunities for specialisation. A purchasing department may become divided into an initial purchasing group and a operational purchasing group, which provides the first with better opportunities to focus on activities related to product development. Still, since company size is not a decision variable within the context of purchasing involvement, it is primarily a driving factor.

Production type has been selected as the second possible driving factor, mainly because of one important observation regarding existing research in the area. This observation was that nearly all research is limited to large series production industries, such as automotive and electronics (see section 1.1.2). Therefore, the empirical research of the current study has been designed to cover different industries and different production types. In Chapter 5, the case studies of manufacturer-supplier collaboration from different industries have demonstrated the universality of the five key processes. This does not imply, however, that the specific activities and the four management areas are equally important to companies with different production types. Ordering and chasing prototypes, for example, is probably more relevant for firms with series production than for unit and process production firms.

The third possible driving factor regards the overall dependence/reliance on suppliers, measured as purchasing share in turnover (purchasing ratio). The more dependent a company is on suppliers for producing its final product, the more likely it is to be dependent on suppliers for developing that product. The higher the supplier dependence, the more likely purchasers are, for instance, to motivate suppliers to build up specific knowledge in areas the manufacturer needs the most. However, the purchasing ratio is a purely financial ratio: it does not provide information on how important supplier products are technically speaking. Even if a manufacturer buys parts from suppliers for a value amounting to 80 % of its turnover, this says nothing about the relations with those suppliers or the kind of parts. These parts may all well be standard parts, with no technical collaboration taking place and the manufacturer doing all the product development itself. In general, however, purchasing ratio may be a useful proxy for supplier dependence.

The fourth and final driving factor considered in this study regards the importance of product development, reflected in the level of R&D expenditure related to turnover. The higher the expenses on research & development, the more likely product development is to take place. Other things equal, more product development means more need for purchasing involvement. Although there is not a one-to-one relationship between R&D expenditure and product development (some expenses may be related to process innovation, and research does not always lead to new products), expenditure does give an indication of the degree of the technology intensity or 'innovativeness' of the company and its products. Another possible indicator which is often used to describe the innovativeness of firms is the proportion of the company's products that are no older than, for example, 3-4 years. This figure may, however, be more difficult to determine than R&D expenditure, and therefore be potentially less reliable. The level of R&D expenditure has the additional benefit of focusing on the development activities and not on the actual success of new products in the market, as the share of new products in turnover does. This proportion or success of new products may not only be an indicator of the need for purchasing involvement, but ultimately also of the *results* of that involvement. Therefore, in the current context, the intensity of product development may better be measured by R&D expenditure than by the proportion new products.

There is one drawback with the level of R&D expenditure, and that is that higher (internal) expenses may mean less involvement of external actors such as suppliers. In other words, high expenditure may indicate a reliance on in-house development, implying less supplier involvement and, consequently, less (need for) purchasing involvement. We assume, however, that higher R&D expenditure is primarily a sign of more development activities taking place overall, rather than indicating a shift in these activities from supplier to manufacturer. This assumption is supported by findings of Håkansson (1989: 100-101), which demonstrate (for a group of 120 small and medium sized Swedish manufacturing companies; see section 3.1) that the relative propensity to co-operate with external partners slightly rises with an increase in total investment in technological development. So, when research and development activities increase (and expenditures go up), external actors including suppliers even become more important collaboration partners.

6.5.2 Enabling factors

There are three areas which seem to be important facilitating or rather enabling factors:

- a suitable *organisation* of the purchasing function, supportive to the required communication and co-ordination in product development;
- well-organised exchange and recording of *information* relevant to the product development process and its management, possibly supported by IT tools; and
- adequate *human resources* in terms of personnel with the right education, skills and experience.

Again, previous research provides little starting points to consider the impact of enabling factors on purchasing involvement. Of the available studies, only Peter (1996: 59-71) and Birou (1994: 74-81) focus on 'prerequisites' or 'integrative mechanisms', but only with regard to their impact on *supplier* involvement in product development. Some of the factors investigated by Birou (1994), however, may have been characterised as enabling factors not only for supplier involvement but also for purchasing involvement in product development. These can be related to the three factors mentioned above as follows:

- organisation - 'structural integrative mechanisms' (Birou, 1994: 164);
- information - 'information importance' and 'information accessibility' (165-166);
- human resources - 'group process: cohesion' (167).

In fact, as discussed in section 3.5.3, Birou discovered negative relations between supplier involvement in product development and project performance in terms of development time, cost and quality. Similarly, the impact of the enabling factors was often found to be negative or insignificant (Birou, 1994: 170-203). Having noted the drawbacks of that study (3.5.3), we maintain that these three factors are potentially important enabling factors; probably even more with regard to purchasing involvement than supplier involvement in product development.

The three factors organisation, information and human resources encompass elements that are likely to increase the organisation's ability for performing the different activities or tasks, and performing them in an efficient and effective way. 'Efficient' meaning that the efforts spent on carrying out the activities is optimised, and 'effective' meaning that the activities are carried out successfully. For example, the activity of '*providing information on new product and technologies*' is carried out efficiently when the efforts involved in collecting and disseminating this information are relatively limited, for instance by using output of available supplier market research and putting this regularly on an intra-net site. This is carried out effectively when the right information is provided, i.e. the information that is actually useful in the development of a new product, and to the right people. This may be enabled, for example, by the technical knowledge of the purchaser involved.

When enabling factors are not or not sufficiently available, this deficit may turn into barriers. Fragmented, totally functionally-oriented organisations, inadequate and outdated information and personnel without the right experience and skills may make purchasing involvement in product development less efficient, less effective and perhaps even completely impossible. Let us briefly consider the three different factors.

Organisation

The first enabling factor regarding purchasing involvement in product development is an organisation of the purchasing function that supports its effective and efficient involvement in product development. This regards especially the organisation of departments involved in the 'initial' purchasing activities (see section 4.1). The most important criterion the organisation should meet is that it enables cross-functional collaboration. More precisely, departments involved in purchasing and research & development (and production) should be able to work closely together. Formal participation in the product development team, for example, may promote cross-functional contacts and collaboration between purchasers and development engineers, and may lead to a more structured and extensive involvement in product development.

In the case studies, we have seen different ways of promoting cross-functional collaboration. Many companies appoint technical specialists to the purchasing department, with different responsibilities. Some manufacturers appoint 'purchasing engineers' that act as a sort of permanent liaison officers between purchasers and development engineers. This has been done, for example, at different business units within Ericsson Radio. Some other companies have 'project purchasing co-ordinators' that are responsible for the co-ordination of all purchasing issues in a particular development project. One of the companies studied in the mini-cases (section 6.3), Fluke Industrial, appoints one initial purchaser to each development project as a co-ordinator for all issues related to purchased items that may arise in that project. Some companies, like Hollandse Signaalapparaten, use 'product specialists' who continuously work with engineers on a special type of product, supplying information on the commercial implications of different technical designs, and suggesting alternative supply sources (Burt and Soukup, 1985). The advantage of using product specialists, who may be involved in different development projects at the same time since different final products may use the same kind of components or material, is that they usually have a deeper understanding of the technical details of the product concerned, and that the supplier of that product is faced with only one contact person. The advantage of using project purchasing co-ordinators is that they have a better overview of the total development project, and that it uses less man-power.

Information

The second enabling factor regarding purchasing involvement in supplier involvement in product development is the exchange and recording of information. Information can be used in two ways to support the involvement of purchasing and suppliers in product development. In the first place, it can be used to provide support regarding the *content* of the development process. This would involve information tools like, for example, a list of preferred suppliers with information concerning their specific technical capabilities to support supplier selection decisions, or overviews of standard components with indications on availability and costs to support certain engineering decisions (Burt and Soukup, 1985). In the second place, information can be used to support the *process* of product development. This would involve, for instance, information on the status of a particular development 'job' carried out by a supplier to support the co-ordination of development activities (Wijnstra *et al.*, 1996: 72-76).

The registration of and access to these various types of information can be facilitated by information technology (IT) (Erens and Van Stekelenborg, 1993). Component overviews, or 'recommended parts lists' can be registered in databases that can be accessed by different people and searched by using different terms. Component-and-Supplier-Management (CSM) systems are supposed to bridge the gap between design and purchasing. Focused on decision support, their functions include part selection and preferred part and supplier management (Taninecz, 1995; Palmer, 1996).

Process support can be provided by IT tools such as E-mail, supportive to unstructured communication patterns; PDI (Product Data Interchange), useful in the transfer of structured design data such as CAD models; and Groupware applications for sharing design data and project documents (Wijnstra and Van Stekelenborg, 1996: 114; Fischer, 1996). In general, the more complex a development project in terms of number of participating departments, suppliers and number of parts, the more relevant the availability of information and the use of IT. When it is not possible or not easy to register or access information in a complex project, this will lead to more frequent problems (miscommunication, misunderstanding) than in the case of a relatively simple project.

In this thesis, the focus is at the role of information in supporting the content of product development, not the process, primarily because process support tools have a range of application which is much broader than purchasing involvement.

Human resources

Perhaps the most critical requirement for purchasing to play a role in product development is adequate human resources. Apart from social abilities and skills necessary to work at the interface of different disciplines and different organisations (see Price, 1995; Van Weele and Rozemeijer, 1996: 106-111), the combination of commercial and technical knowledge seems to be one of the key criteria in selecting and training people to work with the activities involved in Purchasing's development role. This combination of commercial and technical knowledge can be promoted in different ways. For example, employee rotation between engineering and purchasing departments encourages understanding of the links between the two disciplines. Higher levels of education, particularly in engineering and business, also enhance the involvement of purchasers in development projects (Burt and Soukup, 1985; Anklesaria and Burt, 1987; Atuahene-Gima, 1995).

Additionally, management has a responsibility in personally promoting multi-functional skills and knowledge development. We have seen examples of companies where the purchasing manager, through his personal enthusiasm, inspired purchasers to take more interest in technical issues. Related to this, Atuahene-Gima (1995: 221) found that the perceived skills and capabilities of buyers have a positive influence on their involvement in the product development process. If buyers are seen as a hindrance by engineers and lack credibility within the development team, they will play a limited role (Guy and Dale, 1993). This ties in with the importance of communicating the principles and guidelines of purchasing and supplier involvement in product development.

6.6 Summary and conclusions

This chapter has focused on developing a framework of activities constituting purchasing involvement in product development; our first research objective. For the first version of this framework, we have returned to the three areas introduced in section 4.3, Technologies, Suppliers and Projects, and discussed the specific activities within each area. These activities have been identified based on examples of such activities taking place in the cases reported in Chapter 5. Each activity has been related to one or more of the four key underlying purchasing involvement in product development: prioritising, mobilising, co-ordinating and timing.

The second phase of empirical studies, a series of mini-cases of Dutch manufacturers, has led to making a distinction between different levels of responsibility within purchasing involvement in product development: policy, structure, preparation, operation and specification. These mini-cases have also demonstrated that purchasing involvement in product development is more than managing supplier involvement, and that the common underlying process for these additional activities is 'informing'. While this process of informing can easily be combined with the other four key processes underlying purchasing involvement, the levels of responsibility and the areas or objects identified in the first version of the framework are somewhat different dimensions. The levels of responsibility focus on the difference between strategic-tactical-operational activities and the hierarchical level in the organisation the activities are being performed, while the areas differ in terms of the objects the activities are primarily focused at. At the same time, however, the two dimensions have some aspect in common and that is that they differentiate in terms of the time-horizon of the activities involved. The revised version of our framework therefore integrates the two dimensions, and differentiates between four management areas differing in the time-horizon, the object concerned and the managerial level of activities: Development Management, Supplier Interface Management, Project Management and Product Management. The development of this integrated framework of activities is the first objective of our research. By distinguishing different management areas within this framework of activities, it may be easier to implement, improve and audit purchasing involvement in product development, which are the main purposes for which the framework can be used by practitioners.

The framework, however, is an ideal picture. It encompasses all kinds of activities and gives no particular indications on the conditions under which they need and can be performed. These contingencies can be referred to as so-called driving and enabling factors. The second objective of our research is to develop some preliminary insights into the role of these factors, and a number of potential driving and enabling factors has briefly been discussed.

The in-depth case studies presented in the following chapter, the third and final round of empirical studies, investigate the relation between problems and successes in product development and the extent of purchasing involvement in terms of the various management areas and specific activities. Also the role of driving and enabling factors is investigated. The insights developed on the basis of those case studies may indicate when and how to implement or improve purchasing involvement in product development. It is therefore that the following chapter also opens the final part of the thesis; the evaluation of our framework of activities.

Evaluation

Chapter 7

Three In-depth Cases

This chapter deals with in-depth case studies of three different companies which investigate the relations between problems and successes in product development, the extent of purchasing involvement and the underlying driving and enabling factors. Taking the integrated framework of activities presented in Chapter 6 as a starting point, we consider four specific questions:

1. Of the framework, which management areas / specific activities are performed, by whom?;
2. What problems and successes does the company experience in its product development projects or process, and can these be related to the extent and the way the areas / activities are being carried out?;
3. To what extent is the company putting special emphasis on certain areas / activities, and neglecting others based on its size, production type, its reliance on product development and on suppliers (driving factors)?; and
4. To what extent and in which areas is the company limited in its ability to perform the areas / activities in terms of organisation, information and human resources (enabling factors) ?

In section 7.1, the methodology of the case studies is discussed in terms of design and data collection. Sections 7.2 through 7.4 present the three different case studies: Ericsson, Food For Thought and Philips Medical Systems. In each section, first the company is introduced and the current situation with respect to purchasing and supplier involvement in product development is reviewed, mainly by analysing recent development projects. This results in an analysis of the way and the extent to which the management areas and the specific activities from our framework are being carried out, and this pattern is used to explain the product development problems and successes the company is experiencing. Following that, the case describes the situation with regard to the previously identified driving and enabling factors and relates this to the purchasing involvement pattern. Section 7.5 closes the chapter with summary and conclusions.

7.1 Methodology

As has been indicated in section 1.4.2, the case studies in this chapter have an explanatory character. More specifically, the case studies seek to explain the relations between the driving and enabling factors, the extent and pattern of purchasing involvement, and the problems and successes in product development. In order to be able to generalise the findings with regard to these relations, we have chosen to conduct multiple-cases. In multiple-case studies, the cases should be selected to predict either similar results (literal replication) or contrasting results but for predictable reasons (theoretical replication). These case-studies use theoretical replication: in other words, the case studies differ in terms of the key variables and we pursue, in each case, the proposition that a number of driving and enabling factors affects the purchasing involvement activity pattern, which affects the problems and success in product development. Rather than selecting case companies differing in terms of their product development problems and successes or their enabling factors, the choice has been made to select a variety of cases in terms of the driving factors. These factors, as defined in section 6.5.1 (company size, production type, R&D intensity and purchasing ratio), can be established more quickly and easily than the enabling factors and the product development outcomes, which makes the case selection process more efficient.

The three case companies differ in terms of size, production type, R&D intensity and purchasing ratio. The first company, Ericsson, is a major global player in the telecommunication industry. It has some 100,000 employees and turnover in 1996 amounted to 31 billion NLG. Its production is characterised by large series, it spends a large amount of resources on R&D and has a rather high purchasing ratio. The second company, Food For Thought, is an international company active in the development, production and marketing of longlife food products, with a focus on consumer products. Turnover is around 4.4 billion NLG and the company employs some 8,300 people (figures 1996). Production is characterised by a combination of process and large series production, R&D expenses are limited and the purchasing ratio is relatively low. The third and final company, Philips Medical Systems (PMS), is one of the world's four leading medical equipment producers. It delivers diagnostic image producing and processing equipment, related therapeutic equipment and complementary services to hospitals. In terms of employees and turnover, it is smaller than Ericsson and Food For Thought. Production is characterised by small series, R&D expenses are moderate and the purchasing ratio is relatively high.

Table 7.1: Case companies

	Ericsson	Food For Thought	PMS
company size	very large	large	medium
production type	large series	process/large series	small series
R&D intensity	high	low	moderate
purchasing ratio	high	low	high

All three case companies have been studied or monitored for a period extending over two years, though not continuously. The three case studies have been conducted in slightly different manners, and have used different (combinations of) sources of evidence. The first, Ericsson, has involved a limited number of interviews (see Appendix F), but is mainly based on the work of two master students: Parkkinen (1995) and Kanon (1997). These two reports can be classified as being based upon 'direct observations' (Yin, 1994: 80), be it second-hand in the context of the current study. The project by Kanon has lasted for over 8 months, and has involved extensive discussions between the student and the author, and between company representatives and the author (further information in section 7.2). Additionally, various forms of documentation have been studied such as newsletters, handbooks, presentations etc.

The second case study, Food For Thought, has involved a large number of interviews with company representatives from purchasing, product development and marketing functions. Interviews have also been conducted with a number of suppliers (see Appendix F). Again, company documentation has been studied including internal memo's, manuals, external communication, annual reports etc. The third case study, Philips Medical Systems (PMS), has involved a master's project by Sie (1996) which has involved extensive discussions between the student and the author, and between company representatives and the author. This project has been extended with a contract-research project, which has mainly been targeted at developing a specific managerial tool for the company (see Appendix G), but which has obviously also resulted in additional observations and discussions regarding the actual problems at the company. It is worthwhile to note that the first part of the project has been carried out within the context of the PMS' purchasing department while the latter part has been conducted mainly inside the product development department. In addition to and alongside this two-stage project, the author and the student have also conducted several workshops with both purchasers and development engineers from PMS on the topic of purchasing and supplier involvement in product development.

The case studies are thus based on multiple sources of evidence, which enables us to develop converging lines of inquiry by means of data triangulation. This process of basing findings or conclusions in case studies on several different sources of information is supposed to improve the 'construct validity' of the cases, as multiple sources of evidence provide multiple measures of the same phenomenon (Yin, 1994: 92).

7.2 Ericsson

Ericsson is a global telecommunications equipment supplier based in Sweden. It is a highly technology intensive company, as reflected by the 12-14 % of turnover it spends on Research & Development (1996/7). The telecommunications industry is a rapidly changing industry, both in terms of growth (Ericsson's total turnover has grown 200 % in the period 1992-1996) and in terms of technical change, such as the increasing software content of telecommunication equipment and the replacement of fixed networks by mobile networks. Parallel to these changes, a shift is taking place in the production chain, partly initiated by the increased deregulation of telecommunication markets. This forces (new) operators to focus even more on offering competitive end user services, meaning that they have less resources to spend on hardware development. This is therefore increasingly left to telecommunications equipment manufacturers like Ericsson. As a consequence, these manufacturers 'move down' the production chain, looking for component suppliers to take over parts of the development activities they traditionally carried out (see also section 5.5). This implies an increased focus on the involvement of suppliers in product development processes and on the responsibilities of internal departments - such as purchasing - in managing that involvement.¹

Ericsson has a number of policies, principles and instruments to promote and support supplier involvement in product development and which indicate what the role of purchasing should be in that respect. In this case study, the main question is how these policies have been deployed, what this has lead to in terms of activities previously identified regarding Development Management, Project and Product Management, and what problems exist in these areas. Supplier Interface Management is not explicitly discussed in this case, as we have insufficient information on this issue.

7.2.1 The company

Ericsson's organisational structure is a matrix, consisting of local companies on the one hand and business areas on the other. Until 1 January 1997, Ericsson consisted of five business areas: Radio Communications (BR), Public Telecommunications (BX), Business Networks (BZ), Components (BK) and Microwave Systems (BM). Historically, public telecommunication was Ericsson's most important business but since 1993, Radio Communications has been the largest in terms of turnover. Radio or mobile telecommunication now accounts for more than 60 % of total sales.

Our analysis concerns the business area BR (under the period 1995-1997), and especially the business units within that area that produce base stations for mobile telecommunication. Base stations, simply stated, convert radio signals from the mobile communication net to signals that can be transmitted through the fixed network and vice-versa. Headquarters of BR are at the same location where also the major local company within the business area, Ericsson Radio Systems AB (ERA) is located.

¹ As a demonstration of that increased focus, different Ericsson companies have initiated several studies in this area. Besides Parkkinen (1995) and Kanon (1997), these include Granberg and Pählman (1997). Indications at Ericsson, however, of this trend towards increased supplier and purchasing involvement in product development already occurred in the late eighties (Axelsson and Laage-Hellman, 1991).

ERA consists of three business units that each produce base stations according to different standards, aimed at different markets: RMOJ (Japan), RMOG (GSM and NMT systems, mainly Europe), and RMOA (American systems). These business units are closely related to each other, not only organisationally but also in terms of technology. The three units were established in 1992, when a large order in Japan came in and ERA was split up. In the case study, the focus is primarily on RMOG, which is by far the biggest unit in terms of turnover. Some references will be made to the business unit RMOA and finally, the situation within BR is compared on a general level with that at the business areas BZ and BX.

Purchasing organisation

Within the purchasing organisation at Ericsson, a distinction can be made between the corporate level and the business area level. At the first level, there is a corporate unit Procurement & Microelectronics Co-ordination, headed by a Vice-President who reports to Corporate Technology, one of the nine corporate functions. There is also a separate support unit Procurement, but the two units function as one (the split-up is because of budgetary reasons). They provide the strategic framework for the rest of the purchasing organisation in the different business areas, by developing and communicating purchasing policies and guidelines.

At the business area level, there are different purchasing organisations. Within BR, the purchasing organisation is a rather complex combination of centralised and decentralised units, consisting of purchasing departments at three different levels: at the business area, the business unit, and the factory level. At the business area level, there is a purchasing staff (BRV) responsible for developing business area policies, for relations with strategic suppliers and for supporting the business unit purchasing departments. The main task of the purchasing departments at the business unit level is to support the product development process through early participation and to negotiate and conclude contracts with suppliers. As soon as normal production starts, the factory purchasing departments take over responsibility for operational purchasing tasks like call-offs, supplier improvement programmes etc.

Procurement policies and guidelines

The Ericsson Procurement Handbook describes three 'Primary Procurement Processes': Early Participation, Procurement Preparation and Systematic Procurement. They can be related to the steps of the general purchasing process model (Figure 4.1), and for each purchased item, these three processes take place in a chronological order related to the life cycle/development process of new products. Early Participation consists of two main purchasing activities: make/buy decisions and life cycle cost analysis. These take place during the Concept and Definition phases in the process of developing a new product. Procurement Preparation, carried out during the Design and Development phases, includes as activities: supplier evaluation, product approval, supplier classification and agreement process (contracting). Both Early Participation and Procurement Preparation are the responsibility of the business unit procurement departments. Finally, Systematic Procurement encompasses supplier rating and supplier development activities, carried out by factory procurement departments during the Manufacturing phases of the final product's life cycle.

These three primary processes are supported by five basic principles: Strong Central Control, Early Participation, Cross-Functional Collaboration, Decentralised Organisation with local power, and Collaboration and Co-ordination within Ericsson. Strong Central Control applies to having the same rules, policies, standards, systems and tools throughout the whole of Ericsson. This, and the Collaboration and Co-ordination principle are closely related to the principle of Decentralised Organisation with local power, as they together should form the ideal balance between decentralisation and centralisation.

The other two principles, Early Participation and Cross-functional Collaboration, especially regard the role of procurement in product development processes.

Product development projects at Ericsson have to follow the so-called PROPS model. This PROPS model applies to all kinds of projects, and distinguishes four main phases: Prestudy phase, Feasibility study phase, Execution phase, and Conclusion phase. For product development, this model is complemented by a 'work model'. Milestones and Toll-Gates define important moments in the project, and tie the development work model to the general project model. At ERA, a specific product development model is applied, called Radio Base System (RBS) model.

7.2.2 The situation

At RMOG, Parkkinen (1995) studied one particular development project, Aladdin, to find out how the purchasing and development departments were collaborating in product development, and what kind of problems occurred in the process.

The Aladdin project, which was started in Fall 1993, aimed at developing two new radio base stations. The project was the biggest going on at that time within RMOG, with some 300 engineers involved at the same time. It was divided into six 'objects' (the radio unit itself, the cabinet in which it is placed, etc.) which again were divided into smaller 'sub-objects' (f.e. the transmitter and the receiver). To a great extent, the Aladdin project was being carried out according to a concurrent engineering approach (see section 2.2.3), with some detailed parts being already tested while other specifications were still rather general. This meant that the PROPS and RBS project models did not completely apply, reason why some project participants even considered these models to be old-fashioned.

We discuss three departments that are the most important with regard to the involvement of suppliers and purchasing in the Aladdin project: the business unit Procurement department, Product Development Radio Base Station, and Component Technology. As indicated before, the business unit procurement departments are responsible for initial purchasing tasks. At RMOG, the procurement department is part of the staff unit Logistics and Production. It consists of two groups; Operations, which works with procurement service for customer installation projects, mainly in the field of supplier evaluation and contracting, and Development. The Development group consists of 7 people, who are specialised according to specific product groups within two main technological areas; electronics and mechanics. Their tasks include, according to the BR Purchasing Handbook:

- make-or-buy analyses;
- evaluating, selecting and classifying suppliers at an early stage of development projects;
- monitoring prices and life-cycle costs for components;
- ensuring that the list of standard components is being used (see below);
- preparing development contracts for specific components;
- ordering prototypes (at RMOG, however, the purchasing of prototypes is delegated to two people within the Development department);
- developing contracts with suppliers based on predicted volumes over time and the delivery time of the first series; and
- ensuring that the basic information is registered in the purchasing information system before responsibility is transferred to factory procurement.

Evaluation

For each development project, a Procurement Project Co-ordinator is appointed who co-ordinates all the purchasing issues within a development project. In addition to the general responsibility for the activities mentioned above (within the project he is appointed to), the co-ordinator should ensure that in an early stage of the project, the product responsible purchaser is involved when it regards specific parts or components.

The second department is Product Development Radio Base Station. This department, consisting at the time of some 250 development engineers and $\pm$ 300 external consultants, is responsible for developing and engineering radio base stations. All development is carried out in projects, for which a project manager and object managers are selected, who then recruit development engineers from the department. The group of consultants, who mainly hold positions as object or sub-object managers, had grown this large due to increasing workloads that could not be met by the permanent staff.

The third important department is Component Technology. Component Technology maintains a so-called STAKO list of standard (mainly electronical) components which applies to all three radio base station business units (RMOA, RMOG and RMOJ). The department, which is officially part of the RMOA business unit, should function as a central support unit for product development projects by assisting in the selection and application of standard components, by enabling and simplifying the standardisation of components, and by registering new components in the appropriate information system (PRIM, which is Ericsson's basic product database). When a development engineer wants to apply a new component in a design, he has to send a STAKO request to Component Technology. They check whether the STAKO list does not already contain a component that would suit the purpose. If there is, Component Technology will give a negative advice on introducing a new one. If there is not, representatives from Component Technology and from business unit Procurement together with the development engineer concerned will consult and sometimes visit suppliers in order to investigate to possibilities for developing a new component.

On a project level, the STAKO list has a counterpart; the Preferred Part List. This list is made within each product development project, and contains those parts that have a preferred status, meaning that they should be used whenever possible. This ensures that for each new product, there are as many common components as possible. Finally, there is also a Preferred Supplier List (PSL) that classifies Ericsson Radio's suppliers in five categories: Partner, Strategic Supplier, Preferred Supplier, General Supplier and Non-preferred Supplier. Whenever it is impossible to use a component or part from the STAKO-list or the PPL, it is demanded that first Partners, then Strategic Suppliers, etc. are contacted regarding the required new part.

Within the Aladdin project, there were three kinds of meetings in which purchasing and supplier related issues would or could be discussed: Project Team Meetings, Component Meetings and Component Emergency Gatherings. Participants in the Project Team Meetings are the Project Manager, all Object Managers, the Procurement Project Co-ordinator and representatives from the factory where the new base station would be produced, and some others. These meetings were focused at the general results and progress of the project.

Component Meetings were attended by the Procurement Project Co-ordinator and other purchasers from the Development group, representatives from Component Technology, sub-object development managers and factory purchasers. Issues relate primarily to standard components and how to ensure their supply. Initially, the meetings took place each week, but later on only once every two weeks.

Finally, Component Emergency Gatherings ('Komponentakuten') were initiated after some months into the project by the business unit Procurement department. The reason for setting up these meetings was that at the outset in the Component Meetings, it had been decided that a list of all new components within the project would be kept and continuously updated so that there would be one complete overview. However, this list never came off the ground as the number of components grew rather large, and constantly updating the manually distributed list (i.e. paper copies) became impossible. Therefore, only a list of problematic components was made, for example those with a long lead-time. After some time, the discussions regarding these components were intensified and organised as Component Emergency Gatherings. The participants were largely the same as the Component Meetings, but these meetings took place every morning and lasted only for about half an hour.

7.2.3 Management areas

In this section, the Ericsson case - or more specifically, the case of RMOG and its Aladdin project, is analysed in terms of three management areas; Development Management, Project Management and Product Management. Within each area, some specific activities are highlighted.

Development Management

Two specific activities in this area are considered: 'Formulating policies for purchasing related activities of internal departments' and 'Communicating policies and procedures internally and externally'. It is obvious that Ericsson and its business area BR have formulated, quite specifically, policies and guidelines for development related purchasing activities of internal departments. Most of the Ericsson corporate policies in this area discussed above, actually have their origins in the BR business area, where they have been introduced around 1993-1994. So, at the time of the Aladdin project, the Purchasing Handbook with these policies and guidelines had been around for only a year or so. The policies give a great deal of responsibility to the procurement department.

Within the Aladdin project, however, the tasks and activities of Procurement within product development were not explicitly known to most of the people at Product Development and its Prototype Procurement group. The Purchasing Handbook, which contains the policies regarding purchasing's involvement in product development, is not familiar to most engineers. In contrast to the engineers, the people at the Component Technology department did know about the Purchasing Handbook and its general contents, and thought this was very useful.

The fact that the Purchasing Handbook and the policies on purchasing involvement in product development thus do not seem to have been clearly communicated to the development engineers could be related to the newness of the Handbook. Although most engineers seemed to understand what the basic aims of early participation and cross-functional collaboration were, many of the development engineers involved in the Aladdin project were either new on the job or external consultants and they had difficulties in understanding the respective responsibilities of the business unit Procurement department, Prototype Procurement and Component Technology. Engineers with more experience within RMOG stated that they had established personal contacts so they knew the person they should turn to. Obviously, communicating policies on development related purchasing activities and who or which department is responsible for what is especially useful when the responsibilities change or when the people that are affected by the activities change. This is often the case in organisations that undergo rapid growth, such as RMOG at the time.

Moreover, the policies and guidelines on development related purchasing activities seem to stand rather on themselves. They have been developed by the procurement organisation, but have not been integrated with product development procedures, such as the PROPS or the RBS model. There is no general process model that integrates development & engineering with purchasing activities in product development, and consequently there is no automatic trigger for development engineers / Project Managers to involve Procurement in the project.

However, apart from these policies and principles specifically for purchasing, Ericsson has developed a policy that aims at building competence across different functions in the area of technology sourcing. This is a cross-functional policy, and not only applies to Procurement but also to Development and Product Management (responsible for translating market needs into technical specifications, and in principle the initiator of product development projects). This policy, External Technology Provisioning (ETP), can be seen as the whole process of looking for, selecting, and using technology outside the Ericsson company for/in the products the company delivers to final customers. Together with two other processes, Internal Technology Provisioning (which refers to technologies from other Ericsson units than the one doing the actual new product development), and In-house Development, ETP contributes to the Time To Market (TTM) process. A central person in the TTM and the ETP process is the Product Owner; the person that has the full commercial and also technical responsibility for a specific product (usually distinguished at the component level) over the full life cycle of that product. These people usually come from Product Management.

The main reason for Ericsson to start focusing on ETP is that over the years, there has been a substantial qualitative and quantitative shift in what is core and non-core to Ericsson. According to some, the organisation of Ericsson - and especially Procurement - has not developed according to these developments. Within Procurement, there is supposedly too little technical knowledge and many purchasers are still focusing on price and logistical 'supply' issues instead of on initial 'provisioning' tasks. Also, procurement departments are said to be often too small to handle all the tasks associated with External Technology Provisioning. Kanon (1997: 61), however, states that in general the ETP method is mainly promoted by the *procurement* departments, and that other departments seem little aware of the method. In that sense, the ETP policy seems not yet fully deployed outside Procurement.

Project Management

Two activities within the area of Project Management that are noticeable in the case study are 'Determining specific Develop-or-Buy solutions' and 'Co-ordinating prototyping and production start up'. According to Ericsson's Purchasing Handbook, BU Procurement should be involved in the develop/make-or-buy analyses. According to Parkkinen (1995: 33), it is difficult to determine whether Procurement is actually involved in these analyses as they last over considerable time and because many different departments are involved. Besides, most of these analyses are actually carried out in the line-organisation (of the Product Development department) and not within the project itself. In the meetings where the actual Develop-or-Buy decision is taken, no representatives from BU Procurement are present. The overriding impression is that most of these decisions are taken before the purchasers get involved in the project.

Kanon (1997: 58) studied three development projects at Ericsson, one each within the business areas BR, BX and BZ, and concludes that traditionally, the develop-or-buy issue is not structurally raised in development projects. Ericsson, to a large extent, has a typical engineering mentality, and seems to have a natural tendency towards the make/develop decision.

Proto-type purchasing is officially also the responsibility of BU Procurement, but in the case of RMOG this has been delegated to a team of people within the Product Development department. They are also physically located at the development department, which the prototype purchasers see as a positive aspect as it promotes the communication with development engineers.

At one of the other business units, RMOA, prototype purchasing is done by the BU Procurement department. This could be interpreted as a sign of this department's allegedly stronger position than at RMOG. When ERA was split up in RMOA, RMOG and RMOJ in 1992, RMOA managed to attract the most experienced purchasers from the former Procurement department and RMOG had few purchasers to start with. In Fall 1995, during the Aladdin project, RMOG's Procurement still had four vacancies, and the purchasers felt they only had time for the most urgent matters.

Within the Aladdin project, the co-ordination of production start up seemed one of the most problematic issues. Parkkinen (1995: 31) even observes that the few times purchasing issues have been dealt with at the Project Meetings, this has been often initiated by the manufacturing department which warned that components had become critical with regard to the time-table for the first series. Often, manufacturing did not have the necessary information to start ordering components, either because no definite choice had been made yet or because the information in the product information system (PRIM), required to start placing orders, was incomplete or unclear.

Product Management

In terms of 'extending' activities in the area of Product Management, providing information on new products and technologies and suggesting alternative suppliers, we have seen little evidence of these being performed. This is, however, not to say that they are not being performed at all.

For the 'restrictive' activity of promoting design and part standardisation and simplification, Ericsson has the STAKO procedure, for which Component Technology is responsible. This procedure, however, did not always run smoothly. Instead of the 10 days that were set as a target for dealing with a STAKO request, it was estimated that around 75 % of the requests had a lead-time of three months (Parkkinen, 1995: 28). Problems occurred also due to the fact that development engineers sometimes selected components from the STAKO list that had been distributed to them, without informing Procurement or Component Technology. Often, the component later turned out to be difficult if not impossible to deliver. Engineers should therefore always notify Component Technology about using a component from the list, as the list itself did not always contain remarks regarding the actual supply situation. According to the people in Prototype Purchasing, development engineers often incorrectly assume that the STAKO list contains 'off the shelf' components, while in practice they may be very expensive, may have long lead times, and may be only limitedly available due to, for example, sole sourcing positions. At the same time, Prototype purchasers argue that the list is too seldom updated, and that it is too easy to put new components onto the list. The main problem, it seems, is that the STAKO lists are distributed manually, as the information quickly gets outdated.

Development engineers, on the other hand, complain that the STAKO list sometimes contains plainly incorrect information, for example with regard to dimensions, and that there are only limited ways to search in the list. For instance, engineers would like to be able to search the list on performance and dimensional characteristics. It would, in their opinion, also be useful to register a contact person for each component who has experience with that component so that he or she can be contacted by the engineer considering applying that component.

One possible explanation for the problems with the STAKO list in the Aladdin project could be the increasing workload for Component Technology. In two years time, the number of STAKO requests had been growing from 500 to some 1300 a year. Within the Aladdin project, some 350 requests had been filed, part of which was said to be unnecessary and to be the consequence of the external consultants in the development department not having been sufficiently informed and trained regarding this list. Interestingly, many development engineers at RMOG argued that the role of the STAKO list would diminish as the complexity of components grows and more and more components become customer-specific (Parkkinen, 1995: 29). Such a statement seems like a typical engineering point of view (see Table 4.1). The purchasing manager of RMOA, on the other hand, stated that standardisation was a conscious and still appropriate strategy with a view to reducing costs and supply risks.

Preferred Part Lists and Preferred Supplier Lists are project-specific lists for promoting standardisation, and to ensure some basic product quality by restricting the choice of suppliers. According to Parkkinen (1995: 29), however, both the Preferred Parts List and the Preferred Supplier List are hardly known within the Development department.

7.2.4 Driving factors

Company size

Ericsson is a rather large company, and the organisational complexity that goes with it seems to make communication and co-ordination in development projects rather difficult. Part of this may be related to the fact that policies regarding purchasing involvement have been formulated, but not extensively communicated throughout the organisation. The need for Development Management, and especially the communication of the policies and guidelines involved, seems to grow in importance as company size increases.

Production type

Two problems in the development process at Ericsson seem to be related to the large-series type of production being employed: frequent miscommunication in releasing components for production orders and the delays related to the large number of requests for approval to use a standard component. The occurrence of these problems is closely connected to the relatively high number of components involved in Ericsson's products, which is usually one of the key characteristics of large-series production.

R&D intensity

Ericsson spends a rather high percentage of its turnover on research and development, which is a sign of product development being an important process (and competitive weapon) within the telecommunication industry. This importance is also reflected in Ericsson having elaborate product development procedures such as the PROPS and the RBS models and, more specifically, in the attention paid to product development issues in Ericsson's general purchasing processes and principles and the BR Handbook.

Purchasing ratio

Ericsson (RMOG) has a rather high purchasing ratio, and this would signify a high supplier dependence. One area this could be reflected in is Supplier Interface Management, but unfortunately the case provides no information on this area. A higher purchasing ratio, however, would also be associated with an increase in the activities in the areas of Project Management and Product Management.

Besides the quantitative purchasing ratio, the kind of product development taking place and especially the need for and kind of supplier involvement in that process also affects the need for Project and Product Management activities. In the description of the Aladdin project, the main issue regarding purchasing involvement seems the selection of components for the new base station. Many of the problems in the project arose in connection with standard components, and they also got the most attention at the Project Meetings. In other words, it seems as if there is little actual supplier involvement in developing new parts or components.

We have no specific data for the Aladdin project itself, but the RMOA purchasing manager estimated that in general, some 80 % of the components that go into the base station are standard components. Still, the costs of standard components account for less than 25 % of the total costs as special components are relatively expensive. It is therefore still important to collaborate with suppliers in product development, but it only applies to a limited number of suppliers. Additionally, only a few of the really important components of a base station were bought externally while others were developed by other Ericsson companies such as Components.

In other words, activities regarding standard components - such as restrictive Product Management activities - occur more frequently and the problems related to that may seem more important, but that is not to say that actual development collaboration with suppliers is not taking place. One probable explanation for the fact that development collaboration with suppliers is not so evident within the project is that within the Aladdin project, special components are usually not dealt with at Project or Component Meetings, but rather in bilateral contacts between the responsible product purchaser and development engineer. Hence, the Project Management activities of co-ordinating product development activities between the supplier and the manufacturer may take place, but they are not as overt as the activities related to the standard components.

7.2.5 Enabling factors

Organisation

The organisation most pertinent to the issues of purchasing and supplier involvement in product development in this case consists of three departments in the line organisation (Product Development, Component Technology and Procurement) and the project organisation as reflected in the three kinds of meetings (Project Team Meetings, Component Meetings and Component Emergency Gatherings).

The division of responsibilities between the departments in the line organisation, as discussed earlier, was not always evident to the new development engineers. They were especially confused about the borderlines between BU Procurement and Prototype Procurement, and between Component Technology and BU Procurement. Some of them argued that in order to make the development process more efficient, it would be better to organise purchasers according to projects, not products. The purchasers, however, thought the organisation of their department worked fine, with a Procurement Project Co-ordinator who relays any specific questions to the responsible product purchasers. Their specialisation matched those of the factory procurement departments and other business units, which made the communication across those interfaces more efficient.

A general feeling within the project was that the meeting discipline was rather insufficient, both in terms of being present and having efficient meetings. Another practical aspect that seems to have hindered communication is the fact that the three departments are physically located in different buildings.

Evaluation

Especially the development engineers felt that it would have been good if the purchasers and the representatives from Component Technology involved in the project sat with the development engineers in the same rooms. Component Technology and Procurement have admitted the problem, and the latter has reserved four working places as an 'emergency solution' in a later stage of the project. In the long run, Procurement wants to have some permanent places, but it hesitates because of the increased capacity it would require. Prototype Procurement is quite satisfied with its location within the Development department as it facilitates informal contacts.

Regarding the meetings that discuss mostly purchasing related issues, the Component Meetings, the development engineers think these are a good forum for communication and increasing understanding for each other's work. BU Procurement, however, thinks that the Component Meetings should not be organised by Component Technology (as was done in the beginning of the Aladdin project), because they allegedly focus too much on standard components and neglect other parts and components.

Information

The problems with regard to information in the Aladdin project have already been indicated: incorrect and incomplete information in the product information system and the STAKO lists, lists being out of date primarily due to them being distributed manually and not electronically, and so forth. This project involved hundreds of components, which makes information systems support even more important. The problems with regard to maintaining updated information may have been exacerbated by the concurrent engineering approach adopted in the project, which at that time was rather new for RMOG. Many engineers had difficulties in relaying technical information before all the details had been determined.

Human resources

On this aspect, the case study contains little information. The development engineers seem to be content with the competencies and skills of the purchasers at RMOG. The engineers argue that some basic technical understanding facilitates the collaboration but that it is the purchaser's communication abilities and general attitude, not his education, which determines whether the engineer gets something out of contacting him in an early stage regarding the selection of components. As previously indicated, many of the development engineers were either new or external consultants. This has complicated some of the communication within the project, as they did not always know of the Ericsson routines, standards and systems as applied within RMOG.

7.2.6 Conclusion

Based on the purchasing policies, it seems that Ericsson has organised purchasing and supplier involvement rather well. In the Aladdin project, Procurement became involved at an early stage in the project, although the purchasers stated that this was primarily due to their own initiative. Nevertheless, the purchasing issues have not received extensive attention at the project level, and as the project progressed more and more problems became visible especially related to standard components, giving rise to ad-hoc measures such as the Component Emergency Gatherings.

Most of the problems in the Aladdin project seem to concentrate around communication and co-ordination. The problems in that respect can be said to be partly due to temporary factors such as the large amount of people involved that were new to the organisation, but also to more structural factors such as a rather complex organisation with different departments having closely related responsibilities regarding purchasing and supplier involvement in product development.

In general, it can be concluded that at RMOG (and to some extent BR in general), the first efforts for purchasing involvement in product development have been made, but that there are substantial problems related to operational issues.

But how does the situation at RMOG/BR compare to the rest of Ericsson? Some years later than the RMOG study by Parkkinen (1995), Kanon (1997) investigated the differences between the different business areas within Ericsson regarding which department was performing the activities in the four different management areas and to what extent². His findings, however, have to be interpreted with considerable care, primarily due to the fact that he has interviewed only 3-4 people within each individual department.

Kanon (1997: Ch 5) argues that of the Procurement organisations within the three business areas BR, BX and BZ, the first is the most active in development related purchasing activities. Additionally, the Product Development departments in BR perform a lot of these activities too. Altogether, Kanon argues, BR has succeeded quite well in organising and implementing purchasing involvement in product development. One explanation for the 'leading' position of BR may be the fact that the policies and principles of early participation and cross-functional collaboration had been introduced here first. The current Corporate Vice-President Procurement is the former BR Purchasing Director, who started to advocate and implement this kind of working.

Another explanation may be the fact that technologically speaking, BR is a business that is in the growth stage of the business life-cycle. The other former business areas, BX and BZ, can be said to be in the maturity/saturation stages (see also Van Weele and Rozemeijer, 1996: 36). When technologies and businesses are rapidly developing - as in the introduction and growth stages - firms must use external resources, such as the knowledge and competencies of suppliers, in order to keep up with the development. In addition to that, Ericsson has had a longer time to build internal competencies in the technologies used in the products of BX and BZ, and therefore the resistance to supplier and purchasing involvement may be greater.

Recently, however, there seem to be changes going on at Ericsson also in connection with a reorganisation of the business areas. This re-organisation is not only targeted at combining resources in the area of infocom systems, i.e. network systems and products for multimedia communications, by putting the former business areas BX and BZ together. It is also the result of the rapidly growing importance of mobile telecommunication, which experiences annual growth rates of nearly 100 %. BR is now more or less split into a systems area, with products like mobile base stations for the operator market segment, and a telephones area, with end-user devices like mobile and cordless phones for the consumer market segment. Business areas like BX have started re-considering their core competencies (Develop-or-Buy policies), and this puts the role of suppliers more in focus. At the same time, it seems like BR is more focusing on the Time To Customer flow, due to the enormous increases in demand and production capacity it is experiencing. Consequently, their attention for organising the product development process and the involvement of purchasing and suppliers in that process may be decreasing. It could therefore be possible that within some years, the 'leading' position of BR in this area may have diminished.

² Kanon based his findings on some 60 interviews with representatives and managers of Product Management, Product Development and Procurement departments within Ericsson. Twenty-eight of these regarded interviews on the basis of a structured questionnaire similar to the audit instrument presented in Box 9.1.

7.3 Food For Thought³

This case study focuses on two product development projects, each of which involves a purchasing department, a research and development department and a marketing and sales unit. Both projects concern the development of packaging. The first project involves a true packaging *innovation* for a liquid food product. This is a standard product, traditionally sold in small glass bottles (at least, in the Netherlands). The five or six different brands and the additional private labels all used to have their own kind of bottle, varying in shape. In the early 1990s, however, a national project has been started to standardise the large variety of bottles and crates. One of the most prominent participants in the project has been Food For Thought. The second project primarily regards the standardisation of different packaging forms. It started within one particular business unit as an effort to reduce costs, but has subsequently grown into a company-wide project targeted at reducing product variety. One of the most interesting aspects of this project is that it can also be seen as a step towards increased collaboration between hitherto very independent business units, among others in product development.

7.3.1 The company

Food For Thought (FFT) is an international company specialised in the development, production and marketing of fresh and longlife food products. The focus is on consumer products. With headquarters in the Netherlands, it is active in Europe, Africa, South America, the Middle East and the Far East through company-owned operations, joint ventures, sales offices and agents. It has more than 8,300 staff of which 2,600 are in the Netherlands, and turnover amounts to 4.4 billion Dutch guilders of which more than 40 % is realised outside Europe. Despite improving results, the profit margin is still low at 3,7 % (all figures 1996). Food For Thought is made up of various independent business units directly guided by group management. Some of these units (PU's) are involved in the production of food products, while others are responsible for the marketing and sales of these products (CBU's). Of immediate interest in this case study are the business units Production Long Life Products (and especially its purchasing department), Research and Development (a corporate unit), Food Nederland, and Food Export.

Production Long Life Products (PLL) is a production unit for long life products, which are put on the (world-wide) market by commercial business units such as Food Nederland and Food Export. It is one of the largest business units of FFT and has 850 employees. For PLL, the value of total purchases amounts to roughly one-third of turnover. Packaging materials (like solid and corrugated board, systems packaging, bottles and plastic foils) account for roughly 60 percent of purchasing volume: in other words, almost 20 % of the value of the products as sold to the commercial business units. The corporate business unit Research and Development plays an important role in the development of packaging material. This unit is an independent profit centre, which works for the other FFT business units on a tariff basis. Within this R&D unit, there is a group Packaging Development, consisting of 7 people. Food Nederland is a commercial business unit within the division Consumer Products Europe, Middle East and Africa, responsible for the development, marketing and sales of consumer products in the Netherlands. Food Export is a commercial business unit within the same division, exporting consumer products that are bought from internal production units like (primarily) Production Long Life Products or from external suppliers. Some 80 % of the unit's turnover is accounted for by cost of purchases, including the raw material (food).

³ For reasons of confidentiality, the identity of this company has been disguised.

7.3.2 The situation

Project 1: Developing a new reclosable bottle

The project has its origins in 1991 when a competitor of FFT, Meller, wanted to give its bottle an upgrade. The market for this specific type of liquid food product was declining, and at the same time the retail sector was having difficulties with the existing system for returnable bottles: it encompassed 4 different sizes and different forms as each producer had its own bottle design. The retail sector wanted to make the return-system more simple through standardisation, or possibly total elimination of the returnable bottle. Following suggestions from the retail sector, Meller contacted the sector-organisation of producers of this type of food products, which includes FFT and several other competitors.

The sector-organisation decided to start a sector-wide project to study the possibilities of developing standard return bottles and accompanying crates. Apart from a government subsidy, all members would invest in the project based on their resources and marketshare, meaning that FFT and Meller would be the most active. A steering group was formed, with the managing director of Food Nederland as the chairman. Additionally, four working groups were established: Production Technology, Finance, Physical Introduction and Distribution, and Design.

The drawing-board concept that Meller had developed was based on a slightly adapted bottle with a crown-cork. As most members were looking for opportunities to better promote their brand image, this seemed to be inadequate: the bottle should have more 'added-value'. The working groups came up with a list of demands, which resulted in the proposal for a lightweight glass bottle still with a crown cork closure. A screwcap was seen as less appropriate as it took too much effort to turn it loose, and so was a twist-off cap (as on the Heinz ketchup bottle) primarily because it would cost considerably more. It would also be very difficult to realise such a closure in the short term, as it would entail substantial adjustments in filling and closing equipment. The emphasis was still on standardisation, and less on customer convenience. However, when three different design concepts were tested in Summer 1993 in a consumer test, the results pointed to a strong preference for reclosable bottles. Together with hygiene problems regarding screwcap bottles and the clear wish of the marketing people to 'upgrade' the current bottles (i.e. change the design, decrease the weight), this resulted in a preference for the twist-off cap.

The 27 mm diameter twist-off cap (TO 27) of Close Cap (NL) was regarded as the most realistic concept and this supplier was selected for further collaboration although contacts with other suppliers still remained. In 1993, five more detailed bottle designs were developed and in February 1994, a final selection was made. At the same time, the initial four project groups were replaced with 7 new groups, including Technology (involving the aspects Bottle & Closure, Crate and Production Tests), Commerce and Purchasing. This was done as the project grew bigger and became more troublesome than foreseen. Managers from FFT acted as chairman for three groups: the manager of Packaging Development for Technology, the marketing manager of Food Nederland for Commerce and the purchasing manager of PLLP for Purchasing. The chairmen of the project groups would report to the Steering Group in joint meetings, and bilateral co-ordination would take place if necessary. No project leader was assigned.

The working group for commercial issues had not always been that enthusiastic towards the twist-off cap. The costs and the resulting smaller profit margin were seen to outweigh the increased customer benefits. Gradually, they became more positive as the cap producers saw increasingly interesting market prospects and were thus able to quote lower prices. Generally, however, there was still considerable scepticism regarding the twist-off cap, and many producers maintained that they were fully satisfied with the crown cork.

In May 1994, Close Cap gave a second presentation at the sector-organisation, which included the results of tests that Close Cap had run on the proposed cap. For Close Cap, the TO 27 was new in itself but relatively a simple product. The only new aspects concerned the dimensions of the cap, and a new inlay of the cap. Several suppliers were now involved in the project. The cap and glass producers also started to collaborate quite closely since the interface between the bottle and the cap is rather tight. For glass, Unit Glass (UG; NL) had been selected primarily because of its quality and development capacities. Both companies knew each other quite well from previous projects, and carry out basic research together regarding new ways of material reduction and the like, focusing on the interaction between bottle and cap.

The trial runs with filling and closing the new bottles were originally scheduled to take place at the small factory of one of FFT's competitors. As the test run grew bigger and bigger, it was moved to FFT instead. FFT was also the most eager participant in the whole project, as it saw big market potential for the new bottle. The test runs carried with them a huge amount of work for FFT, especially the Packaging Development group. Different caps from Close Cap were tested, with different heights, thickness and so on. Although Close Cap does offer closing equipment, FFT decided to buy a machine from another supplier instead. The Packaging Development manager actually made this decision based on purely technical preferences. However, the machine was a source of a great deal of problems. Test runs have been done over and over again, and Close Cap finally ended up with their engineers giving help to the machine supplier, which is actually their competitor. The supplier itself also provided FFT with a technician for several weeks at no charge.

Internally at Close Cap, the project was rather hazardous. In the industry, there is a conventional wisdom that caps with a diameter smaller than 53 mm cannot be sterilised, as was necessary for the new bottle. The opinion was that the TO 27 cap would not be able to resist the pressure built up in the bottle during the sterilisation process. The mother company was therefore rather negative to the project. With all the problems regarding the filling machine, the pressure from the mother company grew even higher as no progress could be shown, and the Dutch subsidiary has been close to giving up on the project. For the subsidiary, however, the project was an excellent opportunity to show that its product range was not as 'conventional' as it usually looked like, and that it was able to carry such projects through. Normally, new product developments only involve minor changes but this project involved a totally new concept for a relatively conventional market segment. Therefore, the project had the potential of an internal 'showcase', and the Dutch subsidiary kept working on the project. The mother company finally gave up its resistance to the project when upper management got convinced of the benefits of the project and put an end to the internal disagreement.

Much of the detailed development work at Close Cap has been carried out in its Global Technical Centre located in the US. As the caps would also be produced there, production people had to be convinced too, which was very difficult because the volumes involved were 'peanuts' to the Americans. It finally succeeded as the potential volume was predicted to grow to several 100's of millions if other Dutch and even European producers would change from crown corks and screw caps to the new Twist Off cap. However, a key role in the collaboration between Close Cap and FFT was also played by the supplier's local sales & marketing and R&D managers; without them, it is doubtful whether FFT would have managed to collaborate with the Global Technical Centre.

Gradually, FFT had now emerged as the most active partner in the project, with Meller and the other producers taking a back seat. After almost 75 % of all the testing had been completed, one of them and Meller wanted to abandon the project, primarily because of economic and market expectations, fearing that the retail sector would not sufficiently support the new concept.

FFT, however, said: 'We committed ourselves to finishing this project (also because of the subsidies), and we will do that: if need be, on our own'. One of the reasons why FFT wanted to continue is that the product concerned is more important for FFT than for most competitors. FFT also likes to take a leading position in developing new packaging concepts. In March 1996, a first series of (not-returnable, 200 g) bottles was introduced in the market by FFT. Since then, it has introduced two larger, returnable versions. The Dutch retail market leader that buys its private label from FFT has now also started to use the new bottles. Meller has introduced its own version. All in all, the number of different bottles has not decreased with these developments: the intended standardisation did not materialise. It is unclear whether the retail sector is happy with that, but it could be that they have substantially improved their margins with the new bottles and that is what they are most interested in after all. Perhaps the retail thinks that a passive standardisation/sanitation will be less costly than a more active one. FFT, for the moment, seems to be the winner in the process, and the new bottles are selling well.

Compared with other development projects, in the eyes of Close Cap, this one had a rather slow start, and a lack of structure. On the other hand, this project was much more innovative than any other development project that Close Cap has had with its customers in recent years. FFT is a useful reference for Close Cap, even abroad. FFT does not profit from sales to third parties, as the new cap cannot be protected by any patent. Initially, FFT was aiming for a 6 month period of exclusivity, but as the deadlines were delayed and the competitors have been slow in following FFT's lead, this exclusivity has not formally been enforced. The decision was made that the intellectual property rights of the bottle would belong to the sector-organisation. This project is neither a representative project for the normal co-operation between UG and FFT. Dominated by political issues, and therefore more troublesome than usual, the whole project also has lasted considerably longer (1991-1996) than usual packaging projects.

Project 2: Boxes

This project focuses on cost reductions in the area of packaging materials. Originally started as a drive for cost reductions by the commercial business unit Food Export, with the help of Purchasing PLLP and Packaging Development, it has increasingly become a company-wide project, backed by top-management, in order to reduce product variety and make production more efficient.

In the early 1990s, the business unit Food Export had been experiencing low margins, partly because export restitutions on the products sold outside Europe were being reduced in order to comply with GATT regulations. Looking for potential ways for cost reduction in 1994, the then managing director realised that two of the important cost drivers - raw material prices and wages - could hardly be influenced by his business unit alone. The one cost driver that could be influenced was the number of different products, or Stock Keeping Units (SKU's). Food Export, at that time, had an enormous variety of products in terms of ingredients and packaging forms, partly due to a history of frequent take-overs. There was a broad range of products with, for example, fat contents of 7, 8 or 9 %: this meant short production runs and thus high costs. Similarly, there was a huge number of designs for labels on cans and for (board) boxes due to language differences in the various export markets and the preferences of local distributors. This implied high purchase prices for packaging materials. Together, this resulted in an enormous variety in SKU's, and some of this variety was deemed unnecessary.

As Export buys most of its products, including packaging, from the business unit PLLP, the purchasing department of PLLP was involved in the first discussions towards the end of 1994. They were rather pleased that they could now talk with people at Export because before, when they had been pointing to the possibilities of cost reductions in packaging, they had not been listened to.

The managing director of Export decided to exclude his sales and marketing managers from the first discussions, because it was clear that regarding packaging designs, they would be reluctant to change. Soon, the project was named 'ReduX'; reduce product costs at Exports.

The ReduX project was split into different sub-projects:

- brandname standardisation;
- standardisation of the product contents/ingredients;
- material reduction for cans, and
- downgrading and standardising solid board boxes.

Our focus is on the last sub-project on solid board boxes, which entailed different actions:

- changing from white to cheaper brown boxes;
- standardising the designs printed on the boxes, in connection with the standardisation of brandnames, and reducing the number of colours used;
- standardising the size of the boxes; and
- changing the composition and reducing the thickness of the board.

The first investigations showed that there were 330 different boxes. Packaging Development first did some tests on the possibilities to use less and lighter qualities of boards: based on these results, possible cost reductions were estimated at almost 14 % of the total purchasing value.

Around the same time, starting in 1994, Purchasing PLLP had been developing a closer collaboration with board supplier GreenPack, member of the Labda group. For them, FFT had always been a 'nice', not too big customer, but which did not have an integrated supplier policy and often shopped around for its supplies of solid board. GreenPack/Labda saw opportunities for doing more business with FFT by increasing the co-operation, which was very welcome since it was facing decreasing demand in many of its customer segments. FFT had invited GreenPack and two other suppliers, and asked for their opinion and ideas for closer collaboration. After lengthy discussions between Purchasing and Packaging Development and the two other suppliers finally did not result in an agreement, GreenPack was selected as co-operation partner. FFT and GreenPack formed plans to substantially increase their business volume, and to lower prices. FFT offered to aim for more standardisation and better demand forecasts, to which GreenPack responded by offering a price reduction up-front, in anticipation of this standardisation.

The key problem was that other commercial business units than Food Export use some of the same brands and more or less the same boxes, and in order to reap the full possible benefits, these CBU's needed to go along with the project as well. The issue of standardisation was a sensitive one, especially for marketing and sales people, and other units were reluctant to join, also because at that time they did not have the same profitability problems Food Export was facing. In the second half of 1995, Export's managing director asked the division manager to put the issue on the agenda of a management meeting, and he would make a presentation regarding the project and make proposals. Again, one of the other CBU's was unwilling to join the project. A break-through could only be achieved by an over-ruling.

By the beginning of 1996, the reduction in the number of different kinds of board quality had been realised, effectively meaning a quality down-grading for most of the boxes. There had not been one single complaint from people in production and distribution, which indicates that the original boxes were over-dimensioned (or that the handling process has improved). The number of different box sizes had been slightly reduced, but could still be lowered. However, the reduction in colours and printing designs had been less successful. While Food Export went from three brands for a specific line of products to only one, other CBU's kept theirs. So instead of reducing the variety of boxes, it had been increased.

Despite these problems in the standardisation process, GreenPack had already given FFT a kind of 'up-front' price reduction. But when raw material prices for board were going down, GreenPack refused to give further price reductions pointing to the delays in the standardisation project.

In Spring 1996, the original ReduX-project came to a halt. The managing director of Food Export left the company after his superior, one of the board members, also left. In the following months and the beginning of 1997, Food For Thought moved slightly towards an increased co-ordination between the very independent business units among others by clustering the business units into three major groups. Simultaneously, the ReduX project got a restart, but now as an abbreviation of "Reduce Extra's". It was now consciously targeted and communicated to the whole company, backed by top-management. ReduX 'revisited' is organised in a more structure and permanent way. Currently, the project is managed by a small team of three people who work at least half of their time on ReduX. The chairman is someone who does not belong to one of the business units, and the two other members come from Food Export and another CBU. Specialists on production or packaging issues will be involved on a need-to-know basis. The project team reports directly to a Steering Group, chaired by the one of the board members and consisting of various business unit managers, depending on the matter at hand. The Steering Group will, for example, be asked for a final decision when the ReduX team does not succeed to reduce a specific product or packaging variety.

The goals and methods are still very much the same as the original ReduX initiatives. Unnecessary product variety is reduced, and the number of different packagings is reduced among others by multi-lingual printing designs. The costs of board boxes have been further reduced by replacing white boxes with brown ones. Unlike before, however, the ReduX-team will not only give suggestions on how to reduce variety and costs, but carry out the whole project and give it back to the appropriate business unit only after the first series of the 'new' product is being produced. All costs associated with such a project, for example regarding the destruction of old packaging, is put on the budget of the ReduX team itself so that the individual business units cannot start to make financial objections. Initially, the project is primarily focused at Food Export, and the first of their common brands has been 'ReduXed' and re-launched in August 1997. Four brands will have gone through this operation by January 1998, and a number of brands will be eliminated completely.

The project manager emphasises that ReduX is not about short-term cost reductions, but that it focuses on a long-term change of mentality within the company. The challenge will be to maintain this 'variety-discipline' after the project has been carried through (although no formal ending of the project has been planned). For this reason, a reinforcement has taken place of the (permanent) brand-management organisation, which should work across the different business units that are involved in the production and marketing of the products concerned. This 'cross-unit' organisation consists of a brandkeeper, a commercial product manager and a technical product manager. The commercial and technical product managers are responsible for a specific range of products, and typically they are respectively a marketing manager of the commercial business unit that is the prime 'mover' of that brand and the manager of the factory unit concerned. The brandkeeper is responsible for a specific brand, which may include different product ranges, and is typically a marketing director of the CBU concerned. Essentially, these brand-management teams are responsible for the co-ordination of all aspects of the products and their production. Business unit managers, however, should still give their consent for new products, packaging forms and production facilities.

How the new organisation functions is still too early to tell as it is still being introduced (late 1997). The brand management organisation is definitely not a new product development team, it only gives a clear guideline which people should be involved in the major decisions. ReduX still allows for different new product development procedures, and for different forms of product development teams.

7.3.3 Management areas

As in the two projects described in the previous section, the analysis of the involvement of purchasing and the role of suppliers in product development in the case of Food For Thought is focused at the development of packaging. This focus has been chosen because of the importance of packaging both relative to the total purchasing volume and in relation to the production innovation taking place in food products. Since packaging is such a central issue, however, the observations can be related to product development at the company in general.

One of the most noteworthy aspects in this case is the decentralised organisation of the company into profit-responsible production and commercial business units. This, and the effects it has on company culture and the priorities of different managers seem to create important barriers for a smooth new product development process. Related to this, is the virtual absence of a general new product development procedure. Realising this deficiency, different business units such as Food Export have in recent years developed their own procedure in which the activities and interests of the own unit get the most attention. The result is that different procedures are being used across the different business units, and even when they need to collaborate in product development, units know little or nothing about the procedure being used by the other. At the production unit PLLP, even the efforts to develop such a procedure have been unsuccessful until now. The initial proposal was deemed as too complicated and unclear, and no new plans were made. Over the past few years, FFT has seen frequent organisational changes in terms of decentralisation and 'empowerment' which may have reduced the time and attention for other issues.

Development Management

At a first glance, the determination of which technologies to keep in-house or outsource does not seem a problematic issue at FFT. The suppliers and FFT have clearly different technological specialisations - the development and production of packaging versus the development and production of food products. However, after more careful consideration, it becomes clear that one key aspect which does play a role is the great 'depth' of technical knowledge FFT, or rather the Packaging Development department, has on packaging. There are no evident plans to change the size or organisation of this department, so obviously FFT - consciously or unconsciously - has decided to maintain this expertise.

On the one hand, this expertise has helped FFT in continuing and successfully completing development projects, such as in the case of the TO 27 project and earlier projects. On the other hand, it may to some extent have lead to a 'Not Invented Here Syndrome'. In other words, the knowledge FFT has, may have delayed or prevented particular innovations or re-designs. One symptom of that can be seen in the ReduX project, where many boxes turned out to be made of board of a substantially higher quality than necessary. This 'over-dimensioning' is usually blamed on the preferences of the Packaging Development department that, like most other development departments, tends to operate 'on the safe side'. Something similar applies to another type of packaging where, according to the supplier, FFT uses more durable qualities than most competitors.

As will be clear by now, there are no clear guidelines, policies or procedures regarding the responsibilities and authorities of internal departments and suppliers in product development, and hence these cannot be communicated either.

Supplier Interface Management

Monitoring of supplier markets for technical developments is done by all three departments, be it with different backgrounds. Marketing surveys the supplier market primarily with the goal of finding new packaging solutions that may provide an opportunity for or support a new production introduction, for example through a new design or increased customer convenience. Packaging Development, which has an extremely good insight into the supplier market, pays most attention to the technical qualities of new packaging, for example its moisture resistance or bearing capacity. Purchasing focuses primarily on the costs of new solutions, and most of all on the *price* of the packaging. Because of the different perspectives of these three departments, they all have their individual preferences regarding suppliers.

All these monitoring activities, however, are like most other activities hardly co-ordinated. Neither is there a conscious and structured planning of permanent market research, independent from development projects. This means that a development project usually is the trigger for a market survey, for example regarding board boxes. Consequently, there is no such thing as a common base of preferred suppliers. Although some marketers know perfectly well which kind of packagings are being used at a certain moment, they sometimes suggest to involve a supplier for a development project, while Purchasing and Packaging Development at that time would prefer a totally different supplier because they do not know the first one, or have had negative experience with it.

This also points to the fact that supplier development performance is rarely evaluated, or at least not in detail and between the different departments involved. This means that after a project has been completed, the different departments may have different opinions regarding the course of the project and the role the supplier has played in it. Such differences only resurface when the involvement of the same supplier in a new project is considered. Even if the development performance of suppliers would have been structurally evaluated, it would be difficult to incorporate it into the overall vendor-ratings since these are limited to price and delivery performance. Furthermore, besides Purchasing itself no other department at FFT actually seems to be interested in the outcomes of vendor-rating.

In order to maintain a good Supplier Interface, Packaging Development does try to reward the involvement or assistance of a supplier in product development with a production contract. In contrast, the Purchasing manager argues that his department prefers to pay a supplier directly for any development costs incurred and for any possible intellectual property rights (IPR). In that way, FFT would have more freedom in choosing a supplier to produce the new packaging. The best development supplier need not always be the best production supplier. As indicated before, Packaging Development is focused at achieving a solution. When a supplier then manages to (co-)develop such a solution, Packaging Development sees no reason to not select that supplier. This also promotes the changes of that supplier being willing to assist in a future project. These tactics sometimes collide with the intentions of the Purchasing department. In one instance, Packaging Development and Purchasing had just visited a supplier together that had developed a solution to a problem FFT had with regard to a particular packaging when one of the purchasers threatened to go to another supplier if the first one did not lower its prices. The Packaging Development manager reacted quite strongly to this, basically because this would reduce the likelihood of that supplier continuing to be collaborative.

Evaluation

In the end, the first supplier did get the production order, but there have been occasions where a supplier explicitly chose to not inform FFT about new packaging solutions because it felt it was only being evaluated, or even 'squeezed', on price.

Project Planning

The selection of suppliers for a development project can be done by Marketing, Packaging Development and by Purchasing. Sometimes, Marketing has an idea for a new product and packaging, and it has already a preference for a specific supplier, for example because it is the only one producing that particular packaging. On other occasions, Packaging Development gets the request to find a supplier that can develop and produce a new packaging, and quite often this automatically results in the actual selection of a supplier. Either way, Purchasing PLLP is often confronted with a situation where the supplier has already been selected before it gets involved.

Determining the extent and moment of supplier involvement is not such a big issue at FFT. As discussed earlier, FFT has no internal capacity to really develop packagings - only to test them. In other words, when a particular packaging form (f.e. a glass bottle or plastic cup) has been chosen, it is automatically clear how much development responsibility that supplier will have. The moment of supplier involvement is not carefully planned either. However, as a consequence of the fact that most development work has to be carried out by the supplier, the moment is usually quite early.

Project Execution

Due to the lack of detailed new product development procedures, it is difficult to point to clear responsibilities regarding Project Execution within FFT. There are no guidelines for setting up product development teams, and people from the different departments are brought into a project based on ad-hoc and personal considerations. There is no such thing as a procedure for 'change-requests', neither is the responsibility for 'drawing release' clearly defined. What emerges is a picture of ad-hoc co-ordination and improvisation.

The co-ordination of development activities between the internal organisation and suppliers and between different suppliers can be said to be carried out by nearly everyone: Packaging Development, Marketing and Purchasing. Packaging Development clearly takes the lead in deciding which kind of development activities need to be carried out internally and by the supplier(s), based on the functional and technical requirements for the packaging, as in the TO 27 project. However, Marketing is usually the leader of new product development projects and is responsible for the overall co-ordination also regarding the 'technical' activities taking place. In the TO 27 project, for example, but also in other projects, Marketing quite frequently has direct contacts with the supplier in order to get information on the process or results of particular tests or the like. The same applies to Purchasing; they also have frequent direct contacts with suppliers regarding product development activities, especially when financial or delivery aspects are involved. Packaging Development and Purchasing PLLP work quite closely together in this area, and often visit suppliers together, but from time to time they do not exactly know what the other is doing as little time is spent on informing each other about the most recent developments.

The problem of ill-defined responsibilities in Project Execution affects all activities: not only the co-ordination of development activities, but also the communication of design changes and the ordering of prototypes. In essence, there is no clear communication and management structure between FFT and the supplier; there are multiple points of contact and there is no strict division between the responsibilities of the different departments.

One supplier also indicated that this lack of formal procedures and plans made it difficult to know exactly what it was expected to do and when. On the other hand, it gave the supplier also some degree of freedom, which could be useful at times as well. The effects of this lack of co-ordination are most visible in the time-to-market of new products. The introduction of the new coffee milk bottle with the TO 27 closure, for example, has been delayed several times up to a total of 6 months. It has to be noted, however, that this was a rather complicated project also due to it being an industry-wide project. We have no data on product development costs, but it is obvious that the lack of clear responsibilities and communication procedures leads to inefficient, extra or double work and, consequently, higher development costs.

Product Management

At FFT, Marketing is the primary responsible department for new product development and therefore also the key internal customer for information regarding product design. The provision (gathering and disseminating) of information on new product and production technologies in the initial stages of the development process takes place primarily via the Packaging Development department and the different marketing departments. The Packaging Development department and its manager are internally regarded as the key source for information on packaging solutions, but also on potential suppliers. The manager has a very good overview of the supplier market, and is very good in maintaining external contacts. As demonstrated by the TO 27 project, FFT is also externally seen as one of the companies with the most extensive technical expertise in this field, also because it is one of the few that does a great amount of testing. Other companies often follow the ideas of FFT because of its size, knowledge and high-quality image. To a great extent, this is related to the expertise and activities of Packaging Development.

Additionally, the different marketing departments have direct information channels to packaging suppliers. Marketing gets a great deal of information on new packaging directly from the market, through magazines and fairs but also via presentations by large packaging producers such as Tetra Pak. The role of Purchasing PLLP is rather limited in the initial stages of development projects. This may be due partly to the relative passive position of the department itself in the initial stages of product development, and partly to Marketing and Packaging Development, which do not give a lot of opportunities or room for Purchasing to participate. This lack of involvement does not seem to be due to Purchasing's lack of knowledge of the supplier market or technical expertise. Nearly all purchasers in the department have long-time experience in their product range. Sometimes, they inform marketers and others about technical developments or new suppliers through presentations but this seems to take place regardless whether there is actually a development project going on internally. Then, when the timing is not coincidentally right, there will be no follow-up.

Suggesting alternative suppliers, products and technologies is mainly carried out by Packaging Development, and sometimes by Purchasing PLLP. In the later stages of the project on reclosable bottles, for example, Purchasing suggested to involve a second cap supplier when it looked like Close Cap could not meet the agreed deadline for product introduction. However, it is usually Packaging Development that will come up with suggestions for alternatives during the product development process. Regarding the translation and evaluation of packaging designs in terms of the availability, makeability, lead-time, quality and costs Purchasing PLLP seems more active, again together with Packaging Development and Marketing. Packaging Development clearly focuses on the technical aspects such as makeability and quality, while Purchasing makes investigations into the costs and (timely) availability of the packaging.

However, the activities of both departments often seem to overlap each other to a great extent. There seem to be no clear distinctions between the responsibilities of the two departments regarding the communication they have with suppliers.

Standardisation and simplification of packaging designs is clearly something that is primarily carried out by the Purchasing department. For example, in the TO 27 project, Purchasing has been trying to minimise the variety of caps and to keep them simple, in order to create as much 'leverage' at the supplier as possible. In the beginning, the intention was also to develop only one and simple version, but after a while Marketing decided to have at least three different colours for the different (private label) brands and, on top of that, to have a brand logo printed on it as well. Marketing departments, more specifically the individual marketers, are only interested in the costs of the packaging as far as the individual product or project is concerned. As long as the costs can be supported within the context of that project, there are no further incentives to work on cost reductions or minimisation through standardisation. Company-wide benefits resulting from packaging standardisation will not accrue to the individual marketing manager to the extent that it becomes a key issue for him or her. This often results in a variety of packaging, which has been one of the main triggers for the ReduX project. It is interesting to note that, although Purchasing has played an important advisory and informing role in the original ReduX project, it is not a key player in 'ReduX revisited'. Obviously, it is a project that fits very well with Purchasing's activities and the department is very happy with it in that sense, but the organisation (read: FFT top management) has not deemed it necessary to involve Purchasing (and Packaging Development) very closely in it.

Packaging Development has no particular incentive to pay attention to standardisation and simplification as far as economical aspects are concerned as it is not accountable for packaging costs; its responsibility is to develop a solution for a packaging problem in a specific project, and it is paid to do so. Finally, some of the activities in the area of Product Management are carried out directly by suppliers, like providing information on new products and technologies. The supplier of solid board boxes, GreenPack, has actively been stimulating FFT to standardise by offering price reductions.

7.3.4 Driving factors

Company size

FFT, or rather the combination of business units studied here, is not a very large company. Nevertheless, due to the decentralised organisation and the concomitant organisational complexity, the lack of policies and guidelines regarding purchasing and supplier involvement in product development becomes problematic since product development projects usually incorporate several business units.

Production type

FFT's products usually do not incorporate a large variety of (complex) components, and this is partly related to its process type of production. This seems to reduce the need for Project and Product Management activities. However, many of the problems FFT is facing concern activities in the area of Project Execution: obviously, a small number of components and suppliers involved does not mean that there is no need for such activities at all.

R&D intensity

FFT does not spend a high percentage of its turnover on research and development. This is reflected in the company not having any detailed product development procedures, for example like Ericsson. This seemingly lack of attention for general product development processes makes it also difficult to develop policies and guidelines specifically on purchasing and supplier involvement in product development.

Purchasing ratio

If we exclude raw materials⁴, the purchasing ratio of FFT is relatively low. This may explain some of the lack of attention for purchasing issues by the rest of the organisation, which makes the development process from the purchasing point of view so difficult. Still, purchases include the components that are most relevant in terms of product development, packaging, which account for some 15-20% of the costs of the final product. FFT does not seem to attach great importance to it. As one manager put it: 'We develop new products, and then suddenly we realise that the product also needs a packaging. And then, everyone starts 'hobby-ing' for himself'.

7.3.5 Enabling factors

Organisation

At the beginning of section 7.3.3 it has been indicated that one of the dominating elements in this case-study is the decentralised organisation and the effects it has on company culture and the priorities of different managers, which seem to create important barriers for an efficient new product development process. In other words, the formal organisation does not facilitate, let alone encourage cross-functional collaboration. The problem is not due simply to a 'departmentalised' organisation, but rather to a 'fragmented' organisation consisting of independent business units.

Although this organisation of production and commercial business units has been introduced only recently (1993), some of the disadvantages have already become clear to top-management and measures have been taken to redress some of the problems as demonstrated by the clustering of the different business units in three major groups. Similarly, the brand management organisation proposed in the ReduX project aims to create horizontal relations between the different departments/units involved in the production and marketing of the company's products. However, no explicit link with the process of developing new products has been made (yet), and important departments such as Purchasing PLLP and Packaging Development are not included in this new management structure. Additionally, the new organisation is still 'in statu nascendi', business unit managers still have a major influence, and above all it is uncertain whether the whole initiative will continue to attract enough top management attention as the company has become involved in a crucial merger process (September 1997).

As a kind of compensation for the decentralised structure, the different units and departments are all located at FFT's headquarters, almost in the same building. While this is still far away from a situation where marketers, engineers and purchasers together in the same room or on the same floor are jointly working on new products as at some automobile or electronics manufacturers, location cannot be seen as a major impediment to cross-functional collaboration here. Another important aspect of the formal organisation regards the size of the different departments. Both Packaging Development and Purchasing PLLP consist of 7-8 people, and are therefore relatively small compared to the Marketing departments. The marketing department of Food Nederland, for example, consists of about 45 people.

⁴ The unprocessed food products themselves are bought from farmers that are members of the co-operative owning FFT.

Evaluation

Within Purchasing PLLP, only two buyers and the manager are involved in packaging material, and although a lot of that involves large volume purchases, it is clear that a total purchasing volume of 150-200 million NLG and 25 major suppliers implies a heavy workload. Although the logistical co-ordinators that used to belong to the department have recently been allocated to the production departments, the department is still frequently occupied with 'fire-fighting' and consequently there is less time for involvement in development projects.

The deficiencies in the formal organisation are to some extent compensated by the informal organisation. Especially the collaboration between Packaging Development and Purchasing PLLP is facilitated by positive personal relations. However, when personal relations are not present or not so positive, communication gets worse and the lack of formal collaboration patterns becomes even more problematic.

Information

One of the key elements in collaborative product development - or in any collaboration for that matter - is the recording and exchange of information. A lot of the processes and activities previously discussed relate to this, and it has become clear that information is a weak point at FFT. A great deal of information exchange takes place orally, or by memo's and faxes: both internally and externally. Each department does keep project dossiers, but these are for internal purposes only and there is no clear structure. There is no common project documentation for all departments involved, and consequently different departments have different records. This has everything to do with the fact that there are no clear product development procedures with accompanying guidelines for project documentation, and if there are they are limited to one department/unit. It is also the result of the fact that Marketing and not some kind of independent project leader is usually heading the development project. This often creates confusion, not only internally but also externally at suppliers, as not everyone involved in a project automatically gets all the information related to the project. In the TO 27 project, for example, several marketers got involved over time. For these people, it was very difficult to get a good overview of the progress and previous events within the project, leading to misunderstanding and miscommunication. No use is made of Information Technology, as for example could be done by putting important project information on an intranet.

Human resources

In general, there seem to be clear differences between the people working at the marketing departments at FFT and those working at Packaging Development and Purchasing PLLP. The purchasers and the development engineers nearly all have long experience within FFT, usually within the same department. Average age is quite high; nearly 46 within Purchasing. All purchasers have had either a basic or primarily technical education.

Within Marketing, however, especially at Food Nederland, the people are quite young and have been with the company only for a short period. All of them have a commercial education, sometimes with prior experience at other companies. These personal differences in background, education and experience result in different departmental cultures which does not always make the collaboration process easier. Simply stated: Marketing is a group of more dynamic, flexible, sometimes even erratic persons, while Packaging Development and Purchasing people are more conservative and less pro-active. While this is true to some extent, it is also greatly a matter of perception. Actual differences tend to get exaggerated, sometimes in order to find an excuse for communication and collaboration difficulties. Again, there are differences on an individual basis, and some 'counterparts' are seen as a 'positive exception'.

7.3.6 Conclusion

In conclusion, it can be stated that at FFT:

- Development Management: is absent; Develop-or-Buy is not a big issue, and policies and guidelines regarding internal and supplier involvement in product development are virtually non-existent;
- Project Execution/Project Planning/Supplier Interface: is carried out by everyone, hindered by a lack of communication and co-ordination structure, saved by improvisation, flexibility and personal relations; and
- Product Management: is carried out mainly by Packaging Development.

Efficient collaboration in product development, both internally and externally with suppliers, is hampered by an extremely decentralised organisation, (perceived) personal differences in terms of background and attitude, and a lack of a good structure for the recording and exchange of information. Despite all this, FFT has been able to turn out quite some new products (packagings) in the last few years. It seems like product development efficiency, rather than effectiveness, is hindered by it. The projects studied involved a lot of 'blood, sweat and tears', both at the different departments and business units of FFT and at the supplier(s), and sometimes suffered from considerable delays. FFT is in the lucky position that it is such a large and well-known company in this industry, otherwise some suppliers would probably not be so positive on working with FFT a second time.

7.4 Philips Medical Systems

In recent years, cost-reduction efforts at Philips Medical Systems (PMS) have led to increasing discussions on what should be (remain) the core-competencies of the company and what should be outsourced. These discussions have not only focused at production activities but also at development activities. As a consequence, the (potential) involvement of suppliers in product development and the concomitant role of the purchasing function have become an important issue for the company.

The actual trigger of the case study carried out at PMS was a development project in 1992-1995, in which external suppliers had been given greater responsibilities for engineering activities including the delivery of prototypes. Before, prototypes had been produced by an internal workshop for mechanical parts, which later then would be produced by external suppliers. In this project, however, the increased involvement of external suppliers had - at least according to the purchasers involved - led to longer delivery lead-times for the prototypes, resulting in pressure on the project planning. PMS wanted to carry out a more thorough evaluation of this project in order to find out if this had really occurred, also in comparison to previous projects, and to determine the possible causes for such problematic collaboration with suppliers.

7.4.1 The company

Philips Medical Systems (PMS) is a product division within the Professional Products & Systems group of Royal Philips Electronics, located in Best (NL). The company is a full service supplier of a wide range of diagnostic imaging systems. The products incorporate advanced X-ray, magnetic resonance and ultrasound technologies to provide information necessary for patient treatment. Every product is backed by a world-wide network of research and development, sales and service.

Within PMS, the business unit X-ray Diagnostics (XRD) is responsible for the marketing, development and production of X-ray systems. Sales and service is carried out by separate business units that work with other PMS products too. Within the business unit XRD, there are three product groups and one component group (CIS), which develops and supplies common imaging subsystems to the three product groups. The product groups each serve a different application area: cardio-vascular (C/V), universal radio fluoroscopy (URF) and surgery (S). The situation described in this case study applies to XRD, with an emphasis on the product group Cardio/Vascular (C/V). This group is the biggest within XRD in terms of turnover. Each of the three product groups have their own development department. The development department of Cardio/Vascular consists of two sub-groups: Systems Development and Geometry Segments.

There is one purchasing department for the whole of XRD. It consists of four main groups: Supplier Quality Assurance, Operational Purchasing and two Initial Purchasing groups, one for C/V and one for RC and S combined. Initial Purchasing is responsible for market research, supplier selection and contracting, participation in development projects and maintaining supplier relations (through so-called Supplier Account Managers). Operational Purchasing is responsible for placing and chasing orders for development proto-types and regular production items. Of total turnover, roughly 65 % relates to purchased items. Of this purchasing volume, about two-thirds comes from external suppliers while the remainder is supplied by internal suppliers. The CIS component group produces important components for X-ray systems, such as X-ray generators and tubes. External suppliers deliver (electro-) mechanical components and (increasingly) sub-assemblies such as bearings, gear-belt units and table-bases. In terms of the product life-cycle, X-ray systems are rather mature products and PMS is therefore focusing on cost reductions, just as its competitors. This aspect is emphasised by the cost-pressure it is facing from its customers, the hospitals.

For planning and managing product development projects, PMS uses the so-called Systems Management procedure. This is a decision stage model used by most Philips Electronics companies (see section 2.2.2), with every stage being completed with a review of so-called base-line documents. Project-reviews are held by the project participants to discuss the output and create consensus for the way of continuing the project. Management reviews are held by upper management levels (a.o. business unit director, product managers and project managers) to approve or reject decisions taken during the project, and to take a go / no-go decision. According to the Systems Management procedure, each development project consists of six project phases:

- *Phase 0: Policy.* This is a open, more or less permanent phase in which market and technical research is being carried out. This may lead to a new product idea, and in review 0/1 this idea is evaluated. If deemed suitable, a project is started unless the complete product will be outsourced.
- *Phase 1: Feasibility.* The project has officially started, and Systems Management is now applicable. Different technical concepts are developed, one of which is ultimately chosen. Roughly 3 months before review 1/2, the project team is established, with representatives from Development, Purchasing, Process Engineering, Logistics, Service, Quality Assurance, Software Management and (sometimes) Marketing.
- *Phase 2: Overall Design.* The complete system is being designed, top-down starting from the final product (as sold to the customer), to modules or technical building blocks (sub-assemblies encompassing several technologies), to complex components (one main technology with some additions, such as a power unit) to, finally, simple mono-components (such as cast metal parts).
- *Phase 3: Detail Design.* The complete design is now further elaborated until all technical risks have been identified and evaluated based on calculations, simulations, tests and experiments.

- *Phase 4: Engineering/Testing/Market Preparation.* The design is laid down in a complete Technical Product Documentation (TPD). Test models are built and tested, after which Purchasing has to order the production parts.
- *Phase 5: Production Start-up/Market Introduction.* The first production-model is tested before release for delivery takes place. Sales have started, and the project is completed with review 5/6.
- *Phase 6: Production/Sales/Maintenance.* From this phase onwards, sales and production is carried out by the regular functions.

In terms of the four major project phases that are distinguished throughout this study, Concept Development refers to the PMS Feasibility phase, Basic Design to Overall Design, Detail Engineering to the phases of Detail Design and Engineering (3 and 4), and Pilot Production/Start-up to phase 5, Production Start-up/Market Introduction.

7.4.2 The situation

As said before, the inducement for investigating the role of suppliers and purchasing more closely at PMS was the belief that the first experiences with increased supplier involvement in a recent project, L'arc C/N, had shown less favourable outcomes in terms of project lead-time. A closer examination of this and three other development projects revealed that the L'arc C/N project indeed had suffered from considerable development time overrun, more than projects in which the prototypes had more frequently been made by the internal workshop. Table 7.2 shows these and other figures for the different projects.

On the other hand, the L'arc C/N project had not performed so badly; in terms of development budget, it only had a 8 % overrun, and regarding the costprice of the new product, the project even resulted in a 12 % reduction. The project delay was obviously related to a relatively high number of engineering changes during the project. However, this does not automatically imply that at PMS, involving external suppliers to a greater extent has led to more engineering changes; previously, engineering changes could be handled informally between the development department and the internal mechanical workshop, while they have to go through a formal procedure when it concerns external suppliers. In other words; in the L'arc C/N project, engineering changes were recorded more precisely.

Table 7.2: Four development projects

projects variables	CESAR	CESAR PUCK	L'ARC C/N	TILT-table
supplier share of prototyping work (%) (1)	68	74	96	0
development time overrun (%) (2)	n.a.	27	46	25
development budget overrun (%) (2)	n.a.	41	8	2
costprice overrun (%) (2)	n.a.	53	-12	-14
average engineering changes per new mechanical part	0,45	0,64	0,78	0,74
number of new mechanical parts	277	273	166	163
number of purchasers allocated to the project (full-time equivalents)	n.a.	0,1 initial 0,6 operational	1 initial 0,4 operational	0,5 initial
period	1987-90	1990-92	1992-95	1992-95

Based on project documentation, internal evaluation reports, documentation on engineering changes and interviews with project leaders and controllers, and representatives from Production and Operational Purchasing. (1) Measured by the proportion of total material costs (within the development budget) that is spent on prototypes made by external suppliers. (2) All overruns are defined as the realised figure divided by the originally specified target. Source: Sie, 1996.

One interesting aspect, however, was that in the L'arc C/N project, the engineering changes occurred relatively early: compared to the CESAR Puck project, for example, the number of change requests in the final phases of the project (Phase 5: Production Start-up/Market Introduction) had been reduced by 60 %. Nevertheless, this earlier moment of engineering changes taking place did not result in reduced development time. However, development time overrun for the CESAR Puck project might have been calculated too conservative; the product was actually not yet finished when review 5/6 was given, which formally signifies the end of the project.

In terms of costs, the L'arc C/N does seem to have performed rather well. However, some measurement problems occur here. In the first place, the target for the costprice of the product is relatively flexible and is not set very tightly. Savings, therefore, are not a good indicator of the effects of supplier input. In the second place, the development costs themselves only include the costs made by the development department. In the L'arc C/N project, 1.4 full-time equivalent of purchasing capacity was involved, which is considerably more than in the other projects. This capacity, the costs of which are not included in the development costs, may have reduced the need for man-hours put into the project by the development department considerably, and therefore also the development costs. In short, it is not so certain that the L'arc C/N project and its high degree of supplier involvement have led to better total cost performance.

Besides illustrating that determining the effects of increased supplier involvement in product development is not so easy, a point stressed earlier in section 3.5.3, this comparison reveals that increased supplier *involvement* does not lead to better product development results automatically, but requires *co-ordination* and *integration* of activities not only between the manufacturer and the supplier, but also between the different internal departments. If this co-ordination and integration is not taken care of, involving suppliers to a greater extent in product development will only lead to more problems. For example, it turned out that at XRD, the internal lead-time for sending an order for a prototype to an external supplier amounted to 8-11 days, starting with a request from the development department, going through Operational Purchasing, and finally ending up at the supplier. Such a lengthy and complicated procedure does not make it easy nor attractive to involve external suppliers in product development. Likewise, the procedure for handling engineering changes does not seem to be suited for fast and efficient information transfer with external suppliers.

In order to get a better insight into the impediments or bottlenecks for integrating external suppliers in product development and achieving a better co-ordination between the development and the purchasing department in development processes, interviews have been conducted with 10 external suppliers (from a total number of 37 preferred suppliers), 9 development engineers and 8 initial purchasers.

The interviews with the suppliers⁵ resulted in a number of important observations:

- The supplier is being contacted by a large number of different persons, from (Initial and Operational) Purchasing, Development, Logistics, etc. This leads to communication sometimes going through the wrong channels, and to confusion at the supplier. The supplier often does not know whom to contact for issues related to product development, and these communication difficulties discourage supplier initiatives.
- The supplier is not structurally informed about changes in time-tables, drawings and other agreements, leading to confusion. Moreover, the supplier is not well-informed about the general product development procedures at PMS. Lack of project time-tables from PMS also leads to capacity problems at the supplier.
- The supplier is willing, but hardly able to prepare for the plans of PMS for increased supplier involvement in product development since the manufacturer does not indicate specifically what it expects from the supplier. Additionally, at the moment already, the supplier is often faced with contradictory expectations from different departments, or even within one and the same department.
- The usual compensation for development efforts - production orders - is not very much appreciated. The supplier prefers direct payment for the development work, partly because PMS has not always kept its promises due to purchasing personnel changes.
- The supplier sometimes also has internal problems in terms of organising and staffing its development and purchasing departments, and in estimating development costs, which is related to a frequent lack of experience in collaborating with manufacturers in product development.

The internal interviews, with the development engineers on the one hand and the initial purchasers on the other, were especially focused at the expectations they had of the other department or group of people. This also resulted in a number of notable observations:

- Policies and guidelines for the involvement of the purchasing department in product development are hardly developed. As a consequence, purchasing involvement is rather dependent on personal and situational factors, and the development department does not know what to expect from purchasing.
- There is no uniform agreement with regard to the conditions for involving suppliers in product development, for example in terms of compensation, information-exchange and assistance.
- The tasks, responsibilities and goals of the purchasing and the development department are quite separated. Internal reward and compensation are not geared to promoting collaboration between the two departments.
- Purchasing has only limited influence on important issues such as develop-or-buy decisions, and setting development and product cost targets. Purchasing feels it is hindered by the development department since it is judged based on aspects that are largely determined by Development, such as the cost of purchased items that is mainly the result of specifications determined by Development.
- Development feels it is hindered by the purchasing department, for example because it is difficult to communicate directly with suppliers without involving Purchasing. According to Development, this is only to demonstrate the importance of the purchasing department. On the other hand, Development feels it gets too little support from Purchasing in terms of detailed and thorough market research.

In Table 7.3, some results from the interviews have been collected to give some further evidence to the differences in opinion between development engineers and initial purchasers with regard to each other's tasks and goals and the possible measures to improve the collaboration between the two.

⁵ All ten suppliers make mechanical products, ranging from simple components to complete sub-assemblies. Nine are small and medium-sized companies, with 13-80 employees and turnover between 3 and 16 million NLG. One supplier is a large company, with 500 employees and 110 million NLG turnover. All of them deliver products of which the prototypes were previously made by PMS' internal workshop.

Table 7.3 Purchasers vs. Development Engineers

	number of times spontaneously mentioned by initial purchaser (n=8)	number of times spontaneously mentioned by development engineer (n=9)
Main tasks or goals of initial purchasers:		
attending development projects	1	5
supporting development engineers	0	4
maintaining a preferred supplier base for product development	1	1
Main tasks or goals of development engineers:		
collaborating with supplier in product development	1	1
realising a shift from buying simple components to buying complete sub-assemblies	0	1
Satisfaction with other department:		
yes	2	5
no	6	0
reasonable	0	4
Recommended improvements in the collaboration between the two departments:		
more communication	5	4
more cost awareness of development engineers	0	2
leaving purchasing issues to purchasing people	4	0
more purchasing capacity, better to be reached	0	5
more knowledge and information by purchasers on technical developments	0	6

Source: Sie, 1996.

Apart from the large differences, for example with regard to the perceived importance of purchasers supporting development engineers, it is also obvious that some of the issues relating to supplier and purchasing involvement in product development have not received much attention at all from either group.

For a more detailed analysis of the more specific problems that PMS is facing in involving suppliers and purchasing in product development and the underlying reasons for these problems, we again turn to our basic framework, i.e. the integrated set of purchasing activities related to product development. In the following section, therefore, each of the previously identified four management areas is discussed with respect to the extent and way the specific activities belonging to that area are carried out at PMS, and by whom.

7.4.3 Management areas

In reviewing the four different management areas at PMS, the focus of this case study is mainly on the area of Project Management. This focus has been chosen because most of the problems, as discussed before, centre around project planning activities such as determining the extent and moment of supplier involvement in a development project, and around project execution activities such as co-ordinating design and engineering activities between the manufacturer and supplier. Still, all four areas are analysed here.

Development Management

In the introduction, it has been mentioned that due to increasing cost pressure in recent years, PMS has been reconsidering which technologies to keep in-house and which ones to outsource to suppliers. One of the technologies that PMS has defined as core is, for example, X-ray technology, the development of which will thus predominantly be done in-house. Another technology, mechanics, has been deemed as less central for maintaining and improving PMS' competitive advantage, and therefore development activities in that area will increasingly be outsourced to suppliers. In general, PMS can be said to have gone through major efforts in the mid-nineties (1994-1996) to outsource more development work to external suppliers in a move towards so-called 'de-verticalisation'.

These discussions and decisions seem to be held/taken beyond the level of the individual business unit departments described here, at the general management level of PMS. This is not so surprising because of the strategic aspects and the long-term implications of such decisions, and the fact that development departments may not be impartial to decisions of this nature. However, these departments have to deal with the consequences of such Develop-or-Buy decisions, like a decrease or a different character of their development activities. Communication with those concerned about the reasons for and process and outcomes of particular Develop-or-Buy decisions may be important in order to create the necessary understanding and acceptance. The engineers within C/V Geometry Segments, for example, turned out to feel rather unsure and insecure about the exact scope of the 'de-verticalisation' tendency that was being discussed within PMS, but also about its reasons. They doubted, for example, whether suppliers would be able to carry out particular development tasks in a cheaper way than PMS would, as was generally argued. How had this calculations been done? Such lack of understanding may lead to a lack of agreement and commitment which may result in a difficult implementation of the development outsourcing plans. That the development *engineers* felt uncertain and not well-informed by top-management does not automatically imply, however, that the *management* of the development department had never been participating in the discussions taking place at higher levels in the organisation. To our knowledge, it has been participating at least at some occasions, but the exact degree of involvement is difficult to determine. The same applies to the management of the XRD purchasing department. At that department, however, the feeling of uncertainty was less evident, which is not so surprising since outsourcing development work is not a threat to its activities.

It has already been indicated that there were little if any policies on the involvement of suppliers in product development processes, and this also applies to the tasks and responsibilities regarding purchasing related activities of the different internal departments. Hence, there is also little policy to communicate, both internally and externally. Were such policies developed (in more detail), Development clearly feels that Purchasing should get more and better defined tasks in supporting development projects, while Purchasing does not (spontaneously) rate those tasks as very important (see Table 7.3). On the other hand, however, Purchasing does feel hindered in its involvement in product development by Development since its only involved in a relatively late stage of the development process, and since decisions with important ramifications for purchasing activities (such as setting development and product cost targets) are often taken without involving Purchasing. This seems to indicate that Purchasing *does* feel it is important to be involved in product development. In other words, its position seems somewhat ambiguous.

The lack of guidelines for supplier involvement also leads to obscurity for suppliers (as could be seen in the interview observations), reducing the ability and willingness of suppliers to prepare themselves for (increased) collaboration with PMS in product development.

Supplier Interface Management

Related to the general strategy of PMS to increase the degree of outsourcing development work, it can be argued that one important problem in realising that increase is the lack of a good interface with suppliers. In fact, PMS can be said to be trying to change its interface with suppliers, to *move* it: from buying simple components, largely developed internally by PMS to buying more complex assemblies and modules developed to a large degree by the suppliers. This plan to reform the interface puts new demands on the suppliers, perhaps even requires completely new suppliers.

Actually, one of the comments frequently heard at PMS in this context was: 'We do not have suppliers that are capable enough to take more development responsibility and supply complete modules.' This seems to be confirmed at least in some cases by suppliers themselves, with comments from the interviews stating that they experience problems in organising their development process, partly related to a lack of experience in collaborating with manufacturers in product development.

The new requirements have emphasised the importance of market research; monitoring markets for technical developments and technically competent suppliers. As said before, Development thinks that this is primarily the responsibility of Purchasing, and that it should be carried out more thoroughly and extensively. In 1996, Purchasing has actually started to give more attention to market research, by forming so-called Competence Teams in which purchasers working for the different product segments (Cardio-Vascular, Remote Control and Surgery) are grouped together on the basis of product technologies and collaborate in technology-specific initial purchasing tasks such as market research. In terms of pre-selecting suppliers, XRD does have a preferred supplier base of some 35 suppliers. However, these suppliers are not specifically selected on the basis of their product development capabilities. In fact, the performance of suppliers in product development projects is not structurally evaluated, and therefore not included in the vendor-ratings that underlie the preferred supplier base.

One of the key aspects of Supplier Interface Management is that the interface has to be maintained all the time, not only at the moment when a development project is being started by the manufacturer. When the interface is not being supported all the time, it may be impossible or very costly to motivate suppliers to collaborate at the moment a development project does come along. Four out of ten suppliers, for example, indicated that their commitment towards PMS, for example in times of development projects or high market demand, was largely dependent on the commitment PMS showed towards them in times of low demand. PMS hardly seems to realise how often this line of reasoning is adopted by suppliers, and this prevents building a good supplier interface as well.

This lack of supplier interface is also reflected in the fact that motivating suppliers to build up or maintain specific knowledge or develop certain products is not easy for PMS, as illustrated by the observations from the supplier interviews. One problem in motivating suppliers to build or maintain technical skills and competencies useful for PMS is related to the fact that PMS is producing relatively small series. For those suppliers that do business with other, large-volume manufacturers such as copier producer Océ-van der Grinten or DAF Trucks, the production series and purchasing volumes of PMS are rather small, and hence provide too little platform for substantial development efforts.

Exploiting the technical capabilities of suppliers, starting from the skills and resources of supplier for defining new product concepts does not seem to take place. The key technologies for the X-ray systems, the ones in which the most important innovations take place, are controlled by PMS, and therefore suppliers are seldom the source of complete new product ideas. It is not like at FFT, where a new component from a supplier (a new packaging) can trigger a new final product.

Project Management

The most serious problems PMS is facing seem to concern the area of Project Management. Starting with project planning; project-specific Develop-or-Buy solutions were being determined mainly by Development, in the early stage of a development project. No explicit guidelines exist for taking such decisions, and economic aspects may not be given the required attention since the development engineers (as they admit themselves) have no fundamental cost awareness and discipline. For example, Development is not accountable for the costs of the new product and is therefore not encouraged to consider the often negative impact of separating development and production responsibility (between different suppliers) on product costs. Purchasing does not fully participate in the develop-or-buy decisions for specific development projects, even it is part of the Development Team established 3 months prior to review 1/2, since most of these decisions are taken in the very early stages of the development process.

Selecting suppliers for a development project is formally the responsibility of the so-called Purchasing Release Team (PRT). This PRT consists of development engineers, the project leader and the initial purchaser that is assigned to the project. The PRT is only established in the Detail Design phase (3), and disbands at review 5/6. The PRT decides which module, component or part is going to be ordered at which supplier as soon as the development engineer concerned has produced the necessary specifications and/or drawings. However, for some items with long lead-times, detail engineering activities start already in phase 2, Overall Design. When the PRT starts to function in phase 3, the development engineers have already either been contacting suppliers for such long lead-time items to discuss specifications or been detailing the specifications to a great extent. In both cases, the supplier has de facto already been selected before Purchasing by means of the PRT has ever got the opportunity to become involved and contribute to the discussions by offering its supplier market expertise.

Regarding the extent and moment of supplier involvement, these are not explicitly determined as such. In any case, there are no guidelines how to take these decisions, and consequently they are taken on the basis of ad-hoc considerations and personal insights. Moreover, there is no firm idea on the basis of what factors the extent and moment of supplier involvement should be differentiated, although it is clear that such a differentiation would be necessary from the perspective of keeping a project manageable. In the manual that has been developed to solve some of the problems at PMS related to purchasing and supplier involvement in product development, determining the form of supplier involvement in terms of extent and moment is the central activity (Appendix G; see the end of section 7.4)

This brings us to Project Execution activities. Co-ordinating the development, design and engineering activities is mainly done by Development, although it should be noted that this primarily involves engineering activities since the involvement of suppliers usually did not go beyond that. However, the co-ordination of prototyping and production start-up activities is the responsibility of Purchasing, as all prototype orders have to go through Operational Purchasing; this was a rather lengthy procedure as we saw. This division in responsibilities, which may not always have been clear to suppliers, leads to suppliers being often uncertain whom to contact at PMS for development issues, causing problematic communication and co-ordination. More seriously, suppliers have not always been fully and structurally informed about engineering changes and changes in time-tables, perhaps due to Development and Purchasing believing each other to have informed the supplier. In other words; a lack of guidelines and agreement between Purchasing and Development on who is responsible for co-ordinating, which has led to overlaps and white spots in the area of Project Execution.

Co-ordination of development activities between first and second tier suppliers, and between different first tier suppliers does not seem to take place at all, neither does it seem to be an (important) issue at PMS. Again, this may be related to the fact that the involvement of suppliers in product development has been increasing only recently, and therefore these more complicated aspects of project execution have not yet fully manifested themselves.

Product Management

Finally, to what extent and in what way are the extending and restrictive product management activities carried out at PMS? Only some brief observations can be noted here, as these activities have not been considered in great detail, but the extending activities seem very seldom to be done by Purchasing. This goes back to the fact that Purchasing is only involved towards the end of Phase 1 by means of the Project Team, or even - more substantially - in Phase 3 through the Purchasing Release Team. However, the extending activities, providing information on possible technical solutions offered by suppliers and suggesting alternatives, should take place mainly in the early phases of the development project (see Figure 3.8). Development engineers have also indicated that one of the main improvements they would like to see is to have more information provided by purchasers on technical developments in supplier markets (see Table 7.3). Obviously, the development engineers do not see themselves as the ones first responsible for collecting that kind of information.

The restrictive activities, evaluating product designs in terms of part availability, makeability, lead-time, quality and costs, and promoting standardisation and simplification of designs and parts, do not seem to be well-organised either. To some extent, there is a formal procedure that Purchasing needs to approve the introduction of new purchased parts, but it is seldom adhered to. The procedure is hindered by the fact that purchasers are involved very late in the development project and their limited abilities to offer alternatives to the development engineers. With the limited knowledge the development engineers have of supplier markets and their limited concern with and insight into costs it is clear that they can not perform these activities in an optimal way.

Product Management activities are thus not well taken care of, and this is closely related to the fact that the Supplier Interface Management activity of carrying out market research is not well-organised. Market research, and the insights and information resulting from it, form the foundation for carrying out Product Management activities.

7.4.4 Driving factors

Company size

In terms of turnover, PMS/XRD is not a very large company, especially in comparison with other industrial manufacturers in the region that its suppliers work for. This relatively small size is one of the reasons why PMS encounters difficulties in motivating suppliers to build or maintain specific technical skills and competencies (i.e. Supplier Interface Management). Comparing the combined size of the most relevant departments of PMS with those at Ericsson and FFT, the company is in the middle. Since the organisational complexity is thus limited compared to Ericsson, it has less need for explicit policies on purchasing and supplier involvement and the communication thereof. There may, however, be other reasons which make such policies desirable, such as PMS' recent shift towards increased supplier involvement in product development. Another possible driving factor may be that, although PMS is not very large, its organisation is rather complex and decentralised, mainly because of the broad product range (in terms of the technology employed).

Production type

PMS' production is characterised by small series, and it has already been noted that this is one of the factors which makes it difficult to motivate (some) suppliers to collaborate in product development, i.e. create a beneficial Supplier Interface. As is usually the case with assembly-process firms, the products involve a large number of different components, assemblies, etc. This puts emphasis on Project Management (both Planning and Execution), and many of PMS' problems can be related to the activities in this area.

R&D intensity

In terms of R&D expenses relative to turnover, PMS scores somewhere between Ericsson and FFT. Given the importance of product development, it has extensive product development procedures, but no explicit policies and guidelines regarding purchasing and supplier involvement have been formulated (yet). This is related to the fact that only recently, suppliers have become more important in terms of product development. In that sense, PMS can be said to be in a transitory phase in which it is just starting to involve suppliers more in product development. Previously, the need was not so high to have suppliers involved. In other words, product development is important for PMS but has mainly taken place internally.

Purchasing ratio

Despite the fact that XRD is typically an assembly company, external suppliers have not been very important in terms of volume. As indicated at the beginning, purchases account for roughly 65 % of turnover, and two-thirds of that comes from external suppliers due to the fact that important parts, such as X-ray components, come from internal suppliers. Now, with the major cost reduction efforts and the reconsideration of the company's core competencies and technologies, the tendency is towards increased outsourcing in the form of buying modules and assemblies rather than simple components, and in the form of letting suppliers take more responsibility for (part of the) development, design and engineering activities. This puts a stronger focus on the area of Supplier Interface Management.

7.4.5 Enabling factors

Organisation

In principle, the formal organisation at PMS seems rather suitable for cross-functional collaboration in product development. The project teams consist of representatives from different departments, such as Purchasing, and there is even a specific team for supplier selection, the Purchasing Release Team (PRT). Nevertheless, this organisation does not guarantee efficient collaboration as has become sufficiently clear. One problem is that the PRT is established relatively late, the other is that assigning one initial purchaser to each project may sometimes be too little; at least many development engineers feel the purchasing capacity for supporting development projects is often insufficient.

One possible solution to this capacity problem would be to introduce sub-teams besides the normal project team and the PRT. These sub-teams could then deal with one or two specific suppliers that are deeply involved in a development project, and therefore require extensive co-ordination and communication. The development and the purchasing department are also located in two different buildings, and although these are within a reasonable range (± 500 meters apart) locating the two departments more closely together could improve the collaboration and communication. This could, however, come at the expense of the communication with the production departments.

Information

There is a 'Medical Component Database', which is on-line available to development engineers. This database contains most standard 'catalogue' components and parts. However, this database is not connected to CAD/CAM tools, nor to project management tools or the more logistical purchasing information systems used by PMS (COPICS and later SAP). In fact, most of the information systems within purchasing and product development at PMS are 'stand alone' systems, and are often home-made. In general, IT is hardly a supporting or enabling factor with regards to purchasing involvement in product development at PMS.

Human resources

It has already been demonstrated that important differences exist between purchasers and development engineers, especially with regard to their perception of tasks and responsibilities. Purchasers seem to perceive development engineers as hard to work with and not sensitive to cost issues, and feel they get too little room for involvement in product development. Development engineers think that purchasers often have too little technical knowledge and information regarding suppliers, but still try to be involved in all contacts with suppliers. Obviously, they feel that purchasers generally provide too little added value to a development project.

While development engineers also admit that they are not well aware of cost issues, it is unclear whether the purchasers would admit they have too little technical knowledge. In our opinion, the initial purchasers have a fair degree of technical knowledge. In terms of education, of the 15 initial purchasers, three-quarters have a primarily technical education. However, the fact that purchasing has increased its market research activities indicates that it realised it could at least increase the (detail, scope and quality of the) technical *information* it can provide.

Moreover, it is not only purchaser's actual lack of technical knowledge that prevents their involvement in product development, but rather whether other departments - such as Development - perceive such a lack to exist. In the case of PMS, it is fair to say that actual differences between and deficiencies of the two departments have been magnified by mutual perceptions.

7.4.5 Conclusion

In conclusion, it can be stated that at PMS, Project Management activities related to purchasing involvement in product development are not being performed in a co-ordinated manner. This is due to insufficient Supplier Interface Management, which is caused by the fact that PMS is recently trying to change that interface in terms of the (development) responsibilities of suppliers. Both the problems in the area of Project Management and Supplier Interface Management can be traced back to Development Management. More specifically: a lack of policies for the involvement of suppliers and for purchasing related activities of internal departments. The main causes of these problems are the lack of common understanding between the purchasing and development departments concerned; lack of understanding with regard to each other's tasks and responsibilities, but especially lack of agreement and understanding with regard to the possible roles of suppliers in product development. To solve some of these problems, a procedure has been developed for distinguishing different supplier roles in the product development process. This so-called 'supplier involvement portfolio' and its accompanying guidelines on communication and co-ordination are a first attempt to address some of the most pressing problems. This tool is presented in Appendix G.

7.5 Summary and conclusions

At Ericsson, it has been found that in:

- Development Management, purchasing has developed some policies and guidelines but these have not been integrated with product development procedures and are not well-known at other departments;
- Project Management, initial and operational purchasing tasks are carried out by (physically) separate groups, and lack of information often leads to problems in the co-ordination of production start-up;
- Product Management, a separate department maintains a 'library' of standard components for development purposes, but the lists are hard to access and often contain outdated or incomplete information.

Based on its policies, Ericsson seems to have organised purchasing and supplier involvement rather well. Most problems in the Aladdin project seem to concentrate around communication and co-ordination, partly due to temporary factors such as the large amount of people involved that were new to the organisation, but also to more structural factors such as a rather complex organisation with different departments having closely related responsibilities regarding purchasing and supplier involvement in product development. In general, it can be concluded that at Ericsson, the first efforts for purchasing involvement in product development have been made, but substantial problems remain related to operational issues.

At Food For Thought, we found that:

- Development Management is largely absent, since develop-or-buy is not an issue, and policies and guidelines regarding internal and external involvement in product development are virtually non-existent;
- Supplier Interface Management and Project Management are carried out by everyone, hindered by a lack of communication and co-ordination structures, saved by improvisation, flexibility and personal relations;
- Product Management is carried out mainly by the development department, often limiting the purchasing department in its possibilities to bring their commercial and market knowledge to bear on the project.

Efficient collaboration in product development at Food For Thought, both internally and externally with suppliers, is hampered by an extremely decentralised organisation, (perceived) differences in terms of background and attitude between marketers on the one hand and purchasers on the other, and a lack of a good infrastructure for the recording and exchange of information related to product development. Nevertheless, Food For Thought has been able to turn out quite some new products over the past few years, despite several delays. The problems seem to affect the efficiency more than the effectiveness of the development process.

At PMS, we studied one development project in detail, at a time in which the company was planning to rely increasingly on the involvement of suppliers in product development. At this company:

- Development Management is not sufficiently performed, as the lack of guidelines for supplier involvement leads to obscurity not only for the internal departments but also for suppliers, which reduces their ability and willingness to collaborate;
- Supplier Interface Management is an area with new demands, since PMS is trying to change its interface with suppliers by giving them more complex products to develop and to manufacture, requiring more emphasis on market research;

- Project Management seems the most problematic area, with many activities being performed on the basis of personal insights and ad-hoc considerations; and
- Product Management tasks are hardly carried out: engineers see these as the responsibility of purchasers, but the latter are involved too late in the development project and have (still) too little market insight.

At PMS, the internal organisation seems rather suitable for cross-functional collaboration in product development, with purchasing represented in the development team and special supplier selection sub-teams. However, this formal structure does not guarantee actual and efficient collaboration, partly because the moment when these teams are formally established is rather late. Another complicating factor may be the development department's feelings regarding the company's strive for increased supplier involvement, which it perceives as partly threatening to its own work. The purchasing department may, in this context, sometimes be seen as an 'advocate of the devil' rather than as colleagues.

In each of the three case studies, the problems experienced in product development with regard to purchasing and supplier involvement can be related to one or more of the management areas or specific activities from our framework. Company size, production type, R&D intensity and purchasing ratio seem to partly explain the importance companies (should) place on specific management areas or activities. The case studies also show that most of the problems can be traced to a lack of enabling factors (or underlying barriers), the most important of which are: functionally-oriented, fragmented internal organisations, lack of (access to) information, and differences in personal attitudes between departments. In the following chapter, the driving and enabling factors underlying purchasing involvement in product development are explored in more detail, primarily based on the findings of the three case-studies in this chapter.

Chapter 8

Driving and Enabling Factors

The objective of this chapter is to analyse the factors that influence the extent to which the different activities from our framework *need* to be carried out, and the factors that influence the extent to which the activities *can* be carried out: i.e. driving and enabling factors. Identifying these factors has been defined as the second objective of our research, and should result in preliminary knowledge regarding the application of the framework of activities. This knowledge is preliminary, primarily because we have only focused on a limited number of driving and enabling factors. In section 6.5, partly based on literature, the (groups of) factors have been listed which seemed to be of influence. These include company size, production type, R&D expenses and purchasing ratio as driving factors, and organisation, information and human resources as enabling factors. The in-depth case studies in Chapter 7 have focused only on these factors, and the possible impact of other driving and enabling factors may therefore have been neglected.

In essence, this chapter summarises, discusses and compares the findings of the in-depth case studies, and places them in the context of previous research in order to get a better overview of the impact of the various driving and enabling factors. First, section 8.1 deals with driving factors, after which section 8.2 discusses the enabling factors. Relatively more attention is given to the enabling factors. The chapter finishes with conclusions in section 8.3.

8.1 Driving factors

As before, four different driving factors are discussed:

- company size;
- production type;
- R&D intensity; and
- purchasing ratio.

8.1.1 Company size

In the case studies, one problem is at what level of the company should we measure size. Comparing the whole companies (concerns) with each other would hardly make sense since this does not adequately reflect the organisational complexity the departments we have been studying are facing. Regarding the specific business units we focused on, however, turnover figures that can be compared are not available for all of them. An alternative would be to compare the case companies in terms of the number of employees. The best figure for comparisons would then be the total headcount of the purchasing and the development department together, as these two departments have been studied in each of the three cases. Measured by this headcount, Ericsson is clearly the biggest firm (roughly 500), then Philips Medical Systems (about 40), and Food For Thought is the smallest (15).

One of the differences between the case studies that seems to be related to company size regards the area of Development Management. One conclusion in the case studies has been that Ericsson, more than the two other companies, has developed a set of policies and guidelines for the responsibilities of the purchasing department regarding activities in product development. The problem is, however, that these policies have not (yet) been fully communicated to the development engineers. Since Ericsson is such a large and complex organisation, this may become a problem as has been illustrated by the fact that many engineers do not know whom to turn to for purchasing related issues. At FFT, there is a complete lack of policies and guidelines, but since it is a relatively small organisation it seems possible to compensate for this lack of guidelines by using personal relations and improvisation. In a large organisation such as Ericsson, especially when there are many new people, this kind of compensation may only partly help. Also in the case of PMS, we have argued that the lack of policies for supplier and purchasing involvement is one of the causes behind the lack of internal co-ordination in Project Execution activities. However, in our opinion, the main reason why this lack of policies or guidelines is problematic has not to do with the size of PMS, but rather with its efforts to change the responsibilities it gives to suppliers in product development. If there would not be such a change, the organisation seems small enough to compensate for the lack of guidelines by personal communication and improvisation.

Summarising, the formulation and communication of policies seems to be an activity that is more relevant for large organisations than for small ones. Other activities do not seem to become more important with company size. This can possibly be explained by the fact that Development Management is the only area that is focusing on the whole organisation or firm as such, while the other areas primarily focus either on suppliers and supplier relations (Supplier Interface Management) or on development projects (Project Planning and Execution, and Product Management). Only when, for example, the number or diversity of suppliers grows, or the complexity of the project increases would activities in these other areas become more relevant, not when the size of the firm grows.

8.1.2 Production type

Most available research tends to focus on large series production industries (see section 1.1.2). This focus seems to indicate that researchers think supplier and purchasing involvement in product development is only relevant for those kind of industries (see Hartley, 1994: 19). An alternative explanation for the focus on large series (assembly) production industries such as automotive and electronics would be that these have actually realised the highest degree of involvement, and are therefore an interesting study object. The real explanation for the focus of prior research on large series production industries may be that electronics and automotive firms have realised the most explicit or 'sophisticated' ways of involvement, in terms of special management tools and policy documents. This creates the impression that these firms are very active while in essence, in terms of the activities that are being performed, their purchasing involvement in product development is very similar to that of firms with other production types. The reason that firms like Motorola, Xerox, Honda etc. have more explicit or sophisticated ways of purchasing involvement is probably more directly related to factors like having absolutely large purchasing departments and a professional view on purchasing overall than to having a particular production type.

Still, the kind of production type being employed by the manufacturer may have an effect on the importance of the different management areas. Project Execution involves activities that seem important for large series production firms, such as co-ordinating the development activities of different suppliers. Large series production firms are often dominated by assembly operations. When performing assembly operations, it is likely that many parts, with a relatively high degree of complexity (f.e. sub-assemblies) are involved.

This would emphasise the importance of co-ordinating development activities between different first tier suppliers, and between first and second tier suppliers. However, this may not only be true for large series production firms. Also unit production and small series production firms perform assembly operations, and buy a variety of different components and, sometimes, sub-assemblies: see section 5.8 for examples of power plant manufacturers. These Project Execution activities may therefore be just as relevant for unit and small series production firms as for large series production firms. Only process production firms may face less need for the activities in the sense that they normally do not use a great variety of 'parts' in one product, which are usually not very complex either.

The same applies to Project Planning and Product Management: the need for performing these activities seems to be related to the number and the complexity of parts, and is therefore lower for process production firms than for others.

The in-depth case studies have involved one company with large series production (Ericsson), one with a combination of large series and process production (FFT), and one with small series production (PMS). The question is whether some of the specific problems in each case can be attributed to the type of production process being employed. Specific problems in the Ericsson case regarded the frequent miscommunication in releasing components for production orders and the large number of requests for approval of using a component from the standard list, which often led to delays. These problems, involving Project Execution and Product Management activities, are primarily related to the large number of components involved. At PMS, which applies small series production, the products also consist of a large number of different components and there too, Project Execution (and Planning) is a problematic area. Finally, also at FFT (whose production can be mainly described a process production), many of the problems are associated with Project Execution tasks, while its products being developed usually consist of not more than 5-10 different components; much less than the products of either Ericsson or PMS. However, Ericsson and PMS seem to perform Project Execution activities to some basic degree, or at least more than FFT. The fact that all three companies experience problems in this area therefore seems to indicate that the demands on (the intensity of) these activities at Ericsson and PMS are higher than at FFT. In other words, the two firms with large respectively small series production (assembly processes) seem to have a higher need for Project Execution activities than the firm with process production.

Project Planning seems to be more of an issue for PMS than for FFT. For the latter, determining the degree and moment of supplier involvement is not a matter of great discussion since suppliers usually carry out all development work, and because a project normally involves only a few suppliers. For Ericsson, we have little information on Project Planning activities. Product Management seems to be more important for Ericsson than for FFT, again because of the sheer number of components and parts involved. This is also illustrated by the fact that, even while Product Management is organised in a rather structured way at Ericsson, the company still faces considerable problems in that area.

8.1.3 R&D intensity

In the three in-depth case studies, Ericsson is the company with the highest level of R&D expenditure: overall, about 13 % of turnover. PMS spends more on R&D than FFT. Of the three companies, Ericsson seems the most active in Development Management as it has developed a set of policies and guidelines for the responsibilities of the purchasing department regarding activities in product development. The problem is, however, that these policies have not (yet) been fully communicated to the development engineers.

Earlier, we have argued that Ericsson's focus on Development Management may be related to its size. However, it can also be argued that it is at least partly driven by its high level of R&D expenditure. High expenditure puts the product development process at the centre of attention for top management, those who are primarily responsible for Development Management activities.

8.1.4 Purchasing ratio

At first sight, Supplier Interface Management seems the area that is driven the most by purchasing ratio. In other words, activities such as monitoring supplier markets, exploiting suppliers' technical capabilities and supplier performance rating seem to become more important as the manufacturer becomes more dependent on suppliers, as reflected in an increasing purchasing ratio. However, it has already been indicated in section 6.5.1 that purchasing ratio in itself does not always adequately reflect the dependence of the manufacturer on suppliers, since it does not take into account the type of products and the type of supplier relations.

Of the three companies in the case studies, we have no exact figures on their purchasing ratio's. If we look at the costs of purchased goods versus total product costs (i.e. not including margins), however, the figures for Ericsson and PMS are around 70-80 %, and for FFT around 20 %¹. This indicates that FFT has a lower purchasing ratio than the two other companies. At PMS, we have seen that Supplier Interface Management is an increasingly important area because of the increasing responsibilities of suppliers, not only in product development but also in assembly activities. This means that supplier will increasingly supply complex assemblies or modules that they develop partly themselves. In other words, the goal of relying more on suppliers, which is to be reflected in a higher purchasing ratio (and more 'intensive' relations with suppliers), puts special emphasis on Supplier Interface Management.

At FFT, Supplier Interface Management is an area in which various departments (marketing, development and purchasing) are active, each on its own and without any real co-ordination. Based on the company's low purchasing ratio, one could argue that Supplier Interface Management is not so important, and that the situation is therefore not problematic. However, it does form a problem, since the products FFT buys - packaging - are the most important part of the final product in terms of product development. In other words, in terms of costs, purchased goods may not be very important, but in terms of development they are. The low purchasing ratio underestimates the actual importance of the supplier inputs, and Supplier Interface Management is still very important. For Ericsson, we have, unfortunately, little information on this area.

This concludes the discussion of the driving factors.

¹ The figure for FFT excludes the costs of raw materials, i.e. the food product itself, which are bought from farmers that are members of the co-operative that owns FFT. These farmers can thus be regarded as in-house suppliers, and therefore the cost of raw material is not subsumed under costs of purchased goods. Moreover, these 'suppliers' have hardly any collaboration with FFT in terms of product development.

8.2 Enabling factors

The second group of factors that cause differences between firms in terms of whether or not they are performing certain activities from our framework, and which department is performing them, are the so-called *enabling* factors. In section 6.5.2, enabling factors have been described as those elements that make it possible or easier to carry out purchasing related activities in product development. Insight into these enabling factors is useful in identifying the possible explanations for, e.g., a lack of necessary involvement in a specific situation and, in that way, in determining the areas for possible managerial action.

Previously, three areas of enabling factors have been identified:

- internal organisation;
- information; and
- human resources.

The internal organisation of a firm is the first important element that impacts on the ability of an organisation (and the different departments) to perform the different activities. The crucial aspect of the internal organisation is whether it supports cross-functional collaboration, more specifically communication and co-ordination in product development processes. When a firm's purchasing and development departments are organised in such a way that co-ordination and communication regarding their activities takes place only in a very complex and indirect manner, there is a greater likelihood that at least some of the activities from our framework are not being carried out or carried out double.

The second factor that affects the ability to perform certain activities is the availability of information. Product development is a highly information-intensive process, and many of the activities distinguished in our framework have an information aspect to them. When information, for example with regard to the status of drawings of a particular component design, is readily available and accessible to those that need it (f.e. supplier, purchaser and engineer), this may facilitate their mutual communication and the performance of other tasks, such as the co-ordination of the development activities of several suppliers.

The third factor bearing on the ability to perform the various purchasing related activities in product development are human resources. Human resources have various dimensions that may contribute to the ability of an organisation to carry out the purchasing related activities in product development. First, there is a quantitative dimension. When, for example, a purchasing department is faced with an extremely high workload concerning regular purchasing tasks, there is little time or opportunity to perform these more initial purchasing tasks. This dimension, however, is closely associated with the internal organisation of the firm and its departments, and will therefore be discussed under that heading. Second, human resources have a qualitative dimension. When purchasers have a fair degree of technological knowledge, or when development engineers have considerable understanding of cost and availability aspects of component designs, they may be better able to collaborate together in certain tasks. In discussing human resources, we focus on this qualitative dimension.

In the three following sub-sections, each of these areas of enabling factors is described in more detail. For each area, the findings from the in-depth case studies (reported in Chapter 7) are complemented with notions from literature and previous research. Additionally, we briefly refer to some illustrations from the companies studied for their manufacturer-supplier relationships (Chapter 5) and from the Dutch companies of which we have done mini-case studies (Chapter 6).

8.2.1 Internal organisation

The first area of enabling factors regards the structural dimensions of the internal organisation of the firm. The crucial aspect of the internal organisational structure is whether it supports cross-functional collaboration in product development processes. More specifically, this collaboration involves the co-ordination and (where necessary, joint) performance of the different purchasing involvement activities in product development. This collaboration especially regards the two functions most directly involved: purchasing and product development.

It is possible to distinguish two aspects of the internal organisation that have a major impact on the ability of an organisation to perform the activities we argue to be central to purchasing involvement in product development: (1) the organisation of the purchasing department, and (2) the structure, composition and location of the product development team. These two aspects are closely related to each other and sometimes hard to distinguish in practice. However, since they are in essence separate organisational parameters, they are treated separately.

Organisation of the purchasing and development department

Introduction

Regarding the organisation of the purchasing department, there are various elements that seem to impact on the ability to perform the various activities, and to perform them effectively and efficiently. In the first place, the *specialisation* within the department may be of influence. The *degree* of specialisation determines to some extent the knowledge a purchaser has (can achieve) about suppliers and specific products. When a purchaser is responsible for a broad range of products and suppliers, it is more difficult to know every detail of individual suppliers and products. Detailed knowledge is often useful for performing the purchasing activities related to product development. The degree of specialisation depends, among others, on the size of the purchasing department in relation to the total range of products and services it buys and the number of suppliers it buys from. The *principle* of specialisation is also relevant. For example, while the purchasers may be specialised in terms of suppliers (suppliers A - G, suppliers H - M, etc.) which produce different products, the engineers may be specialised on the basis of technologies (plastics, ceramics, electronics, etc.). This makes the communication between the two departments more complex than when both purchasers and engineers are specialised according to technologies, since there is not a one-to-one situation.

In the second place, the *horizontal complexity* of each of the two departments may be an influencing factor. Horizontal complexity refers to the number of different units or groups with specific tasks within each department (Daft, 1986: 18). The more complex the purchasing and development departments are organised, the more likely it is that some unit (or person) has as a specific task the performance of purchasing related activities in product development. When a purchasing department is divided into a unit that performs the operational purchasing tasks and a unit that performs the initial purchasing tasks, this may increase the overall ability of that department to perform those initial tasks, many of which are related to product development. In literature, one finds many examples of firms that have created special groups within the purchasing department to deal specifically with tasks in the area of product development. Dobler and Burt (1996: 158) assert that some purchasing organisations divide responsibilities into 'materials engineering' and buying activities. Materials engineering is responsible, among others, for co-ordinating with design engineering and supplier pre-qualification. McLean (1964) already described that Martin Denver (aerospace engineering) had a special group within the purchasing department, responsible for interfacing with design engineering.

In the second half of the 1980's, General Motors Europe, as another example, established a so-called Advance Purchasing group within its European Central Purchasing department. This Advance Purchasing group was responsible for managing purchasing aspects and supplier involvement in the early stages of product development projects, and was actually located in the same buildings as the development department (Axelsson and Laage-Hellman, 1991: 208-209).

On the other hand, however, a very high degree of complexity may make it more difficult to co-ordinate various activities within the purchasing department itself and with the development department. Take a situation where, for example, three different purchasers from different purchasing groups are responsible for (a) the initial purchasing tasks (developing the specifications together with engineers, making the contract), (b) the 'tactical' tasks such as supplier cost reductions and quality improvement, and (c) the truly operational tasks such as order and delivery issues. While this separation may ensure that the different tasks are carried out by people with the right profile for each task, it entails a greater need for co-ordination between the different purchasers.

In the third place, the *reporting relationship* may be a factor of influence. At some firms, the purchasing and development departments have been brought under the responsibility of one and the same manager. Such is the case at BMW, where purchasing has been combined with R&D and design (Templeman and Treece, 1994: 44). Having the purchasing and the development department report to the same manager (at some level) will imply that, at some point, the departments need to agree on common goals, which increases the likelihood that they co-ordinate their actions. An example of a company that has gone quite far in integrating its purchasing and development department, not only regarding development projects, but rather on a *permanent* basis is the Dutch manufacturer of military radar systems, Hollandse Signaalapparaten. This firm employs duo's of so-called 'Article Specialists', consisting of one purchaser and one engineer, who are specialised in a specific range of products. These duo's give assistance to development projects in areas like develop-or-buy decisions, supplier and part selection, and specification, and have a permanent character. Hollandse Signaalapparaten has about 20 of these duo's, which report to 'Article Teams' for a specific technological area (f.e. mechanics). These teams, six in total, consist of the responsible group leaders from R&D and purchasing. The teams, in their turn, report to a Steering Group which consists of the R&D manager and the purchasing manager. This joint organisation constitutes a permanent integration between the development and the purchasing department (Cuijpers and Wijnstra, 1996; see also section 6.4.4).

Findings

None of the three case companies has a joint reporting relationship for the purchasing and the development department.

At Ericsson, the specialisation of purchasers in the Business Unit Procurement department is based on products. With several development projects going on at the same time, this may mean that a purchaser has to contribute to different projects simultaneously. Some of the engineers, however, argued it would be better to have purchasers specialised according to projects. In that case, purchasers would be full-time allocated to a specific project. This may be difficult because the specialisation of the BU Procurement department matches that of the (operational) purchasers at the factory level, which facilitates their communication and co-ordination. When the initial purchasers are full-time allocated to projects, they will obviously deal with a range of components and thus with different operational purchasers at the factories. If several projects are going on at the same time, the factory purchasers will also be dealing with different initial purchasers. Consequently, the co-ordination between initial and operational purchasers becomes more complicated than in the current situation.

The purchasing organisation at Ericsson can be said to rather *complex*, since the part that is involved in initial purchasing tasks already consists of three different units: Procurement, Prototype Procurement (part of the Product Development department) and Component Technology (the separate department responsible for standard parts management). On the one hand, this means that each of them can focus on a limited number of tasks. On the other hand, it carries the risk that the various purchasing related activities in product development become very fragmented, especially if there is insufficient communication between the different groups. Many of the engineers found the division of responsibilities between the three rather confusing, and did not always know whom to turn to for specific issues. It has to be noted, however, that many of the engineers at Ericsson were new to the organisation.

At Food For Thought (FFT), the purchasers are specialised according to products too. However, there are only two purchasers for packaging, and consequently they have to deal with a broad range of packaging materials and a variety of suppliers. The limited size of the department also means that there is no high degree of complexity in its organisation. Apart from the operational, more logistical purchasing tasks related to ordering and delivery, which have recently been delegated to the production departments, each of the purchasers is responsible for all kinds of purchasing activities for his specific range of products and suppliers. The purchasers are still very much occupied with short-term activities, 'fire-fighting', partly due to the production departments still asking for their assistance, partly due to their own priorities. Consequently, the purchasers spend little time on product development issues.

Finally, at the business unit XRD of Philips Medical Systems (PMS), the purchasing department, at least the Initial Purchasing group, is primarily organised on the basis of internal customers: there is one group for the product group Cardio-vascular diagnostics, and one for Remote Control and Surgery combined. This means that the development departments of these respective product groups are faced with their 'own' initial purchasing group. The advantage of organising the department in this way is that the interface with the product development departments is relatively simple. The disadvantage may be that for those products or technologies that are common to both groups, the organisation according to internal customers may entail a duplication of knowledge and resources. PMS has started to compensate for this disadvantage by establishing Competence Teams for different technologies, across the two initial purchasing groups. These teams of purchasers carry out initial purchasing activities that can be carried out in common for the two internal customers, such as supplier market research.

In terms of complexity, the purchasing department at PMS consists of four groups: the two initial purchasing groups, a Supplier Quality Assurance group, and Operational Purchasing. Operational Purchasing is only responsible for ordering and chasing proto-types; regular production items are ordered by a separate logistical department. This structure would seem to enable the different purchasing groups to focus on its respective tasks but, just as in the case of Ericsson, the negative effect seems to be that some activities are difficult to handle exactly because of this separation of responsibilities. Ordering prototypes and communicating engineering changes (to suppliers) seem complicated processes at PMS.

Structure, composition and location of the product development team

Introduction

Product development requires the integration of various specialised capabilities: marketing, engineering, manufacturing, purchasing, etc. This integration is usually achieved by establishing some form of project organisation, often labelled as a development team. These teams can be organised in different ways. At the one extreme, there are team structures that consist of people that are still very closely connected (in terms of task performance control and career paths) to the functional organisation of their firm, and where no strong project manager role exists.

At the other extreme, there are autonomous team structures, where individuals from different functional areas are fully dedicated to the project team and where the project leader has a very strong position, for example in task performance evaluation (Clark and Wheelwright, 1992). The choice for any specific team structure may be dependent on factors such as the nature of the development project undertaken, the priority and resources given to the project, and the company tradition regarding cross-functional collaboration (see also Simonse, 1998: 203-209).

Apart from the structure of the development team, the *composition* of the team is also a major decision variable. The company functions or departments that have representatives included in the project team are usually those that are most *involved* or most *affected* by it. The involvement may regard activities like the definition of the new product concept (marketing), the actual development and engineering of the product specifications (engineering), or the preparation of production facilities (manufacturing). Being included in a development team enables a function to (better): be informed about the development process (its progress, the problems, the choices made); communicate and co-ordinate with other functions regarding specific activities or decisions; and influence the development process and take part in decisions, defending its specific interests with regard to the development process itself and the new product.

For these reasons, the participation of the purchasing function may benefit the performance of the activities from our framework. In the first place, participation means that purchasing representatives are likely to be better informed about the project which enables them to better 'tailor' some of their activities to the needs of the project. In the second place, they can communicate and co-ordinate better with the other project members so that, for example, it may be decided that development engineers perform certain activities (e.g. co-ordinating the development work of different suppliers) and purchasers others (e.g. market research). Finally, purchasing may be able to influence certain decisions to its own interest; for example, selecting a supplier that is already a preferred partner to develop a specific component.

In addition to internal representatives, development teams may also include external members such as suppliers (O'Neal, 1993: 5; Woodruff, 1990; Simonse, 1998: 85, 99-102). This would especially concern the suppliers that perform an important share of the project's development work and/or develop a key component or part. In a survey of 60 US companies, Ragatz *et al.* (1997) studied both their most and least successful² supplier integration cases. Of the various management practices, supplier membership on the buying company's development project team was the single largest differentiator between most and least successful supplier integration efforts (1997: 195-196).

The third aspect of the organisation of product development teams regards their physical location. For the complex communication involved in product development to evolve rapidly and effectively, close physical location of development team members is often argued to be of great importance (Clark and Wheelwright, 1992: 20). However, in a survey based on 325 buyers from a broad cross-section of industries in the US, the buyer's ability (as rated by his supervisor) to obtain consideration by development engineers of the purchasing implications of alternative designs did not seem to be affected significantly by the co-location approach alone (Anklesaria and Burt, 1987). The researchers argue that it is probably the buyer's experience and performance in that setting that has an important impact.

² Successful was defined by the respondents themselves in terms of overall satisfaction, and degree of achievement of the established goals.

Sometimes, full-time location of purchasers at one development team may not be possible or desirable, for example when other tasks require close communication with other purchasing colleagues or other departments. One solution would then be that they are 'co-located': maintaining two offices, one in the purchasing department and one in the engineering or development team area. Supplier representatives may also be located close to the team. In the case of *residential engineering*, supplier engineers are stationed at the customer site. Nishiguchi (1993) claims that already in 1958, these resident engineers were seen at Toyota. Supplier engineers, however, need not always be located at the customer site: customer engineers may also be located at the supplier site, as is the case at Philips Car Systems (Wetzlar, D) where major car manufacturers have located representatives to discuss and develop new designs (Philips Koerier, 1996). During the course of a development project, the location of the people involved in the collaboration with the supplier may also change: at the outset, the supplier engineers sit at the customer to develop the basic design of the final product together, later on customer representatives are located at the supplier to co-ordinate the final engineering activities and the production start-up. Fokker Aircraft used to apply residential engineering too, especially in the early stages of the development process: when the major uncertainties had been reduced to an acceptable level, the engineering activities of Fokker and the supplier could be 'de-coupled' and carried out at their separate locations (Van Stekelenborg, 1996). In the US survey mentioned earlier by Ragatz *et al.* (1997: 197), co-location of buyer and seller personnel was also a significant differentiator between most and least successful supplier integration efforts. However, in an absolute sense, co-location was not used extensively. It is used more frequently when the technical complexity of the purchased part is high, when the part is of strategic importance and when electronic communication tools are limited (*ibid.*).

Findings

In the in-depth case studies, different structures of development teams and different forms of purchasing participation can be distinguished. Generally speaking, the team structures and form of purchasing participation at Ericsson and Philips Medical Systems are quite similar. At Food For Thought, however, the situation is rather different in both aspects.

In the case of Ericsson, product development projects are carried out by a cross-functional team in which the purchasing function participates by means of a Procurement Project Co-ordinator. This co-ordinator is responsible for all purchasing related issues within the project, and should ensure that the appropriate purchasing product specialist is involved in an early stage when it comes to specific parts or components. Although the Procurement Project Co-ordinator sits in at the project team meetings, most of the purchasing issues in the Aladdin project we studied were referred to the separate Component Meetings. In the case of that specific project, the Component Meetings were organised by the Component Technology group. In the eyes of Procurement, this led to a too strong emphasis on issues regarding standard components while problems with the more customised components were relatively neglected. This underlines that formal participation of the purchasing department in the project team does not automatically guarantee that purchasing issues in general (or certain specific issues) are given the attention at the team level that the department finds desirable. One of the indications in the Aladdin project that the attention at the project team level for purchasing and supplier related issues was indeed too little, regards the fact that when purchasing issues were discussed, they often had been brought up by manufacturing. In those instances, manufacturing would warn the other project members that components had become critical with respect to the project time-table, often because no definite choice for a supplier or a design had been made.

For Food For Thought (FFT), it has already been argued that the internal organisation does not facilitate cross-functional collaboration in product development. Additionally, the collaboration is complicated by the virtual absence of a common product development procedure. The marketing department (commercial business unit), which is responsible for starting and managing development projects, may have a procedure on its own, but the role of other departments is hardly discussed. Neither are there any common guidelines on the composition of development teams. In fact, the development teams have such a 'loose' structure and the participants (other than the project leader from marketing³) usually spend so little time on any individual project, that one can hardly speak of a true team structure. In the words of Clark and Wheelwright (1992): it is a functional team structure. Because of the lack of procedures and explicit team structures, much of the communication and collaboration in the development projects at FFT takes place through informal and ad-hoc contacts. As a consequence, the involvement of purchasing is usually limited during the initial stages, varies from project to project, and is very much dependent on factors such as the personal motives and attitude of the project leader.

At Philips Medical Systems (PMS), purchasing is represented in the development team by an initial purchaser who is assigned to the project (part-time or full-time). In addition to the development team, there is a Purchasing Release Team, consisting of development engineers, the project leader and the same initial purchaser. This Purchasing Release Team (PRT) is responsible for supplier selection decisions. However, its formal participation in both teams does not guarantee the actual involvement of purchasing in various purchasing and supplier related decisions in the development project. In the first place, most develop-or-buy decisions are usually taken before the formal establishment of the development team, and purchasing consequently is often not involved in those decisions. In the second place, the PRT starts to operate only in the Detail Engineering phase of the project when, for long lead-time items, engineers have already been contacting suppliers to discuss specifications and/or detailing the specifications to a great extent. In that way, for long lead-time items, supplier selection has in fact already taken place before the PRT is established and before purchasing has become involved. The case of PMS demonstrates that it is not only membership of the development team (and sub-teams) that impacts purchasing's abilities to participate in product development, it is also the *moment of establishment* of these teams.

In none of the three case studies, purchasers and engineers are actually physically co-located. In the case of Ericsson, development engineers felt it would be good to have (some) purchasers co-located at its offices. Although Procurement did reserve some offices, this was only meant as an emergency solution since the department was unsure whether it would economically be possible in the long-run to expand its staff, which it thought would be the consequence. In the case of Food For Thought and Philips Medical Systems, co-location is not practised and neither under discussion. In both cases, the distance between the development and purchasing departments is not more than a few hundred metres, so the need for co-location is not perceived as very urgent. Additionally, at these two companies, the level of involvement in and time spent on an individual project by the purchasers concerned is limited. Therefore, the physical location of purchasers with the development team may have been regarded as not beneficial to their other tasks. Part-time 'co-location' could have been an option, but the costs may have been prohibitive.

At none of the three case companies do suppliers formally participate in the development team, let alone did supplier engineers reside at the manufacturer's location. However, Philips Medical Systems (PMS) has more recently been starting to experiment with supplier involvement in development (sub-)teams and locating development engineers (part-time) at the supplier's location. For PMS, this close involvement may be more necessary because, in contrast to the other two companies, some of its suppliers are (increasingly) involved in the development of complete modules, which requires more intensive communication and co-ordination (see the findings of Ragatz *et al.* (1997) mentioned earlier).

³ This may, for example, be a (senior) brand manager.

Discussion

The case studies show that different firms have different ways of organising (1) the purchasing department and (2) the product development team. One explanation for those differences is that the organisational design has to fit with the specific context the firm is facing. This point of view is associated with the contingency theory of organisational development (pioneered by Burns and Stalker, 1961). One of the proponents of this school of thought, Galbraith (1973), frames the choice for alternative organisational designs as a choice between different information-processing networks. Galbraith places particular emphasis on the so-called *lateral relations* between different functions: "interdepartmental group problem solving becomes a mechanism to decentralize decisions and reduce hierarchical overloads" (1973: 18). Lateral relations (between purchasing, product development and others) are exactly the kind of organisational mechanisms that many firms are creating to support the performance of purchasing related activities in product development.

Seven different forms of lateral relations can be distinguished, located on a continuum ranging from a fully functional organisation to a complete product-oriented organisation (Galbraith, 1973: 46-66):

1. direct contacts;
2. liaison roles;
3. temporary task forces;
4. permanent teams;
5. integrator roles;
6. managerial-linking roles; and
7. matrix design, with dual authority.

Direct contacts between managers jointly affected by an issue are the simplest form of lateral relations. *Liaison roles* involve special representatives, like the engineering liaison at the manufacturing department. Such roles become useful when the contacts between departments grow. *Task forces* are horizontal relations dealing with issues that involve multiple departments. *Teams* involve problem solving on a more permanent basis. The three remaining forms of lateral relations involve integrating roles and matrix designs, and differ in their usage of power. Going from integrator roles, through managerial-linking roles to matrix designs we see power being based (cumulatively) on expertise, formal decision authority, budget control, dual reporting, and finally, specialised full-time resources.

In the order as described, the different forms of lateral relations are increasingly sophisticated and costly, and should therefore be used in proportion to the amount of 'task uncertainty'. Galbraith (1973: 4-6) defines this uncertainty as the difference between the amount of information required to perform a task and the amount of information already possessed by the organisation. The required amount of information is dependent on output diversity (in products, customers, etc.), diversity in input resources (in machines, technical specialisations, etc.) and the required level of performance; the amount possessed is a function of the newness of a task. As task uncertainty in an organisation grows, different departments are differentially affected. Some departments face large increases in uncertainty, while others experience little. These increases in differences in task uncertainty leads to *differentiation* in power and attitudes of members of the organisation. The bigger the differences in task uncertainty, the more power is needed to influence organisational behaviour and to achieve *integration* (Galbraith, 1973: 90). These concepts of differentiation and integration have originally been introduced by Lawrence and Lorsch (1967).

The different structures of product development teams and the more permanent relations between the different departments that have been encountered in the case studies can be related to the forms of lateral relations distinguished by Galbraith (see Table 8.1).

Table 8.1: Characterisation of product development organisations

Company	Organisational element	Characterisation according to Galbraith
Ericsson	product development team	team
	Procurement Project Co-ordinator	integrator role
FoodforThought(FFT)	(lack of explicit) development team	direct contact
Philips Medical Systems (PMS)	product development team	team

Returning to the notion that the organisational form chosen should fit with the specific context, one would expect - if the three companies have an appropriate form of lateral relations in place - that PMS and Ericsson are facing more uncertainty than FFT, since (as Table 8.1 indicates) the latter company has the least elaborate form of lateral relations.

On some of the aspects of uncertainty, Ericsson and PMS can indeed be said to face more uncertainty than FFT: they have a greater diversity in input resources as their products incorporate a greater variety of different components and technologies, and they have a greater variety in customers (FFT is mainly facing individual consumers which are relatively homogeneous). On another aspect, which Galbraith seems to use as an important indicator of uncertainty (1973: 111), the differences are less evident: the role and importance of product development at the company. Although the product development projects undertaken by FFT may not be as technically complex as those by PMS and Ericsson, as reflected in its relatively low R&D expenditure (see section 8.1.3), they occur relatively frequently and have a large impact on the company's product range. Hence, the differences in uncertainty faced by the three companies may not be as large as indicated by the variety in the lateral relations they have chosen for managing the purchasing related activities in product development. Apart from that, it has become clear that especially at FFT, the cross-functional collaboration in development projects is rather problematic, which also seems to indicate that a more substantial, elaborate form of lateral relations between the different departments during product development would be required.

This concludes the discussion of internal organisation as the first factor in enabling and facilitating the effective and efficient performance of the purchasing related activities in product development. As the second factor, the role of the availability of information is analysed.

8.2.2 Information

A second requirement for many of the activities associated with purchasing involvement in product development is information.

At Ericsson, standard component lists (the so-called STAKO lists) form an important information support tool. Their actual use (in the project we studied), however, has been rather problematic. The lists are difficult to access and are quickly outdated since they are distributed manually (on paper). The lists do not contain all the necessary actual data, for example regarding the supply situation (market shortage, lead time, etc.). Therefore, development engineers not informing the department responsible for maintaining the lists that they have opted for of a particular component sometimes becomes very problematic in a later stage, when the component turns out to be not an 'off-the-shelf' component.

The Preferred Part Lists and Preferred Supplier Lists, which are specific to each development project and also meant to promote standardisation, seem to be hardly known by engineers and are seldom used. In the description of the case (section 7.2.5), some of the causes behind these problems have been discussed. Anyhow, the case illustrates that the mere existence of certain information is not sufficient: it has to be updated, accessible, complete and its existence has to be known too. Since the development project involved a large number of different components, the problematic registration of and access to information has caused considerable difficulties.

At Food For Thought (FFT), there are no such things as standard component lists or preferred supplier lists which can be accessed by the different departments involved in product development. If the marketing, purchasing and development department maintain records, for example, with regard to the capabilities of various suppliers, these are not structurally shared. In addition, there is hardly any shared project documentation. Information Technology is not used at all. To some extent, one can say that this lack of information is not very dramatic as the development projects at FFT are usually not that complex in terms of the number of internal participants, suppliers and new parts. On the other hand, important decisions such as supplier selection, which are de facto often taken by marketing or development, are not always based on important information such as the supplier's current performance (f.e. regarding the quality and delivery of other, existing products).

At Philips Medical Systems (PMS), finally, there is an on-line standard component database, maintained by the purchasing department. However, because it is not integrated with other systems, its actual value is rather limited. IT is not a strong enabling factor at PMS.

8.2.3 Human resources

Introduction

Probably the most crucial element in an organisation's ability for performing the different purchasing activities in product development are human resources. A firm may have a strong organisation in terms of a truly cross-functional development team and a purchasing department that is well-organised with respect to tasks in product development. It may even have good information systems with regard to supplier and component data. Still, the *people* working in that organisation and with those systems determine, in the end, to a large extent whether the various purchasing activities in product development are indeed being carried out, and how well they are being carried out. These people represent the human resources of the firm.

Our discussion of these human resources is focusing on those within the purchasing department. Prior research has also focused on the attributes of buying personnel, assuming that these make more difference than the personal attributes of development engineers or other members of the organisation. Therefore, our case studies have mainly focused at purchasing departments too, even if the collaboration with other departments was studied rather closely. Regarding the human resources of the product development department, the case studies contain very little information. Based on literature and previous research, several aspects of these human resources can be distinguished:

- kind of previous experience;
- kind and level of training/education;
- degree of technical expertise;
- degree of pro-activeness; and
- capabilities as perceived by others (credibility).

Previous experience that purchasers have had in other functions within the firm, primarily the technical functions such as product development, may enhance not only their technical expertise but also their understanding of how they can contribute to the product development process. In a survey of 67 purchasing managers of Australian firms actively engaged in R&D, Atuahene-Gima (1995: 223) found that the internal mobility of buyers has a significant positive influence on the degree and moment of their participation in the product development process. Also in a US survey, based on 325 buyers, previous experience in the engineering area was positively related to the buyer's performance in the product development process (Anklesaria and Burt, 1987: 13).

The *kind and level of education* purchasers have is the second aspect that may affect their involvement in product development. In the same US survey, the buyer's ability (as rated by his supervisor) to obtain consideration by development engineers of the purchasing implications of alternative designs was positively related to having an engineering degree or an MBA, or both (Anklesaria and Burt, 1987: 12). Atuahene-Gima (1995: 220-221) also found that purchasing managers with a university education are more likely to be involved in the product development process than those without.

These first two aspects are closely related to the third aspect: *degree of technical expertise*. In fact, the first two are argued to contribute to this technical expertise, which enables the purchaser to "speak the engineer's language" (Dobler and Burt, 1996: 57). Technical expertise, as measured by the ability to read engineering drawings or blueprints, was also positively related to the performance of the buyers in the US study (Anklesaria and Burt, 1987: 14). Guy and Dale (1993: 29-30) also provide anecdotal evidence of this importance of technical expertise in the case of two UK defence companies. It is difficult to determine how much technical expertise purchasers should have, but it is likely that there is some kind of maximum. Clearly, at some point there may be a sort of trade-off with other capabilities such as cost-awareness and negotiation skills and, more importantly, with increasing personnel costs. Endlessly increasing the technical expertise of buyers may result in growing, costly overlaps with the competencies of engineers.

The fourth aspect concerns the *degree of pro-activeness* of buyers. Pro-activeness refers to the willingness and aggressiveness of purchasers to participate in activities related to product development. This aspect is difficult to measure as it is very much related to personal attitude. It is closely connected to the perception that purchasers have of their job: do they think their primary responsibility lies with the more operational purchasing tasks, or do they emphasise the initial tasks associated with product development? Purchasers that are content to focus on routine tasks such as filling out ordering forms will be more reluctant to participate in more uncertain processes such as product development. Of the various engineer-purchaser duo's at Hollandse Signaalapparaten, the example discussed earlier, those duo's most actively offering their assistance in product development issues also seem to be the most successful and the most appreciated by the rest of the organisation. Atuahene-Gima (1995: 219-221) refers to pro-activeness as 'risk taking propensity', measured as the aggressiveness in buying new and untried materials and selecting new suppliers. In his study of Australian buyers, this risk taking propensity is positively related to the extent of participation in the development process.

The final aspect of human resources concerns the overall capabilities *as perceived by others*. No matter how technically skilled and pro-active purchasers are, if their counterparts in the product development process - primarily, development engineers - do not perceive purchasers as being capable of adding value to the process, the involvement of purchasers will be not very effective.

Dobler and Burt (1996: 158) argue:

"Management directives, policies and procedures supporting early purchasing involvement all help. But it is only when design engineers realize that the early involvement of a professional buyer is a productive asset, and not a nuisance, that early purchasing involvement makes its full contribution".

If buyers are seen as a hindrance by engineers and lack credibility with the development team, they will play a limited role (Guy and Dale, 1993). Atuahene-Gima (1995: 221) also found that this confidence of engineers in the skills and capabilities of buyers has a positive impact on the involvement of the latter in product development. The importance of *perception* implies that it is not sufficient to improve the skills and capabilities of people, but that this improvement should also be communicated throughout the organisation.

In order to support the development of human resources in terms of these five aspects, there are several areas in which possible measures can be taken. In the area of *recruitment and training*, emphasis may be given to the education and technical experience of potential employees, and their perception of the tasks of purchasing (Atuahene-Gima, 1995: 225). By means of *job or employee rotation*, engineers could be brought into the purchasing department, and purchasers assigned to the development department. This would create more technical expertise in the purchasing department, and a better mutual understanding of the links between engineering and purchasing (Burt and Soukup, 1985: 96; Guy and Dale, 1993: 30). Finally, *communication with other departments* about the possible support purchasing can (should) offer could create a more positive perception of the actual capabilities of purchasers.

Findings

In the case studies, we have found several examples of how human resources affect the extent to which and the way in which the purchasing related activities in product development are being carried out. At Ericsson, the engineers argued that, more than detailed technical expertise, the purchaser's communication abilities and attitude determine whether an engineer is likely to contact him in the product development process. Purchasers also stated that it was mainly their own initiative which had led to their early involvement in the Aladdin project. This points to the importance of pro-activeness. At the same time, however, many engineers (often external consultants that were new to the organisation) did not know the exact tasks of purchasing in product development. In that respect, the department could have spent more time and effort on communicating its tasks and policies (as described in the handbook) throughout the rest of the organisation. This could enhance the perceptions of others of purchasing as a strategic function, thereby improving its perceived capabilities.

At Food For Thought, one of the most important observations regarding human resources concerns the differences in age and kind and level of education between the people in marketing and those in purchasing (and development). The purchasers are frequently occupied with 'fire-fighting', i.e. the more operational tasks, which leaves less time for activities regarding product development. In that perspective, the purchasers do not seem to be highly pro-active: at least, many marketing people do not perceive them to be that way. Although all purchasers have worked for the company for a considerable time and seem to have a fair degree of technical knowledge, marketing tends to contact the development department first when it wants to have information on new packagings or a potential supplier. This can be attributed to a large extent to the knowledge the development manager has of the supplier market, on top of the department's technical expertise. No job rotation takes place at FFT, and the purchasers have no experience in departments such as marketing or product development.

At Philips Medical Systems, finally, many development engineers think that the purchasers have too little technical knowledge, which hampers their contribution to the development process. Similarly, purchasers often argue that engineers have too little insight into cost issues, and leave too little room for their involvement in product development by contacting suppliers directly, etc. These mutual perceptions do not facilitate the collaboration between the two departments. There is no job rotation programme, but recently the purchasing department hired a former development engineer whose tasks involved improving the contacts with development. PMS has also increasingly been hiring university graduates, while previously most purchasers had lower levels of education. This could be interpreted as a sign that the company thinks such an educational background would benefit the performance of the department's tasks, many of which concern involvement in product development.

One important conclusion of the case studies is that the character and attitudes of other people than purchasers, such as development engineers and marketers, also seems to have an impact on the involvement of purchasing in product development. Even when purchasing's human resources are 'optimal' for performing product development related tasks, their actual involvement is also affected by, for example, the attitudes of marketers and the technical and commercial capabilities of engineers. However, previous research and also our own empirical studies have not considered these aspects in great detail. Future research should focus more on these issues.

8.3 Summary and conclusions

This chapter has presented a detailed discussion of the impact of driving and enabling factors on the extent to which the different activities or management areas from our framework need to and can be carried out. The discussion has been primarily based on empirical findings from the in-depth case studies and, where appropriate, these have been compared with findings in prior research.

Company size seems to specifically affect one of the five management areas, Development Management, or more specifically the need for formulating and communicating supplier and purchasing involvement policies. It seems that Ericsson has some problems in the area of Development Management, partly because of its greater size compared to the other two companies. Regarding *production type*, prior research seems to emphasise that especially in firms with large series production, purchasing involvement in product development is intensive. Apart from the influence of company size and purchasing professionalism, the explanation may be that it is not so much the distinction between large series, small series, unit and process production that matters, but rather the distinction between assembly processes and process production. This distinction regards, among others, a difference in the number and variety of parts incorporated in the final product, and those factors are driving factors in the need for activities in the areas of Project Management (planning and execution) and Product Management. In the case studies, Ericsson and PMS, which apply large and small series production respectively, indeed seem to have a greater need for especially Project Execution activities than FFT. FFT also seems to have less need for Project Planning and Product Management activities.

The third driving factor concerns *R&D expenditure*. Of the three case companies, Ericsson spends the most on R&D and besides its size, this may also account for the importance it seems to attribute to Development Management. The fourth and final driving factor, *purchasing ratio*, may have an impact on Supplier Interface Management, as it seems an area that becomes more important as the purchasing ratio increases. In the case studies, FFT has a lower purchasing ratio than the other two companies, but many of the purchased products (packagings) are so important for innovations in its final product that Supplier Interface Management is still a very important area.

The first enabling factor regards the *internal organisation* of the firm, more specifically the organisation of the purchasing department and the development team. With respect to the organisation of the purchasing department, three aspects have been distinguished: degree and principle of specialisation, horizontal complexity and reporting relationships. Ericsson and PMS both have relatively large purchasing departments, which are rather complex, and the purchasers are highly specialised according to products. FFT has a small, simply organised purchasing department where each purchaser is responsible for a wide range of products. With respect to the organisation of the development team, also three aspects have been distinguished: structure or autonomy, composition and location. In the case studies, Ericsson and PMS have more autonomous development teams, with a stronger involvement from purchasing than FFT. Co-location is not (substantially) applied in any of the three companies.

The conclusion with regard to internal organisation is that not every firm needs the same form of organisation, as they are facing different contexts. Finding different organisation forms of purchasing departments and development teams is therefore logical. In the cases we studied, however, FFT seems to have an organisation that does not fit with the context it is facing. This involves primarily the structure or autonomy of its development teams.

The second enabling factor regards the availability of and access to *information*. All three companies seem to have a 'deficit' in this respect. Ericsson does seem to possess better structured and accessible information in the form of lists and systems than FFT, but it is also facing higher demands in that respect because of the complexity of its development projects.

The third and final enabling factor regards *human resources*, where we distinguish between experience, education, technical expertise, pro-activeness and credibility. In the case studies, all three companies have some problems in terms of their human resources. The purchasers at Ericsson seem pro-active, but the problem is that not all engineers perceive them to be technically capable enough. At FFT, the purchasers do not seem very pro-active, and their technical expertise is reasonable but less than that of the development department, which also has good market knowledge. At PMS, engineers argue that the purchasers have too little technical expertise and purchasers think that the engineers have too little financial insight.

As indicated in the beginning of this chapter, our empirical studies have only considered a limited number of driving and enabling factors. Especially with regard to the driving factors, we have focused on rather narrowly measured factors, which means that other closely related aspects that possibly have an impact on the need to perform different activities have been neglected. For example, besides the overall R&D expenses other characteristics of firms' development projects, such as the degree of product innovation, may be an important factor. These potential omissions are discussed in the final chapter, as part of the limitations of this study and the suggestions for further research.

Chapter 9

Conclusions, Implications and Recommendations

In the final chapter, the conclusions, implications and recommendations of the research are presented. First, a brief summary is given. In the second section, the research questions posed at the beginning of the study are recapitulated, and the conclusions are discussed. Section three deals with the possible contributions and limitations of this study. The chapter continues with the practical application of the integrated framework of activities, among others in terms of the possibilities for generalisation of the research findings. The section also contains additional recommendations for business professionals. In section five, recommendations for further research are presented and the chapter concludes with an epilogue.

9.1 Summary

To an important degree, the objectives and the design of the research presented in this thesis have been inspired by prior research in the field of purchasing involvement in product development. This research, in our opinion, seems limited in its scope, empirical basis and perspective as it is (1) limited to the short-term issues related to individual development projects, (2) mainly based on experiences in the automobile and electronics industries, and (3) nearly exclusively focused on the role of the manufacturer's purchasing department. Moreover, there seems to be no clear conceptual foundation, no coherent definition of what purchasing involvement in product development is. The current research has been designed to deal with these shortcomings, and aims to develop an overview of the various activities that can be distinguished within purchasing involvement in product development. It also seeks to provide some indications on the situations in which these activities are appropriate and on the requirements for performing them. More specifically, the research objectives of the study have been to develop:

- *an integrated framework of specific activities that constitute purchasing involvement in product development*, which can help firms to implement, improve and to audit the involvement of purchasing in product development; and
- *preliminary knowledge regarding the application of this framework of activities* in terms of the factors that influence the extent to which the activities *need* to be carried out (i.e. driving factors), and the factors that influence the extent to which the activities *can* be carried out (i.e. enabling factors).

The first step in the research has been to select from literature a number of key processes in inter-organisational product development, and to identify the main areas or 'objects' that purchasing involvement in product development pertains to. Together, these areas and key processes form the delineation for possible activities related to purchasing involvement in product development. In step two, this 'conceptual framework' has been used to analyse 9 cases of product development collaboration between a manufacturer and a supplier. The main objective of this step has been to identify specific activities that can be seen to contribute to the key processes, and group them according to the management areas. In step three, based on the findings from a second series of 9 'mini' case studies on the purchasing organisation of Dutch companies, the initial framework has been adapted.

Instead of three, four areas are now distinguished and an additional key process has been identified. Specific activities have been identified for each of the four areas, by combining the activities observed in the first series of case studies with those from the second series. The fourth and final step of the research has consisted of three in-depth case studies, in which the framework of activities developed in the previous steps of the research is used to analyse what kind of problems arise due to the extent or way management areas or specific activities are being carried out. In these in-depth case studies, we also investigate whether and how the driving and enabling factors affect the execution of different activities regarding purchasing involvement in product development.

9.2 Conclusions

In this section, the main conclusions of the research are presented. These are organised according to the research questions posed at the beginning of this study.

- What are the key processes that purchasing involvement in product development should realise or at least contribute to?

The first research question regards the processes that underlie purchasing involvement. Distinguishing these processes at the outset establishes a basis for distinguishing specific activities that form the involvement of purchasing in subsequent stages of the research. It also provides a binding element between those different activities, thereby addressing one of the shortcomings of a great deal of prior research, which presents a rather fragmented view of purchasing involvement in product development.

Adopting a view on product development as a process of interaction between firms or actors, three processes are of fundamental importance: the *combination*, *mobilisation* and *co-ordination* of resources. These processes underlying inter-organisational product development in general can be elaborated specifically for manufacturer-supplier collaboration, by distinguishing four key processes. These are *prioritising*, *mobilising*, *co-ordinating* and *timing*. Prioritising deals with making choices. This involves not only the choice of the actual collaboration partners, but also the choice for a specific form and intensity of supplier involvement. Companies have limited resources to handle supplier involvement, therefore they have to set their priorities. Mobilising involves convincing or motivating suppliers to pursue a particular development, for example by creating financial incentives or by sharing new technical knowledge. Without mobilisation, suppliers may not be interested nor willing to undertake the efforts and make the commitments that are required for effective collaboration. Co-ordinating involves the adjustment and adaptation of development activities and resources between suppliers and the manufacturer. Without co-ordination, development collaboration may result in double work, work that has accidentally not been done and incompatible technical solutions. Timing involves the co-ordination and adaptation of development activities and resources over time. Without timing, product development may suffer from bottle-necks, unnecessary delays, and missed deadlines. These four processes - prioritising, mobilising, co-ordinating and timing - form the basis for managing supplier involvement in product development.

The nine case studies of manufacturer-supplier collaboration have demonstrated that it is helpful to describe and analyse the processes of managing supplier involvement in product development by using these four processes since it can provide a possible explanation of the problems and successes in the different relations. Although elements of all four processes can be found in most of the cases, mobilising seems the most important or problematic process to take care of.

One reason for that may be the different interpretations suppliers and manufacturers seem to have of the character of their relation in terms of its importance for the other: not knowing what a relation or collaboration means for the other party does not put the right emphasis on, nor facilitate the mobilisation of that party. An alternative explanation for the apparent dominance of mobilisation processes may be found in the methodology of the case studies. Mainly purchasing and marketing *managers* have been interviewed, which may have biased the observations towards strategic issues such as mobilisation, versus the more operational issues of co-ordinating and timing.

However, in the second series of case studies, of Dutch manufacturers' purchasing organisations, it has become clear that the four key processes related to managing supplier involvement do not completely cover the essence of purchasing involvement in product development. Purchasing involvement is more than only managing supplier involvement; it also involves activities that are directed purely at the design of the new product. The essence of these activities that do not concern actual supplier involvement consists of the collection and dissemination of information. These are activities not directly related to managing supplier involvement, such as supplier selection and performance monitoring, but activities that take place prior to (and in parallel with) selecting and working with particular suppliers, like carrying out market research, evaluating different alternative component designs in terms of availability and costs. We group these kind of activities under the key process of '*informing*', which refers to both acquiring information and subsequently sharing it.

Summarising, the involvement of purchasing in product development should aim to realise or contribute to five key processes: prioritising, mobilising, co-ordinating, timing and informing.

- In what areas can purchasing involvement contribute to these general processes?

Apart from a definition or delineation of purchasing involvement in product development in terms of key processes, the research has acknowledged explicitly that purchasing involvement is not limited to the context of single development projects. One of the shortcomings of the main body of prior research on purchasing and supplier involvement in product development is its almost exclusive focus on *periodic* tasks within specific development projects. From other strands of literature, however, it becomes clear that there are also more *permanent*, long-term oriented tasks to consider.

Initially, to account for this diversity in tasks, three different areas or *objects* of purchasing involvement have been distinguished: Technologies, Suppliers and Projects. 'Technologies' is concerned with the division of work between the firm and its suppliers in the development of technical knowledge and competencies. In that sense, it includes decisions that set the stage for the other areas of purchasing involvement. 'Suppliers' encompasses handling individual supplier relationships but also the total supplier network of the firm as a whole, and consists of more permanent and ongoing activities. 'Projects' involves managing or contributing to product development projects; tasks which per definition have a limited time-frame.

After using this distinction between three different areas in the first series of case studies, it has been adapted and refined on the basis of the second series of case studies. From these 9 'mini' case studies of Dutch manufacturers, it has become apparent that besides a distinction into various areas or objects, a categorisation can also be made into different *levels of responsibility*: from operational to strategic. One argument for distinguishing these different levels or layers of responsibilities is that purchasing involvement in product development, like purchasing and purchasing management in general, involves activities at different hierarchical or management levels. By using this dimension of levels of responsibility, the resulting framework may provide a useful structure for the activities to be implemented in practice.

Starting at the operational level, purchasing's involvement in product development involves a design or rather *specification responsibility*: contributing to the development of the actual product by suggesting and communicating criteria and alternatives regarding the design of new products as far as materials, components or assemblies from suppliers are concerned. The second level, *operation responsibility*, includes tasks like planning and co-ordinating development activities of suppliers *during* a development project, while preparing and starting a development project is regarded as a *preparation responsibility*, the third level of responsibility. The fourth level, *structure responsibility*, includes the more permanent tasks related to the establishing and maintaining relations with a base of preferred development suppliers. Finally, at the most strategic level, *policy responsibility* regards the formulation and communication of guidelines and policies regarding the role and tasks of the different departments and suppliers in product development, and the development of develop-or-buy strategies.

Specification and operation activities will normally be performed by purchasers or engineers. Preparation and structure activities usually fall under the responsibility of purchasing managers or their development colleagues, while policy tasks will generally involve the highest (purchasing, development and general) management levels.

When comparing these five different levels of responsibility with the three areas identified initially, it becomes clear that they overlap to some extent. Policy responsibility closely resembles the area of Technologies, structure responsibility relates to Suppliers, and the responsibilities of preparation and operation relate to Projects. Only specification responsibility has no real overlap with one of the three areas, as it is actually focused at a different object: the new product itself. Because of the overlap, a decision has been taken to integrate the two dimensions, object/areas and levels of responsibility, which results in the distinction of four *management areas*: Development Management, Supplier Interface Management, Project Management and Product Management. Within Project Management, a further distinction is made between Project Planning and Project Execution. In this adapted version, the areas differ both with regard to the managerial level or time-horizon of the different activities involved (varying from strategic/long-term to operational/short-term), and the object they are concerned with (technologies, suppliers, projects and products). These four areas are closely related. While, for example, develop-or-buy strategies are included under the heading of Development Management, changes in supplier relationships, under the heading of Supplier Interface Management, may be necessary to realise these strategies. Project Management activities, such as planning the extent of involvement for a specific supplier in a particular project, affect and are affected by the permanent relationship between the manufacturer and the supplier as dealt with in the area of Supplier Interface Management. In many respects, Supplier Interface Management is the critical link between the long-term, strategically oriented activities in the area of Development Management, and the more short-term oriented activities in Project and Product Management (see Figure 9.1).

Across these different areas, the five key processes have to be effectuated in order to achieve effective purchasing involvement in product development. Together, the four different areas and the five key processes form the delineation for the activities that make up purchasing involvement in product development.

Figure 9.1: Interrelations between the four management areas and underlying key processes

- What are the specific activities that realise or contribute to the general processes in the various areas?

Based on the delineation of purchasing involvement in product development in terms of five key processes and four different management areas, a number of specific activities has been identified in the two series of case studies. When a particular activity (a decision or a process) observed in one or more of the cases arguably contributes to one of the key processes within one of the different areas, it has been selected for inclusion in the framework of activities which, together, form purchasing involvement in product development. Not all of activities are actually carried out in each of the cases: the framework is a collection of all activities carried out in the different cases.

The four areas with the specific activities and their relation to the key processes are presented in Table 9.1. This overview forms the integrated framework of purchasing activities related to product development; the first research objective of this study. The framework can be regarded as 'integrated' since it has been constructed along the two dimensions of management areas and key processes.

At the beginning of the case studies, there has not been any explicit assumption that for each area, all five key processes have to be realised. Implicitly, the possibility has been acknowledged that not every process is equally important in all areas. The case studies, in fact, have not provided illustrations for all processes in each of the areas. In three of the four areas, one or two of the key processes are not represented. However, there seem to be possible explanations for those 'omissions'. In the area of Development Management, mobilising is missing. This is plausible since the activities in this area have primarily to do with making initial choices and plans, not with actually realising certain processes. In the area of Supplier Interface Management, timing is not represented.

Also this seems plausible since by definition, this area involves permanent and less time-critical activities. Finally, in the area of Product Management, co-ordinating and timing are missing, which could be explained by the rather 'technical' nature of this area; it is not focused at the *process* of development.

Table 9.1: Integrated framework of specific activities

Areas	Activity	Key processes*
Development Management	<ul style="list-style-type: none"> Determining which technologies to keep/develop in-house and which ones to outsource to suppliers Formulating policies for the involvement of suppliers Formulating policies for purchasing related activities of internal departments Communicating policies and procedures internally and externally 	<p>P</p> <p>C, T</p> <p>C, T</p> <p>I</p>
Supplier Interface Management	<ul style="list-style-type: none"> Monitoring supplier markets for technical developments Pre-selecting suppliers for product development collaboration Motivating suppliers to build up/maintain specific knowledge or develop certain products 	<p>I</p> <p>P</p> <p>M, C</p>
Project Management	<p>Planning:</p> <ul style="list-style-type: none"> Determining specific Develop-or-Buy solutions Selecting suppliers for involvement in the development project Determining the extent ('workload') of supplier involvement Determining the moment of supplier involvement <p>Execution:</p> <ul style="list-style-type: none"> Co-ordinating development activities between suppliers and manufacturer Co-ordinating development activities between different first tier suppliers Co-ordinating development activities between first tier suppliers and second tier suppliers Ordering and chasing proto-types 	<p>P</p> <p>P, M, C, T</p> <p>P, C</p> <p>P, T</p> <p>C, T, I</p> <p>C, T, I</p> <p>C, T, I</p> <p>C, T, I</p>
Product Management	<p>Extending activities:</p> <ul style="list-style-type: none"> Providing information on new products and technologies being developed or already available in supplier markets Suggesting alternative suppliers, products and technologies that can result in a higher quality of the final product <p>Restrictive activities:</p> <ul style="list-style-type: none"> Evaluating product designs in terms of part availability, makeability, lead-time, quality, and costs Promoting standardisation and simplification of designs and parts 	<p>I</p> <p>P, M, I</p> <p>I</p> <p>P, M, I</p>

*: P= prioritising, M= mobilising; C= co-ordinating; T= timing; I= informing.

• Which factors influence the need for a firm to carry out specific activities?

The factors that may influence the relevance or necessity of performing specific activities related to purchasing involvement in product development have been labelled as 'driving' factors. Four possible driving factors have been analysed:

- company size;
- production type;
- the overall dependence/reliance on suppliers; and
- the importance of product development.

Company size, measured in turnover, has been selected as the first possible driving factor, primarily as an indication of overall organisational complexity. The more complex an organisation, the more important it may become, for example, to develop and communicate guidelines for supplier involvement. Production type has been selected as the second possible driving factor, mainly because nearly all research is limited to large series production industries, such as automotive and electronics.

This seems to imply that purchasing involvement in product development is mainly relevant for large series production firms. The type of production employed by the manufacturer has therefore been investigated as a possible driving factor. The third possible driving factor regards the overall reliance on suppliers, measured as purchasing share in turnover. The more dependent a company is on suppliers for producing its final product, the more likely it is to be dependent on them for developing that product. The final driving factor regards the importance of product development, measured as R&D expenditure related to turnover. The higher the expenses on research & development, the more likely product development is to take place. Other things being equal, more product development means more need for purchasing involvement.

On the basis of the third series of (in-depth) case studies, the need for one of the four management areas, Development Management, or more specifically the need for formulating and communicating supplier and purchasing involvement policies, seems to be dependent on company size. The influence of *production type* seems limited in the sense that it is not the distinction between large series, small series, unit and process production that matters, but rather the distinction between assembly processes and process production. This distinction also pertains to a difference in the number and variety of parts incorporated in the final product, and those factors seem to be driving factors in the need for activities in the areas of Project Management (planning and execution) and Product Management.

The influence of *R&D expenditure* seems limited to the area of Development Management, where firms with high levels of expenditure seem more active than others. The fourth and final driving factor analysed in the research, *purchasing ratio*, would seem to have an impact mainly on Supplier Interface Management, which would become more important as the purchasing ratio increases. However, it is qualitative rather than quantitative dependence on suppliers which seems to matter in this respect.

- Which factors influence the ability of a firm to carry out specific activities?

The factors that influence the ability of firms to perform certain activities have been labelled 'enabling' factors. The ability of a firm to carry out certain activities may not only make a difference between carrying out and not carrying out activities; it may also increase the capability of performing activities in an effective and efficient way. Three enabling factors have been considered:

- the internal organisation of the purchasing department and the development team;
- the availability of and access to information; and
- the quality of human resources.

The first enabling factor regards the *internal organisation* of the firm, more specifically the organisation of the purchasing department and the development team. With respect to the organisation of the purchasing department, three aspects have been distinguished: degree and principle of specialisation, horizontal complexity and reporting relationships. With respect to the organisation of the development team, again three aspects have been distinguished: structure or autonomy, composition and location.

In the case studies, a high degree of purchasing involvement in product development seems to be especially correlated with development teams being established in the early phases of development projects, with a formal participation by purchasing from the very beginning. The general conclusion with regard to internal organisation is, however, that not every firm needs the same form of organisation, as they are facing different contexts. Finding different organisation forms of purchasing departments and development teams is therefore logical.

In the case studies, an organisation that does not fit with the context it is facing, primarily with regard to the structure or autonomy of its development teams, seems to result in considerable problems with regard to communication and co-ordination in the product development process.

The second enabling factor regards the availability of and access to *information*. In the case studies, structured and accessible information in the forms of lists and systems seems an important factor in enabling and sustaining purchasing involvement in product development. This applies especially when a company is facing high demands in terms of the registration and exchange of information due to a high complexity of its development projects.

The third and final enabling factor regards the quality of *human resources*, where a further distinction has been made between experience, education, technical expertise, pro-activeness and credibility. In the case studies, all three companies have problems in terms of their human resources. Sometimes, the purchasers are pro-active, but the engineers do not perceive them to be technically capable enough. Alternatively, purchasers are not very pro-active, while their technical expertise is reasonable but less than that of the development department, with the consequence that purchasers are hardly involved. In another case, the human resource problems seem to affect both the development and the purchasing department: engineers argue that the purchasers have too little technical expertise and purchasers think that the engineers have too little financial insight. One important conclusion is that not only the human resources within the purchasing function, but also those within the product development (and marketing) function affect purchasing involvement.

9.3 Contributions and limitations

The contributions and limitations of this study can be divided into those that are primarily related to the actual results and insights, and those that mainly pertain to the ways in which these results have been achieved, i.e. the research methodology. Both types of contributions and shortcomings, however, are closely connected to each other.

In terms of the knowledge or insights this research has generated, the main contribution in our opinion concerns the framework or framework of activities itself, which provides a comprehensive and structured overview of the purchasing tasks that can be distinguished with regard to product development. The foundation of the framework in terms of key processes and management areas provides a clear demarcation of what purchasing involvement in product development encompasses and what it should contribute to. A second possible contribution involves the management areas that have been distinguished, and the observation that they are closely connected to one another. Specifically the area of Supplier Interface Management functions as a binding element between the strategic, policy-oriented area of Development Management and the more operational areas of Project and Product Management.

Apart from the conclusions and contributions regarding the field of purchasing involvement in product development, the current study has also resulted in some potentially useful insights for the fields of purchasing management and product development in general. With regard to purchasing management, this study has illustrated that a conceptualisation of the purchasing process in terms of separate yet closely related roles as introduced by Axelsson and Håkansson (1984) may be a useful starting point for the identification of purchasing tasks that have not always been considered as such (as in the case of involvement in product development).

A second contribution results from the notion that apart from a project or request by the manufacturer, capabilities or ideas of suppliers may also initiate manufacturer-supplier collaboration on a new product. This notion implies that the trigger for purchasing activities need not always be a perceived need, i.e. a request from an internal customer. This means that not all purchasing processes do and should contain the same sequence of steps (specifying, selecting, contracting, etc.), a point raised earlier by Van Stekelenborg (1997: 258).

With regard to product development, this research underlines that concurrent or simultaneous engineering approaches advocated over the past decade need to give more attention to 'cross-organisational' collaboration with suppliers, as has also been argued by De Graaf (1996: 164). The activities distinguished within the areas of Project Management and Product Management provide an overview of the decisions and processes that the inclusion of suppliers in concurrent engineering methods should focus on.

In terms of the methodology of the research, one of the contributions concerns the fact that the empirical studies have been carried out in a variety of industries and companies. This should provide a possibility for generalising the conclusions and recommendations to other companies than those involved in the research. This point is considered in more detail in the subsequent section, on the application of the research findings. Another contribution is related to the fact that part of the empirical studies (the first series of case studies) have also been based on the point of view of the supplier. Including the supplier's perspective in the analysis of manufacturer-supplier collaboration in product development provides better insight into the possible problems, and the causes of these problems, regarding such collaboration.

Apart from these possible contributions or merits the research may have, a number of shortcomings or limitations can also be identified. In terms of the knowledge developed in the research, the first limitation regards the level of detail for the activities listed in the framework. Although the case studies, which the framework of activities has (partly) been derived from, provide specific illustrations of the different activities, the framework describes the activities in quite general terms. In that perspective, the framework of activities is rather generic. The research has not structurally investigated how different companies execute the activities in different ways, and the (dis)advantages of the different alternatives. Instead, the study has focused at whether or not the 'generic' activities are executed, and at the reasons and the implications of (not) performing them.

The second possible limitation pertains to the driving and enabling factors. In the research objectives posed at the beginning in the first chapter, the knowledge on those factors developed in this research has been described as 'preliminary'. This is reflected in the fact that, especially with regard to the driving factors, we have focused on a limited number of rather narrowly measured factors, which means that other aspects that possibly have an impact on the need or the ability to perform different activities, have been ignored. In terms of driving factors, notably little emphasis has been given to product development characteristics other than project complexity and total R&D expenditure. In further research, the typology by Pavitt (1984) could be used in trying to identify other possible driving factors related to product development or innovation characteristics.

In terms of methodology, one limitation concerns the fact that we have not investigated the actual effects of the various activities in terms of development project performance (lead-time, costs, quality) or opportunities to benefit from technical developments in supplier markets. We have not carried out any 'before' and 'after' studies at a particular company, which could have measured some of these effects. Note, however, that we have previously argued that not all effects of purchasing involvement in product development are readily measurable, especially not the long-term effects.

9.4 Application of the results and further recommendations for business

In this section, we discuss the practical application of the research results. Primarily, this regards the framework of activities pertaining to purchasing involvement in product development and the overview of a number of driving and enabling factors concerning these activities. In addition to suggestions and guidelines for the application of that framework, some specific recommendations are given.

9.4.1 Applications

- Practical purposes for the framework of activities

The framework of activities can be used as an instrument by business professionals such as managers or consultants, for three purposes: implementing, improving and auditing purchasing involvement in product development. The first purpose it can serve is guiding the implementation of purchasing involvement in product development. For companies that are just starting to increase their collaboration with suppliers in product development or aiming for a structured and far-reaching consideration of purchasing issues related to product development, the framework can serve as a reference list for the kind of activities, decisions and processes that should be considered. As it is a list of quite generic activities, it can only 'guide' this implementation in terms of the aspects to consider, rather than give clear directives on how to implement specific activities. On the other hand, the generic character means that it is sufficiently general to be applied by different kinds of companies.

One way of using the framework of activities as a reference list for implementation purposes is by presenting it along a time-dimension, so that it can be compared to and eventually integrated with any (activity stage) manual for product development projects the firm concerned may have. In Table 9.1, the relation with the process of a development project is not so clear. In order to better envisage this relation, Figure 9.2 presents the framework of activities with its different management areas in a *time dimension*. This representation could serve as a kind of 'blueprint' for the type of purchasing related activities that should be integrated into the product development manual, and at which stage of the development process. The figure presents the different areas as being separated, but note that in Figure 9.1 the relations between the different areas (and with the key processes) have been emphasised.

Development Management and Supplier Interface Management are presented as stretching the whole time-scale, forming the permanent 'infrastructure' on the basis of which the other activities have to be carried out. Just as Project Management activities, Product Management activities are carried out during a specific development project. The latter are focused at the product, the former at the process, hence the distinction between the two. The activities within Project Management and Product Management have been related to the different development project phases. If the figure would have allowed, several of these blocks of projects could have been placed next to each other within the boundaries of Development and Supplier Interface Management to indicate that projects are recurrent 'episodes' within these more permanent areas.

In the area of Project Management, a further distinction has been made between co-ordinating development, design and engineering activities whereas previously, we have made a distinction only regarding the parties the co-ordination focuses on (manufacturer, first tier supplier, second tier supplier). In Chapter 2, four main phases of product development projects have been discussed: Concept Development, Basic Design, Detail Engineering and Pilot-Production / Start-Up. Related to these four phases, we distinguish three kinds of product development activities that are carried out by the manufacturer and/or supplier(s): (basic) development activities, design activities and engineering activities.

Figure 9.2: Implementation-guideline: activities and management areas in relation to the product development process

Co-ordinating development activities involves exchanging information on basic issues such as desired product performance, technical possibilities and production requirements. The manufacturer will communicate its needs and demands, and the supplier(s) will indicate the (im)possibilities, and possible alternatives. The co-ordination of design activities, involves planning, checking, re-scheduling and providing information regarding the progress of activities such as determining product architecture and establishing technical specifications. Co-ordinating engineering activities involves the same processes but now regarding the final engineering activities targeted at the release of product specifications. In this phase, there are usually many design changes, which makes the communication of change requests - both from the manufacturer to the supplier and vice-versa - a crucial element in this co-ordination. The differentiation between development, design and engineering activities has not consistently been used in our (empirical) research, and is therefore open to further investigation.

The precise moment when the various activities are being performed at any individual firm is dependent on the way the overall development process is organised, which may not fit exactly with the process depicted here. This is, among others, the case when the manufacturer applies concurrent engineering methods, in which case the different activities may show greater overlaps in time. Note that connections or 'feedback-loops', for example, between Project Management and Supplier Interface Management, as previously discussed, have not been included here. In this respect, it should be stressed once more that Supplier Interface Management is an essential element, linking long-term and short-term activities.

The second, closely related purpose of the framework is to guide improvements in a situation where, for example, supplier involvement in product development is rather chaotic and ill-managed, leading to problems in terms of communication and co-ordination. Alternatively, it can be used when purchasing involvement in development projects is effective in itself but very ad-hoc and costly, which makes management feel that a structured, long-term approach is necessary. As the framework of activities provides a comprehensive coverage of purchasing involvement by distinguishing different, tightly linked management areas, it may point business professionals to important aspects previously ignored.

The third purpose, which ties in with the second one, involves auditing. The framework can be used as a 'checklist' of activities, for which to identify the current level or state of involvement, which then may be compared to 'benchmarks' based on previous situations, future goals or other business units or companies. The audit could be performed as a qualitative assessment by an internal or external expert, or as a survey among purchasers, engineers and other employees concerned (marketing, product management). Box 9.1 contains an audit-questionnaire, with graphs showing how the results could be reported. It is important to realise that the firm's specific context (in terms of driving factors) determines whether a specific score should be considered sufficient or not. In general, firms with a small and simple organisation, and relatively low expenditure on R&D, for example, need not achieve a high score for Development Management. These driving factors are discussed further at the end of this section.

This audit-instrument may be used for assessing the current state of purchasing involvement in product development at a specific company (or business unit). The main purpose of such an audit would be to establish the current state of involvement, and identify some opportunities for possible improvement in terms of the management areas identified by our framework. For the main part, the audit-instrument consists of a questionnaire which may be distributed among purchasing managers, senior purchasers, product development managers and senior development engineers as it is primarily designed to be filled in by representatives from the Purchasing and the Product Development departments. Some of the questions differ for each department, but only one complete version of the questionnaire is presented here, with the distinguishing questions being indicated. Finally, the instrument encompasses a 'score-board', which can be used to summarise the outcomes of the questionnaire in order to get a quick overview of the results.

The questionnaire consists of 2 parts. The introductory part, containing a few general questions, may serve to provide a general appraisal of the situation by the interviewee and a background to the more specific questions. The main body of the questionnaire comprises some 25 questions, one for each of the activities identified in our framework. Some of the activities are split among two questions, in order to get a better insight into the actual activities being performed.

Box 9.1: Audit-instrument

Introduction					
A1.	Is your company dependent on the knowledge and capabilities of suppliers for the development of new products?	not at all 1	barely 2	considerably 3	completely 4
A2.	Is it in your opinion important that purchasing activities are clearly and early co-ordinated with the development of new products (<u>desired state</u>)?	not at all 1	barely 2	considerably 3	completely 4
A3.	Is there at your company a clear and early co-ordination between purchasing activities and the product development process (<u>actual situation</u>)?	not at all 1	barely 2	considerably 3	completely 4
A4.	Should there be efforts to increase this co-ordination in the near future?	not at all 1	barely 2	considerably 3	completely 4
Purchasing manager:					
A5.	To what extent is the R&D/Product Development department, in your opinion, satisfied with the role of the Purchasing department in product development?	not at all 1	barely 2	considerably 3	completely 4
Development manager:					
A5.	To what extent is the Purchasing department, in your opinion, satisfied with the opportunity and room they get from your department to provide added value to the development of new products?	not at all 1	barely 2	considerably 3	completely 4
Purchasing manager:					
A6.	Does your department get enough opportunity and room from the R&D/Product Development department to provide added value to the development of new products?	not at all 1	barely 2	considerably 3	completely 4
Development manager:					
A6.	Is your department satisfied with the role and activities of the Purchasing department in the development process for new products?	not at all 1	barely 2	considerably 3	completely 4

Main body

Development Management

1.	To what extent does your department take part in discussions and decisions on keeping certain technological knowledge in-house or not ?	no, never 1	seldom 2	quite often 3	yes, always 4
2.	To what extent does your department have clear guidelines and objectives regarding its own responsibilities and tasks in product development?	not at all 1	barely 2	considerably 3	completely 4
3.	To what extent does your department have clear guidelines and objectives regarding responsibilities and tasks of suppliers in product development?	not at all 1	barely 2	considerably 3	completely 4
4.	To what extent have these guidelines and objectives been clearly communicated to other departments?	not at all 1	barely 2	considerably 3	completely 4
5.	To what extent have these guidelines and objectives been clearly communicated to suppliers?	not at all 1	barely 2	considerably 3	completely 4

Supplier Interface Management

6.	To what extent does your department carry out market research specifically targeted at technical information and developments?	no, never 1	seldom 2	quite often 3	yes, always 4
7.	Does your department maintain a base of preferred suppliers for which the abilities for co-operative product development are an important criterion?	no, not at all 1	barely 2	to some degree 3	yes, permanently 4
8.	Does your department encourage or motivate suppliers to build up knowledge or develop products in those areas where your company needs it?	no, never 1	seldom 2	quite often 3	yes, always 4
9.	Does your department try to exploit the full potential of the specific technical knowledge and capabilities of suppliers?	no, never 1	seldom 2	quite often 3	yes, always 4
10.	Does your department evaluate the 'development-performance' of suppliers?	no, never 1	seldom 2	quite often 3	yes, always 4
11.	Are these specific 'development' evaluations considered in the general ratings of suppliers?	no, never 1	seldom 2	quite often 3	yes, always 4

Project Planning

12.	Does your department participate in project-specific Develop-or-Buy discussion and decisions?	no, never 1	seldom 2	quite often 3	yes, always 4
13.	Does your department - within the frame of a specific development project - decide which suppliers are to be involved?	no, never 1	seldom 2	quite often 3	yes, always 4
14.	Does your department - within the frame of a specific development project - decide to what extent to involve suppliers?	no, never 1	seldom 2	quite often 3	yes, always 4
15.	Does your department - within the frame of a specific development project - decide at which moment the suppliers will be involved?	no, never 1	seldom 2	quite often 3	yes, always 4

Project Execution

16.	Is your department responsible for the co-ordination of development activities between suppliers and internal departments?	no, never 1	seldom 2	quite often 3	yes, always 4
17.	Is your department responsible for the co-ordination of development activities between different 1st tier or direct suppliers?	no, never 1	seldom 2	quite often 3	yes, always 4
18.	Is your department responsible for the co-ordination of development activities between 1st and 2nd tier suppliers?	no, never 1	seldom 2	quite often 3	yes, always 4
19.	Is your department responsible for ordering and 'chasing' prototypes made by suppliers?	no, never 1	seldom 2	quite often 3	yes, always 4

Product Management

20.	Within a specific development project, does your department provide information regarding new products and technologies developed by suppliers?	no, never 1	seldom 2	quite often 3	yes, always 4
21.	Does your department analyse in an early stage of a development project the availability, development time, quality and costs of supplier parts?	no, never 1	seldom 2	quite often 3	yes, always 4
22.	Within a specific development project, does your department suggest alternative suppliers, products, or technologies that could result in a better, more innovative, cheaper, or faster to develop final product?	no, never 1	seldom 2	quite often 3	yes, always 4
23.	Does your department actively promote standardisation and simplification of supplier parts of new products?	no, never 1	seldom 2	quite often 3	yes, always 4

Score-board

The outcomes of the questionnaire can be summarised in the following 'scoreboard'. Average scores may be calculated per management area for each individual respondent. When several respondents per department have filled in the questionnaire, average scores cannot only be computed for each management area but also for each individual activity. These may then be compared to previous scores of the same department when, for example, the company has been aiming to increase that department's involvement in product development. The scores of the purchasing and product development department may also be compared to each other, to see whether there are substantial overlaps or gaps between each other's activities. Finally, the score-board may be used to compare purchasing departments across different business units or divisions. The scores can be represented by a spider-web graph, which makes it relatively easy to compare different score-boards (over time, of different departments) at the same time (see illustration).

Areas	Activity	Question	Score
Development Management	• Determining which technologies to keep/develop in-house and which ones to outsource to suppliers	1	..
	• Formulating policies for purchasing related tasks of internal departments	2	..
	• Formulating policies for the involvement of suppliers	3	..
	• Communicating policies and procedures internally	4	..
	• Communicating policies and procedures externally	5	..
	Average Development Management		../5
Supplier Interface Management	• Monitoring supplier markets for technical developments	6	..
	• Pre-selecting suppliers for product development collaboration	7	..
	• Motivating suppliers to build up/maintain specific knowledge or develop certain products	8	..
	• Exploiting the technical capabilities of suppliers	9	..
	• Evaluating suppliers' development performance	10	..
	• Including development performance in general supplier ratings	11	..
	Average Supplier Interface Management		../6
Project Planning	• Determining specific Develop-or-Buy solutions	12	..
	• Selecting suppliers for involvement in the development project	13	..
	• Determining the extent ('workload') of supplier involvement	14	..
	• Determining the moment of supplier involvement	15	..
	Average Project Planning		../4
Project Execution	• Co-ordinating development activities between suppliers and manufacturer	16	..
	• Co-ordinating development activities between different first tier suppliers	17	..
	• Co-ordinating development activities between first tier suppliers and second tier suppliers	18	..
	• Ordering and chasing proto-types	19	..
	Average Project Execution		../4
Product Management	<i>Extending activities:</i>		
	• Providing information on new products and technologies being developed or already available in supplier markets	20	..
	• Suggesting alternative suppliers, products and technologies that can result in a higher quality of the final product	22	..
	<i>Restrictive activities:</i>		
	• Evaluating product designs in terms of part availability, makeability, lead-time, quality, and costs	21	..
	• Promoting standardisation and simplification of designs and parts	23	..
	Average Product Management		../4

- **Driving factors:** situations where (parts of) the framework should be applied

The preliminary knowledge developed in this study on the driving factors behind the different activities or management areas can be interpreted as indications/contra-indications on the conditions in which (specific parts of) the framework of activities are relevant or particularly important. In a sense, these indications, together with the knowledge regarding the requirements or enabling factors, form a first version of a 'manual' when and how to use the framework of activities. Together, the framework and the (preliminary) manual can be said to form a method for organising purchasing involvement in product development.

Based on the investigation of potential driving factors, the framework of activities seems to be largely applicable to firms with different sizes, different production types, different purchasing ratio's and different levels of R&D expenditure. As far as can be concluded from the case studies, it is only with respect to individual management areas, that different firms seem to require different degrees of involvement. Development Management is an area that seems to require particular attention at large companies, and/or companies where product development is an important process (measured in R&D expenditure). Project and Product Management activities seem especially important for firms with assembly processes (that use a large number and/or variety in parts).

- **Enabling factors:** conditions for the framework of activities to be applied successfully

The preliminary knowledge developed in this research on the enabling factors behind the different activities/management areas can be used for trying to establish or improve the firm's internal environment in terms of the means required for performing the activities, or even performing them (more) efficiently and effectively.

Based on the investigation of potential enabling factors, it seems that the organisation of the purchasing department and the product development team supports purchasing involvement in the best way when this 'internal organisation' fits with the particular business context the firm is facing.

This means that firms which have a great diversity in input resources, which face rapid technological developments, and which are highly dependent on product development, should have a fairly autonomous development team and a purchasing department with a strong specialisation and separation regarding initial vs. operational purchasing tasks. For all kinds of firms, participation by purchasing in the development team seems an enabling factor with regard to their involvement in the various activities defined in our framework. Registration and availability of information forms another enabling factor, especially for firms with development projects that are technically and/or organisationally rather complex. Finally, the quality of human resources seems to be the ultimate condition whether purchasing involvement can be successfully achieved. When purchasers have limited education and little or no experience outside their department, when they have little technical expertise and a limited degree of pro-activeness, and/or are perceived as such by others (primarily engineers), this may form a barrier to achieving purchasing involvement in product development.

9.4.2 Further recommendations

With respect to some of the activities, we formulate some further recommendations among others by referring to examples of how these activities could be executed. These recommendations are organised according to the four management areas.

• Development Management

In formulating policies (guidelines and objectives) for the involvement of suppliers in development projects, specific attention should be given to the different forms of involvement with respect to the extent and moment of involvement. This applies in particular to firms that usually have a large number of suppliers involved in a project, as the differentiation between forms of involvement then becomes highly relevant with respect to optimising communication and co-ordination efforts. For individual firms, the factors on which this differentiation should be based, may vary. In general, however, these factors pertain to the risk and importance of the supplier product concerned within the context of the whole project, and the respective capabilities of the supplier and the manufacturer. In Appendix G, an example of such guidelines is presented as they have been developed for one of the companies in our research.

Formulating policies (guidelines and objectives) for purchasing related activities of internal departments could be done by taking the list of activities developed in this research, and allocating responsibilities to specific departments. Possibly, these guidelines may differentiate between 'consultation' and 'decision' responsibilities to account for the different contributions various departments may be able to provide. The allocation of these responsibilities should be based on the competencies of the different departments, their wider tasks and authorities, and a consideration of the impact of this allocation on a smooth communication and collaboration process. Where possible, the guidelines should be incorporated in the firm's product development procedure.

Communicating the policies internally and externally is especially important for making all participants in the product development process familiar with and willing to accept these guidelines. When, for example, a purchasing department has created a memorandum or handbook with regard to the role it wants to play in product development, it may become very difficult to achieve this role when the development department is not informed about that. Similarly, when a firm formulates supplier involvement guidelines that suppliers do not know of, it may difficult if not impossible for these suppliers to understand what the customer expects from them. Communication may take place through internet or intranet applications, sharing documentation, presentations, supplier-meetings, etc.

- **Supplier Interface Management**

For *pre-selecting suppliers for product development collaboration* it is important to focus on methods and areas of supplier (vendor) rating that are directed at future performance and general capabilities, rather than at past performance and product related aspects. This means that detailed assessments of suppliers by means of audits on location become especially relevant. One interesting means of easily making (part of) such an assessment available to various company representatives is by reporting the audits on videotape.

For *motivating suppliers to develop specific knowledge or products*, 'technology roadmaps' may be a useful tool to start with. These roadmaps present an overview of future technological needs as expected by the manufacturer, and are confronted with the supplier's current capabilities. This should trigger a discussion between the manufacturer and the supplier on the kind of technologies or products the supplier should develop knowledge and capabilities in. A first step towards *fully exploiting the technical capabilities of suppliers* may be to invite them periodically to present some of their current research efforts or newly introduced products, as far as possible with respect to contractual obligations to other customers. One way of making such presentations time and cost-effective both for the supplier and the manufacturer, is by hosting in-house technical fairs where suppliers present themselves and their products to a broad audience of manufacturer employees (see Millen-Porter, 1996).

Evaluating supplier development performance should, preferably, be done during or directly after each joint development project. Parameters for evaluation may include: deviations from planned hours or delivery date, response time, and the ratio of engineering hours put in by the supplier vs. supervision hours by the manufacturer (Alfrink, 1997). These evaluations should also be incorporated in the general rating of the supplier, meaning that the information is also used for the pre-selection of development partners (maintaining the preferred supplier base). By sharing or even jointly carrying out the evaluation with the supplier, the results may show a more careful appreciation of the actual performance and its causes, and create a more fruitful incentive for the supplier to improve its performance.

- **Project Management**

Many of the recommendations that could be put forward regarding Project Planning activities have already been mentioned under the heading of Development or Supplier Interface Management.

With regard to the *co-ordination of development activities between the manufacturer and the supplier*, it is recommended that there is a clear interface, in terms of contact persons. Depending on the type of relationship, the interface may be maintained by one single person or by a team of people from different internal functions. This applies both to the supplier and the manufacturer. The essence is that the number of people involved in the direct communication with the counterpart should be as large as necessary, and as small as possible (see Appendix G).

For the *co-ordination of development activities between different suppliers*, it is important to consider which firm is the most appropriate co-ordinator. In some cases, the manufacturer may be the most suitable party, for example, when two different first-tier suppliers have no prior experience with each other. In other cases, the supplier may be the appropriate party, for example, when it should co-ordinate the development work carried out by a second-tier supplier which it knows rather well, or whose product the manufacturer has little knowledge of. By letting suppliers co-ordinate their work with each other, the manufacture may achieve considerable savings in supervision and communication costs.

The feasibility of that option, however, is highly dependent on the technological and managerial skills of the suppliers concerned.

- **Product Management**

Providing information on new products and technologies available in supplier markets benefits from constantly performing market research, based on the needs and interests formulated by departments such as development and marketing. The information could be distributed by means of intranet applications, periodical news bulletins or through personal, pro-active contact with internal clients. Supplier Technology Expo's, as described above, may be an additional form of information exchange.

Promoting standardisation and simplification of product designs is facilitated by maintaining standard part lists or libraries, which are readily accessible and provide complete and up-to-date information. A suitable 'trigger' for the restrictive and extending product management activities can be formed by a procedure according to which every material, part or component that goes into a new product design should be formally accepted by a group or department which has the required technical and supplier market expertise, and which can be held accountable for (or at least has an awareness of) the costs of purchased items. The procedure should be organised in such a way that the requests for introduction/acceptance of a part are submitted as early as possible, and are dealt with quickly and efficiently. Information Technology could provide an important supporting role in this respect.

9.5 Recommendations for further research

Based on the results of this study, several directions for future research can be identified.

First, it would be interesting to carry out investigations regarding the actual impact of performing the activities listed in our framework. This could be done in the form of longitudinal case studies, in which firms are studied that carry out an implementation or improvement project by using the framework of activities as a guideline. One way of assessing the effects of such an effort would be to compare similar development projects over time within a specific firm. By carrying out intra-company comparisons, some of the problems in measuring the effects of supplier and purchasing involvement in product development would be mitigated (see section 3.5). The effects should be measured not only with regard to development lead time and costs, and product costs and quality, but also with regard to communication and supervision costs.

This brings us to a second recommendation for future research, and that is to investigate the long-term effects of purchasing and supplier involvement in product development more closely. These long-term effects have been largely ignored in prior research, which seems to result in underestimating the potential benefits of involving purchasing and suppliers in product development. One seemingly relevant objective would be to develop measures for assessing these long-term effects.

A third recommendation pertains to the different ways in which the generic activities can be executed. Further research may focus on comparing different approaches to individual activities, for example, over time within one company or simultaneously for different companies. Primarily, the analyses should focus on the feasibility, effectiveness and efficiency of different approaches. Closely related to this, future research may also try to adopt a less 'rational' or mechanistic definition of the activities taking place (see section 6.1). This may imply a shift from 'managing' the activities or process of purchasing involvement in product development to 'coping' with these activities and processes.

Rather than a rational and systematic decision model, an incremental decision process model may fit more closely with purchasing involvement decisions, actions and processes as taking place in practice. Of the goals and means, especially the means are highly uncertain. Adopting the view of decision processes taking form incrementally also leaves room for considering the re-actions of a firm to the actions of external actors such as suppliers. Ford (1998: 4) argues that strategies in complex business markets is essentially an interactive process of 'coping, reacting and re-reacting to the actions of significant others'. Applied to purchasing involvement in product development, such an interactive view emphasises that the actions and re-actions of suppliers should also be taken into account in developing the involvement strategy and taking particular purchasing and product development decisions. Despite the fact that this study has given more attention to the role and perspectives of suppliers themselves than most other research in the area of purchasing involvement in product development, it is not characterised by such a truly interactive view of purchasing involvement processes.

A fourth recommendation concerns the use of contracts in managing supplier involvement in product development. This issue has not been investigated in-depth in the current study, partly because the use of contracts seems very limited in practice, partly because they are only one of the means in achieving some of the key processes underlying purchasing involvement in product development. Future research could focus more on contracts in manufacturer-supplier collaboration in product development, the reasons why they are used or not in specific situations, and *how* they are actually used in a relation. As a starting point, Ardon and Van Weele (1994) have presented an extensive checklist of the contractual aspects to be considered in product development collaboration.

The fifth recommendation directly related to the present study would be to consider other potential driving factors than the ones covered by our empirical studies. This would primarily involve technical and development characteristics such as product technology (e.g. electronics vs. mechanics) and the dominance of process or product innovation in a certain industry sector. An additional driving factor would be the maturity of a technology or industry, as discussed in the case of Ericsson (section 7.2.6). The impact of these driving factors could also be related more specifically to the ways in which the activities are being executed. Additionally, further research could also focus on more carefully isolating the influence of driving factors, either in surveys or case studies, for example, by studying two telecommunications equipment manufacturers with different R&D expenditures or purchasing ratio's.

The final recommendation concerns the enabling factors. Especially the influence of human factors may be studied further. Interesting issues may involve the optimal mix of skills and knowledge within purchasing departments, and how training and hiring may be affected by the increasing process orientation of firms.

In a wider context, this research may provide interesting leads for research on achieving and maintaining collaborative supplier relations by focusing on issues such as mobilisation. It also indicates some aspects which may be worthwhile to consider in further research on the organisation of purchasing departments.

9.6 Epilogue

At the beginning of this study, the research objectives have been described as to develop an integrated framework of specific activities concerning purchasing involvement in product development, and to develop preliminary knowledge on the factors that drive and enable the performance of such activities. Hopefully, by achieving these objectives we have made a small contribution to the advancement of knowledge in the field of purchasing and product development, and to the improvement of the profession as a whole.

During the course of the research project the present study is based on, we have collaborated rather intensively with a number of companies. This has been very useful for our research, and hopefully this study provides them something in return. Our impression is, however, that even conducting interviews may already have positive effects for the company too as it may increase the awareness of specific problems and issues, and help to analyse the company's current situation. Research too is a highly interactive process.

Both the empirical studies and the other research activities have been carried out in two countries; the Netherlands and Sweden. However, as mentioned in the first chapter, the idea has never been to make a direct comparison between those two countries in terms of supplier and purchasing management and product development. Nevertheless, over the years one develops a personal impression of those differences. In my opinion, Swedish companies are in general more focused on collaboration than their Dutch counterparts. Swedish firms seem to have a stronger feeling of 'we're in it together', sometimes enforced by a 'buy Swedish' tendency. This is not to say that (especially the large) Swedish companies are not outward looking, on the contrary. However, the business community is so small - even if geographically more disperse than in the Netherlands - that there is a strong web of interlinking relations between them. In the Netherlands, there seems to be a more 'Anglo-Saxon' business atmosphere, where relations may be broken temporarily because of individual interests (recall the SWD-Holec and the PMS case). In the future, it may be interesting to build a database of Dutch customer and supplier relationships that can be compared to the Scandinavian one (section 3.1.1) to investigate these personal impressions more systematically.

The combination of two very different research environments - the Faculty of Technology Management at Eindhoven University of Technology and the department of Business Studies at Uppsala University - has been very interesting, sometimes difficult, but challenging at least. Eindhoven has a more engineering-like approach of solving actual current problems experienced by firms by developing certain tools or methods in rather specific management areas, while Uppsala has a more distant, descriptive and more integral way of looking at the situations firms are facing, and the actions they develop to deal with that. In Eindhoven, we seem to believe strongly in the 'makeability' of the business environment. In Uppsala, we see firms as 'coping' with most of their environment. Hopefully, this thesis has brought together some useful notions of both schools, at least that was one of the underlying intentions. The risk, obviously, is that the result is a unhappy compromise of both. It is for the reader to decide which of the two applies here.

In the long run, being in different business and academic environments may not only have a potential value for the contents of the research, but certainly also for the researcher himself. It confronts him with differences not only in cultural aspects and business practices, but also with regard to opinions concerning the goals and methods of academic research. This may lead him to consider those different aspects more critically, and to question his own perceptions. It seems advisable to stimulate (young) researchers to undertake this kind of 'migration' between different environments as it may increase their 'learning capacity'.

Finally, the research carried out for this study has been presented as if it has been designed this way right from the start. As any researcher will know, this is not true. During the project, we have adjusted our focus, rephrased research questions, eliminated case studies, introduced new aspects etcetera. Not describing these twists and turns in the thesis increases its clarity and readability but, regrettably, it also takes away the possibility for other (future) researchers to learn from those experiences for their own research.

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Appendix A

Interviewguide

Part A: Background information
 Part B-F: Supplier nrs 1-5
 Part G-K: Customer nrs 1-5

Part A: Background Information

A1	Branch	
A2	Number of employees	
A3	Turnover in SEK	
A4	Development of turnover last five years	<i>Strong Increase</i> <i>Increase</i> <i>Relatively Unchanged</i> <i>Decrease</i> <i>Strong Decrease</i>
A5	Total costs	
A6	What drives production in the focal company	<i>Custom order Driven</i> <i>Order to Stock</i> <i>Do not Know</i>
A7	What kind of production does the focal company employ	<i>Unit Production</i> <i>Small Series</i> <i>Large Series</i> <i>Process Production</i> <i>Distributor</i> <i>Do not Know</i>

A8	Purchasing costs as a share of turnover	%
A9	Development of the purchasing cost share the last five years	<i>Strong Increase</i> <i>Increase</i> <i>Relatively Unchanged</i> <i>Decrease</i> <i>Strong Decrease</i>

Purchasing divided according to type of inputs:

A10	Raw materials as part of total purchasing costs	%
A11	Intermediate goods as part of total purchasing costs	%
A12	Components as part of total purchasing costs	%
A13	Large systems of components as part of total purchasing costs	%
A14	Production equipment as part of total purchasing costs	%
A15	Services (incl. transports) as part of total purchasing costs	%
A16	Finished goods as part of total purchasing costs	%
A17	Other as part of total purchasing cost	%
Sum		100 %

Appendix A

Geographical dispersion of purchases:

A18	Domestic purchases as part of total purchasing costs	%
A19	Purchases within the rest of Scandinavia as part of total purchasing costs	%
A20	Purchases in the rest of Europe as part of total purchasing costs	%
A21	Purchases from North-America as part of total purchasing costs	%
A22	Purchases from the rest of the world as part of total purchasing costs	%
Sum		100 %

A23	Development in geographical dispersion of purchases in the last 5 years	<i>Fast Internationalisation</i>	<i>Gradual Internationalisation</i>	<i>Unaltered</i>	<i>Increased orientation on domestic market</i>
A24	Number of suppliers that account for 50 % of purchasing costs				
A25	Number of suppliers that account for 80 % of purchasing costs				
A26	Total number of suppliers				
A27	Development of the number of suppliers the last 5 years	<i>Strong Increase</i>	<i>Increase</i>	<i>Relatively Unchanged</i>	<i>Decrease</i> <i>Strong Decrease</i>
A28	Have there been any changes in the approach of the supplier base the last 5 years (e.g. concentration, 'partnerships')?				
A29	Have there been any changes in the internal organisation of the purchasing department the last 5 years?				

Geographical dispersion of sales:

A30	Domestic sales as part of total turnover	%
A31	Sales in the rest of Scandinavia as part of total turnover	%
A32	Sales in the rest of Europe as part of total turnover	%
A33	Sales to North-America as part of total turnover	%
A34	Sales to the rest of the world as part of total turnover	%
Sum		100 %

A35	Development in geographical dispersion of sales in the last 5 years	<i>Fast Internationalisation</i>	<i>Gradual Internationalisation</i>	<i>Unaltered</i>	<i>Increased orientation on domestic market</i>
A36	Number of customers that account for 50 % of sales				
A37	Number of customers that account for 80 % of sales				
A38	Total number of customers				
A39	Development of the number of customers the last 5 years	<i>Strong Increase</i>	<i>Increase</i>	<i>Relatively Unchanged</i>	<i>Decrease</i> <i>Strong Decrease</i>
A40	Have there been any changes in the approach to the customer base the last 5 years?				

A41	Location of production (geographically, number of locations)
A42	Location of research and development activities (geographically, number of locations)

Part B Supplier

Name of supplier

Code number:

Contact person:

Telephone:

Supplier relationship - background information

B1 Branch	
B2 Turnover in SEK	
B3 Location	
B4 Product delivered to the focal company	<i>Raw Materials</i> <i>Intermediate Goods</i> <i>Components</i> <i>Large Assemblies</i> <i>Production equipment</i> <i>Services</i> <i>Finished Goods</i>
B5 Degree of standardisation of product sold to the focal company	<i>Standard</i> <i>Adapted for several customers</i> <i>Specially adapted</i> <i>Do not know</i>

B6 What drives production at the supplier	<i>Customer order driven</i> <i>Order to Stock</i> <i>Do not Know</i>
B7 What kind of production does the supplier have	<i>Unit production</i> <i>Small series</i> <i>Large series</i> <i>Process production</i> <i>Distributor</i> <i>Other</i>
B8 Degree of internationalisation of the supplier's supplier base (from supplier's perspective)	<i>Mainly domestic</i> <i>Someabroad</i> <i>Major part abroad</i>

B9 Degree of internationalisation of supplier's customer base (from supplier's perspective)	<i>Mainly domestic</i> <i>Someabroad</i> <i>Major part abroad</i>
B10 Competitors of focal company that the supplier sells to	<i>Unclear</i> <i>None</i> <i>One</i> <i>Some</i> <i>Many</i>
B11 Names of these competitors	

B12 Location of these competitors	<i>Mainly domestic</i> <i>Mainly abroad</i> <i>Both</i>
B13 How many suppliers does the supplier have	<i>Unclear</i> <i>A few</i> <i>Many</i> <i>Very many</i>
B14 Number of supplier's suppliers that have an impact on the relation with the focal company	<i>Unclear</i> <i>None</i> <i>One</i> <i>Some</i> <i>Many</i>

Supplier relationship - characteristics

B15 Duration (in years)	
B16 Ownership connection; the supplier is ...	<i>Parent company</i> <i>Subsidiary</i> <i>Sister-company</i> <i>Temporary connection</i> <i>No ownership ties</i>
B17 Purchasing volume in SEK	

Appendix A

	supplier 1
B18 Change in purchasing volume during the last 5 years	<i>Strong decrease</i> <i>Decrease</i> <i>Unchanged</i> <i>Increase</i> <i>Strong increase</i>
B19 Possible causes for the change in purchasing volume	<i>Market trends</i> <i>Change at the focal company</i> <i>Change at the supplier</i> <i>Other</i>
B20 Change in the supplier's responsibilities in relation to the focal company (in what way)	<i>Increase</i> <i>Unchanged</i> <i>Decrease</i>
B21 Duration and content of written agreements	
B22 Use of parallel suppliers	<i>Single source</i> <i>Dominating, but others are used</i> <i>One of several equally important</i> <i>One of several with different importance</i>

B22*/54FW Part of the focal company's total need that is supplied by this supplier (%)	
B23 Focal company's position in supplier's customer base	<i>Single customer</i> <i>One of several large ones</i> <i>Dominating among few</i> <i>Dominating among many</i> <i>One of many small ones</i>
B23*/55FW Part of the supplier's total production that is bought by the focal company (%)	
B24 Localisation of parallel suppliers in relation to the focal company	<i>Mainly domestic</i> <i>Mainly abroad</i> <i>Both</i>

B25 Number of people involved in the relationship from the focal company	
B26 Number of people involved in the relationship from the supplier	

B27 Frequency of contact	<i>Depending on project</i> <i>Daily</i> <i>Several times a week</i> <i>Once a week</i> <i>2-3 times a month</i> <i>Once a month</i> <i>Less</i>
B28 Content of the relationship (f.e. order-, delivery-, price-, technical questions, market, organisation)	
B29 Content of the contacts	<i>Mainly order/delivery questions</i> <i>Mainly price questions</i> <i>Mainly technical questions</i> <i>Combination of at least two of these</i> <i>Other</i>
B30 Administrative adaptations specifically for this relationship	<i>Use of EDI</i> <i>Other major adaptations</i> <i>Other minor adaptations</i> <i>No adaptations</i>

Supplier relationship - production

B31 Delivery frequency	<i>Depending on project</i> <i>Seasonally dependent</i> <i>Daily</i> <i>Several times a week</i> <i>Once a week</i> <i>2-3 times a month</i> <i>Once a month</i> <i>Less</i>
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B32	<i>Delivery from stock</i>
Order-delivery time	<i>Less than 24 hours</i>
	<i>2-3 days</i>
	<i>One week</i>
	<i>2-3 weeks</i>
	<i>4-6 weeks</i>
	<i>6-18 weeks</i>
	<i>More than 18 weeks</i>
B34	
Effects of delays (duration and type)	

B35	<i>None</i>
Quality control at focal firm	<i>Some form of quality control</i>
	<i>Systematically and thorough</i>
B36	<i>None</i>
Quality control at supplier	<i>According to the focal company's norms</i>
	<i>According to the supplier's norms</i>
	<i>Common/detailed norms</i>
B37	<i>In principle none</i>
Characteristics of the product that can cause disturbances in the production at the focal company	<i>Some special qualities</i>
	<i>Unaffected, but problems in a later stage</i>
B38	<i>None</i>
Adaptations in the material flow specifically for this relation	<i>Minor adaptations</i>
	<i>Major adaptations</i>
	<i>Totally integrated physical treatment or transport-system</i>

Supplier relationship - co-operation in development

	supplier 1
B39	<i>No</i>
Is there, or has there been any form of co-operation in product- or process development?	<i>Yes, in product development</i>
	<i>Yes, in process development</i>
	<i>Yes, in both</i>

B40	<i>None</i>
Number of current co-operation projects	<i>One minor</i>
	<i>One major</i>
	<i>Continuously, not big</i>
	<i>Continuously, and big</i>
B41	<i>Grown</i>
Development of the co-operation in the last 5 years	<i>Unchanged</i>
	<i>Decreased</i>
B42	<i>Decreased or grown interest at the supplier</i>
Possible cause for the change in the extent of co-operation	<i>Decreased or grown interest at the focal company</i>
	<i>Decreased or grown interest at both companies</i>
B43	<i>Standard norms</i>
Specifications and characteristics of the product are determined by	<i>Supplier</i>
	<i>Focal company</i>
	<i>Both</i>

B44	<i>None</i>
Focal company's involvement in the technical development of the product	<i>Some involvement</i>
	<i>Very active/dominating</i>
	<i>Does everything, only production is subcontracted</i>
B45	
Extent of the co-operation (number of months/year spent)	
B46	<i>None</i>
Degree of formalisation in the co-operation	<i>Specific agreements for individual projects</i>
	<i>Long-term, formal agreements</i>
	<i>Long-term, formal agreements, most favoured partner</i>
B47	<i>Focal company</i>
Who initiates the co-operation	<i>Supplier</i>
	<i>Both</i>

Appendix A

B48	<i>Focal company</i>
Who is the most active in the co-operation	<i>Supplier</i>
	<i>Both</i>
B49	
Themes for projects (areas of technology)	

B50	
Results of the co-operation for the focal company (knowledge, production technology, new products, increased sales, lower costs, new markets)	
B51	
Results of the co-operation for the supplier (knowledge, production technology, new products, increased sales, lower costs, new markets)	
B53	<i>Each is responsible for its own expenses and revenues</i>
Arrangements for the economical side of the co-operation projects	<i>Some sharing of expenses and revenues</i>
	<i>Shared responsibility for the total project</i>
B52	<i>No special expectations</i>
Expectations regarding future co-operation in the relation	<i>Some expectations</i>
	<i>Great expectations</i>

Part G-K: Customer companies

	customer 1
Name of customer	
Code number:	
Contact person:	
Telephone:	

Customer relationship - background information

	customer 1
G1	
Branch	
G2	
Turnover in SEK	
G3	
Location	

G4	<i>Raw Materials</i>
Product delivered to the customer	<i>Intermediate Goods</i>
	<i>Components</i>
	<i>Large Assemblies</i>
	<i>Production equipment</i>
	<i>Services</i>
	<i>Finished Goods</i>
G5	<i>Standard</i>
Degree of standardisation of product sold to the customer	<i>Adapted for several customers</i>
	<i>Specially adapted</i>

G6	<i>Customer order driven</i>
What drives production at the customer	<i>Order to Stock</i>
	<i>Do not Know</i>
G7	<i>Unit production</i>
What kind of production does the customer have	<i>Small series</i>
	<i>Large series</i>
	<i>Process production</i>
	<i>Distributor</i>
	<i>Other</i>
G8	<i>Mainly domestic</i>
Degree of internationalisation of the customer's supplier base (from customer's perspective)	<i>Some abroad</i>
	<i>Major part abroad</i>
G9	<i>Mainly domestic</i>
Degree of internationalisation of customer's customer base (from customer's perspective)	<i>Some abroad</i>
	<i>Major part abroad</i>
G10	<i>Unclear</i>
Competitors of focal company that the customer buys from	<i>None</i>
	<i>One</i>
	<i>Some</i>
	<i>Many</i>
G11	
Names of these competitors	

G12	<i>Mainly domestic</i>
Location of these competitors	<i>Mainly abroad</i>
	<i>Both</i>
G13	<i>Unclear</i>
How many customers does the customer have	<i>A few</i>
	<i>Many</i>
	<i>Very many</i>
G14	<i>Unclear</i>
Number of customer's customers that have an impact on the relation with the focal company (and in what way)	<i>None</i>
	<i>One</i>
	<i>Some</i>
	<i>Many</i>

Customer relationship - characteristics

G15	
Duration (in years)	
G16	<i>Parent company</i>
Ownership connection; the customer is ...	<i>Subsidiary</i>
	<i>Sister-company</i>
	<i>Temporary connection</i>
	<i>No ownership ties</i>
G17	
Sales volume in SEK	

G18	<i>Strong decrease</i>
Change in sales volume during the last 5 years	<i>Decrease</i>
	<i>Unchanged</i>
	<i>Increase</i>
	<i>Strong increase</i>
G19	<i>Market trends</i>
Possible causes for the change in sales volume	<i>Change at the focal company</i>
	<i>Change at the customer</i>
	<i>Other</i>
G20	<i>Increase</i>
Change in the focal company's responsibilities in relation to the customer (and in what way)	<i>Unchanged</i>
	<i>Decrease</i>
G21	
Duration and content of written agreements	

G22new/54FW	<i>Single customer</i>
Parallel customers	<i>Dominating, but there are others</i>
	<i>One of several equally important</i>
	<i>One of several with different importance</i>

G22*/55FW	
Part of the production that goes to this customer (%)	
G23	<i>Singlesupplier</i>
Focal company's position in customer's supplier base	<i>One of several large ones</i>
	<i>Dominating among few</i>
	<i>Dominating among many</i>
	<i>One of many small ones</i>
G23* (old G22)	
Part of the customer's total need that is supplied by the focal company (%)	
G24/56FW	<i>Mainly domestic</i>
Localisation of parallel customers in relation to the focal company	<i>Mainly abroad</i>
	<i>Both</i>
G25	
Number of people involved in the relationship from the focal company	
G26	
Number of people involved in the relationship from the customer	

	<i>customer 1</i>
G27	<i>Depending on project</i>
Frequency of contact	<i>Daily</i>
	<i>Several times a week</i>
	<i>Once a week</i>
	<i>2-3 times a month</i>
	<i>Once a month</i>
	<i>Less</i>

Appendix A

G28	
Content of the relationship (f.e. order-, delivery-, price-, technical questions, market, organisation)	
G29	<i>Mainly order/delivery questions</i>
Content of the contacts	<i>Mainly price questions</i>
	<i>Mainly technical questions</i>
	<i>Combination of at least two of these</i>
	<i>Other</i>
G30	<i>Use of EDI</i>
Administrative adaptations specifically for this relationship	<i>Other major adaptations</i>
	<i>Other minor adaptations</i>
	<i>No adaptations</i>

Customer relationship - production

	customer 1
G31	<i>Depending on the project</i>
Delivery frequency	<i>Seasonally dependent</i>
	<i>Daily</i>
	<i>Several times a week</i>
	<i>Once a week</i>
	<i>2-3 times a month</i>
	<i>Once a month</i>
	<i>Less</i>
G32	<i>Delivery from stock</i>
Order-delivery time	<i>Less than 24 hours</i>
	<i>2-3 days</i>
	<i>One week</i>
	<i>2-3 weeks</i>
	<i>4-6 weeks</i>
	<i>6-18 weeks</i>
	<i>More than 18 weeks</i>

G33	<i>Max. 1 day</i>
Focal company's total production cycle-time in relation to the customer	<i>2-3 days</i>
	<i>4-7 days</i>
	<i>8-15 days</i>
	<i>15 days-4 weeks</i>
	<i>4-8 weeks</i>
G34	
Effects of delivery delays (duration and type)	
G35	<i>None</i>
Quality control at customer	<i>Some form of quality control</i>
	<i>Systematically and thorough</i>
G36	<i>None</i>
Quality control at the focal company	<i>According to the focal company's norms</i>
	<i>According to the customer's norms</i>
	<i>Common,/detailed norms</i>
G37	<i>In principle none</i>
Characteristics of the product that can cause disturbances in the production at the customer	<i>Some special qualities</i>
	<i>Unaffected, but problems in a later stage</i>

G38	<i>None</i>
Adaptations in the material flow specifically for this relation	<i>Minor adaptations</i>
	<i>Major adaptations</i>
	<i>Totally integrated physical treatment or transport-system</i>

Customer relationship - co-operation in development

G39	<i>No</i>
Is there, or has there been any form of co-operation in product- or process development?	<i>Yes, in product development</i>
	<i>Yes, in process development</i>
	<i>Yes, in both</i>

G40	<i>None</i>
Number of current co-operation projects	<i>One minor</i> <i>One major</i> <i>Continuously, not big</i> <i>Continuously, and big</i>
G41	<i>Grown</i>
Development of the co-operation in the last 5 years	<i>Unchanged</i> <i>Decreased</i>

G42	<i>Decreased or grown interest at the focal company</i>
Possible cause for the change in the extent of co-operation	<i>Decreased or grown interest at the customer</i> <i>Decreased or grown interest at both companies</i>
G43	<i>Standard norms</i>
Specifications and characteristics of the product are determined by	<i>Customer</i> <i>Focal company</i> <i>Both</i>
G44	<i>None</i>
Customer's involvement in the technical development	<i>Some involvement</i> <i>Very active/dominating</i> <i>Does everything, only production is subcontracted</i>
G45	
Extent of the co-operation (number of months per year spent)	

G46	<i>None</i>
Degree of formalisation in the co-operation	<i>Specific agreements for individual projects</i> <i>Long-term, formal agreements</i> <i>Long-term, formal agreements, most favoured partner</i>
G47	<i>Focal company</i>
Who initiates the co-operation	<i>Customer</i> <i>Both</i>

G48	<i>Focal company</i>
Who is the most active in the co-operation	<i>Customer</i> <i>Both</i>
G49	
Themes for projects (areas of technology)	
G50	
Results of the co-operation for the focal company (knowledge, production technology, new products, increased sales, lower costs, new markets)	

G51	
Results of the co-operation for the customer (knowledge, production technology, new products, increased sales, lower costs, new markets)	
G53	<i>Each is responsible for his own expenses and revenues</i> <i>Some sharing of expenses and revenues</i> <i>Shared responsibility for the total project</i>
Arrangements for the economical side of the co-operation projects	
G52	<i>No special expectations</i>
Expectations regarding future co-operation in the relation	<i>Some expectations</i> <i>Great expectations</i>

Appendix A

Appendix B

Scandinavian database

The database contains data for 100 Scandinavian companies; 15 located in Norway and 85 in Sweden. We have chosen to only present data here on their supplier relationships, but most companies come from industries involved in mechanical engineering and transportation equipment, and some are producers of plastics and paper. All interviews have been conducted using the interview guide listed in Appendix A.

Appendix B

(all numbers are percentages, unless stated otherwise)	N	subgroups	B39			B40		B45	
			none	product	form of collab.	major project	intensity		
					process	both	continuous, small	continuous, big	months spent
									average nr months
relationship age (B15)	34	suppliers 2 yrs or younger	76,7	13,3	0	10,0	25,0	18,8	6,3
	74	suppliers 3-5 yrs	54,2	23,6	13,9	8,3	8,3	27,1	10,4
	101	suppliers 6-10 yrs	67,0	14,4	12,4	6,2	5,4	23,2	8,9
	123	suppliers 11-20 yrs	52,8	31,5	8,3	7,4	14,9	32,8	4,5
	67	suppliers 21-30 yrs	56,5	27,4	3,2	12,9	6,6	37,8	3,7
	38	suppliers 31-50 yrs	59,5	21,6	2,7	16,2	3,8	30,7	15,4
	14	suppliers > 50 yrs	30,8	13,1	15,4	30,7	0,0	44,4	11,1
	451								
product (B4)	141	raw material suppliers	63,6	17,0	7,7	11,7	8,8	44,1	4,4
	134	semi-manufactures suppliers	64,6	16,5	9,5	9,4	7,4	12,4	0,2
	98	component suppliers	55,7	32,9	3,4	8,0	4,7	34,4	14,1
	18	assembly suppliers	35,3	47,1	0,0	17,6	30,7	15,4	23,1
	32	equipment suppliers	44,8	20,7	20,7	13,8	4,7	33,3	4,8
	22	services suppliers	52,6	5,3	31,6	10,5	26,7	33,3	0
	20	finished goods suppliers	36,9	52,6	0,0	11,5	13,3	26,7	10,0
	465								
position supplier (B22)	190	single supplier	51,1	26,2	9,4	12,3	9,3	30,3	13,4
	139	dominating supplier	61,5	19,3	11,5	7,7	10,6	27,1	7,1
	80	one among equal' supplier	68,5	13,7	5,5	12,3	8,5	29,8	4,3
	43	one among different' supplier	70,0	17,5	2,5	10,0	0,0	31,6	0,0
	451								
position customer (B23)	18	single customer	31,3	37,5	25,0	6,2	7,1	42,9	0,0
	35	dominating among few' customer	33,3	39,4	9,1	18,2	18,5	37,0	14,8
	103	one of several large customers	50,5	22,1	12,6	14,8	13,1	27,5	14,5
	20	dominating among many' customer	55,0	35,0	0,0	10,0	0,0	8,3	25,0
	214	one of many small' customer	71,9	16,2	5,2	6,7	8,1	21,6	3,6
	390								

subgroups	B43 joint determin. specifications		B47 initiator		B48 most active party		B46 formalisation		B53 cost sharing	
	manufacturer	supplier	both	manufacturer	supplier	both	(1= none, 4= long term contracts)	(1= no sharing, 3= total sharing)		
suppliers 2 yrs or younger	25.0	88.9	0.0	11.1	87.5	0.0	12.5	2.30	1.50	
suppliers 3-5 yrs	27.0	72.7	0.0	27.3	43.8	21.9	34.4	1.56	1.38	
suppliers 6-10 yrs	33.3	80.6	2.8	16.6	47.2	33.3	19.5	1.46	1.07	
suppliers 11-20 yrs	27.8	65.1	2.3	32.6	32.6	18.6	48.8	1.36	1.00	
suppliers 21-30 yrs	20.5	60.7	7.1	32.2	34.6	19.2	46.2	1.34	1.00	
suppliers 31-50 yrs	47.1	53.3	0.0	46.7	14.3	0.0	85.7	1.47	1.00	
suppliers > 50 yrs	25.0	77.8	0.0	22.2	33.3	0.0	66.7	1.29	1.00	
raw material suppliers	18.2	70.2	2.1	27.7	42.2	13.3	44.4	1.6	1.14	
semi-manufactures suppliers	32.3	68.9	4.4	26.7	37.8	20.0	42.2	1.2	1.26	
component suppliers	24.1	76.9	0.0	23.1	43.2	16.2	40.5	1.6	1.00	
assembly suppliers	16.7	81.8	0.0	18.2	40.0	30.0	30.0	2.0	1.00	
equipment suppliers	55	66.7	0.0	33.3	35.3	41.2	23.5	1.3	1.00	
services suppliers	76.9	50.0	12.5	37.5	25.0	12.5	62.5	1.3	1.00	
finished goods suppliers	14.3	60.0	0.0	40.0	20.0	10.0	70.0	1.7	1.00	
single supplier	28.3	61.5	2.6	35.9	36.3	14.3	49.4	1.47	1.21	
dominating supplier	32.1	76.4	3.6	20	19.6	33.3	47.1	1.41	1.00	
one among equal supplier	25.8	80.8	0	19.2	73.1	7.7	19.2	1.79	1.22	
one among different supplier	40.0	69.2	0	30.8	38.4	15.4	46.2	1.00	1.11	
single customer	7.7	81.8	0.0	18.2	54.6	27.2	8.2	1.23	1.33	
dominating among few customer	32.0	68.2	0.0	31.8	59.1	4.5	36.4	1.72	1.11	
one of several large customers	29.2	70.6	0.0	29.4	37.5	25.0	37.5	1.51	1.08	
dominating among many customer	45.5	77.8	0.0	22.2	22.2	11.1	66.7	1.90	1.00	
one of many small customer	35.1	59.6	5.3	35.1	19.6	23.2	57.2	1.28	1.00	

Appendix B

Appendix C

Overview of interviews

Truck industry

Scania Sven Berg, Roger Rytterström Lars Eriksson	Södertälje purchasing director, TMC purchasing manager, TMD purchasing Special Projects, TMC	Sweden 940616, 950614 950814 950814
Valeo Jan Wiklund	Linköping managing director	Sweden 950621, 950815
DAF Trucks J. de Haan R. Oudenaller H. Kronenburg J. Gijsbers G. J. Engel	Eindhoven buyer expediter senior buyer purchasing manager Engines senior buyer, driveline components	Netherlands 951019 951019 951019 951019, 951026 951026
Robert Bosch U. Roschmann	Stuttgart application engineering and sales Commercial Vehicle Group, K5	Germany 960514

Telecommunication hardware

Ericsson Radio Leif Låsson	Kista purchasing director RMOA	Sweden 950817
Ericsson Radio Kenneth Kjellström	Kumla purchasing manager PCB factory	Sweden 960711, 970521
Ericsson Components Bertil Skoglund	Kista business center manager RF Power Products	Sweden 960529
Cityprint Leo van de Windt Jan Hofman	Almelo team leader sales marketing representative	Netherlands 960130 960130

Plastic components

Perstorp Components Anders Pellmyr Hans Borrling Kay Grinneback	Västra Frölunda purchasing director marketing manager manager technical dept	Sweden 950818, 960122 960122 960122
ICI Polyurethanes Neil Sutton Dennis Murray Keith Williams	Shepton Mallet site/commercial manager mgr new business development Flexible Foam technical service specialist Flexibles	United Kingdom 960418 960418 960418

Appendix C

Food & beverages

Pripps Bryggerier Åke Carlsson	Bromma purchasing manager	Sweden 940705,951124,960304
Munksjö Förpackningar Lennart Stenberg	Norrköping sales manager	Sweden 960123
Friesland Dairy Foods Dick Heere	Leeuwarden manager purchasing department, Production Long Life Products	Netherlands 951220, 960105, 960308, 960725
Ad Halma	purchaser packaging material, Production Long Life Products	951220, 960105, 960308, 960725
Cees Karstkarel	manager packaging development, Research & Development	951220, 960105, 960308, 960725
Thomassen & Drijver-Verblifa Jacqueline Turlings	Deventer sales manager Dairy	Netherlands 960108

Power plants

ABB Stal Micael Hedlund Jonas Tegström Bo Svensson Thomas Rönnebring Leif Johanneson	Finspong procurement director procurement engineer - plants sales & public relations procurement engineer procurement manager	Sweden 940616 940616, 950816 950816 950816 950816
ABB Installation Björn Lundqvist	Norrköping sales engineer	Sweden 960124
Stork Wärtsilä Diesel Projects Hans Oldert	Amsterdam manager strategical purchasing	Netherlands 951212, 960209
Holec Projects International Jos Rijs Rob van Schagen	Hengelo sales head of procurement	Netherlands 960130 960130

Appendix D

Background information case companies

This appendix contains both some quantitative and qualitative background information on the manufacturers and suppliers from the case studies in Chapter 5, and a short overview of all their supplier and customer relations. All descriptions pertain to the moment of (or period prior to) interviewing, which has been between Summer 1995 and Summer 1996. Most figures for each company regard either 1994 or 1995.

D.1 Focal Companies

On average, the companies in the case studies are rather big: for manufacturers, the number of employees ranges from 90 to 21,000, and turnover varies from 250 million to 6 billion Dutch guilders (NLG)¹. The suppliers are obviously smaller, with turnover between 28 million and 4 billion NLG and number of employees between 140 and 15,000. Clearly, there is quite some variation. The manufacturers generate more value-added (measured as turnover minus cost of purchases) per employee, and have higher transaction volumes both per customer and supplier than suppliers. For manufacturers, most purchases consist of components (35 %), semi-manufactures like steelplate, (26 %), assemblies and raw material (both 8 %).

Table D.1: Interview sample, average values for manufacturers and suppliers

	manufacturers (n=9)	suppliers (n=9)
number of employees	3910	2850 ²
turnover (million NLG)	1,605	765
value added / employee (million NLG)	0.6	0.2 ²
purchasing ratio (as share of turnover)	54 %	52 % ²
total number of suppliers	912	161 ⁵
average purchasing volume per supplier (million NLG)	34	1.6 ⁵
relative number of suppliers accounting for 80 % of purchases (as share of total number suppliers)	25 %	9 % ⁵
total number of customers	122 ²	577 ²
average sales volume per customer (million NLG)	13.2 ⁴	5.3 ²
relative number of customers accounting for 80 % of sales (as share of total number customers)	31 % ⁵	18 % ²

(numbers in superscript indicate number of missing values)

¹ Throughout the study, the exchange rate 1 SEK = 0.25 NLG is adopted ($\pm$ 0.125 ECU).

D.2 Supplier and customer relationships

The interviews have resulted in a complete coverage by the questionnaire of 40 customer relationships (for one supplier (Ericsson Components), only the focal customer relationship has been discussed and for another (Holec Projects) only four customers in total) and 40 supplier relationships (for Ericsson Kumla, no supplier relations have been completely covered according to the questionnaire) .

The suppliers have an average turnover of 2.1 billion NLG. The purchasing volume involved in the relationship with the focal manufacturer averages 20.6 million NLG. More than half of all supplier relationships (26) involve the delivery of components, 7 involve assemblies and 6 regard semi-manufactures like chemicals or steel plate. Again more than half involve products that are specially adapted for the focal company (25), 8 involve products adapted for several customers and 7 entail standard products.

A majority of the suppliers delivers to many if not all of the focal company's competitors (21), and 13 deliver to some or one of them. In most cases (25), the focal company considers itself to be one of several large customers to the supplier, and in five cases even the dominating customer. In about one-quarter of all cases, the focal company sees itself as one of many small customers. On average, the focal company buys roughly 9 percent of the supplier's total production. Vice versa for the focal company, the supplier is the dominant supplier for that particular product category in most cases (16), and in 13 cases even the single supplier. On average, the supplier accounts for some 60 % of the focal company's total need for that product. The importance and intensity of the relationships in our sample is also reflected in the number of people involved: the relationships involve frequent contacts between, on average, 6 people from the focal company and 5 from the supplier, with a maximum of 20 people.

Customers have an average turnover of 4.2 billion NLG. The sales volume involved in the relationship with the customer averages 35.6 million NLG, and the relationships are on average almost 30 years old (one dating back from 1910, and in several cases from around WW II). Almost 90 % of the relationships involve products that are specially adapted for the customer, 3 involve products adapted for several customers and 2 entail standard products. More than half of all customer relationships (21) involve the delivery of components, one-quarter involves semi-manufactures, 5 regard assemblies and 4 regard services.

A large part of the customers buys from some of the focal supplier's competitors (17), and 13 from one of them. In 9 cases, the focal supplier is single supplier. In a large number of cases (15), the focal supplier considers itself to be one of several large ones, and in 14 cases even the dominating supplier. In just two cases, the focal company sees itself as one of many small suppliers. On average, the customer buys roughly 62 percent of its total need for that product from the focal supplier. Vice versa for the focal supplier, the customer is the only one for that particular product in 80 % of all cases (compare the degree of customisation of the product), and in 10 % of the cases the dominating customer. On average, the customer accounts for some 97 % of the focal company's sales of that product, and 6 % of total turnover. The importance and intensity of the relationships in our sample is again reflected in the number of people involved: the relationships involve frequent contacts between, on average, 6 people from the focal company and 12 from the customer, with a maximum of 50 people. This figure for the customer side is substantially higher than in the case of the supplier relationships.

D.3 Technological collaboration

For each of the 9 manufacturers, the five supplier relationships discussed cannot be taken as a representative sample of their supplier base since we have focused at supplier relationships that are interesting from the point of view of technological collaboration. Therefore, findings on the intensity of technological collaboration with suppliers from this sample cannot be extrapolated to supplier relationships in general. However, although the selection of supplier relationships is not large and neither representative as far as technological collaboration is concerned, the sample provides us with a picture of a substantial part of the manufacturers' supply base: on average, the five suppliers together account for some 20 percent of the manufacturers' total purchases (ranging from 5 to 35 %), with individual supplier shares ranging from close to nil to 20 percent.

Because of the explicit focus on relationships involving technological collaboration, it should not be surprising that in 18 of the 40 supplier relationships, the two parties have collaborated in product development, in five cases in process development and in 14 cases even in both. Three relationships have not involved any form of technological collaboration. Focal companies see themselves as being involved in the technical development of the products concerned in all relationships but one; in 35 % even on a very active or dominating level. Half of the 37 collaborative relationships are characterised by continuous co-operation, either with major resources (7) or only limited resources (12) invested. Additionally, 11 of the collaborations involve one major project at that time and 3 only a small project. Four relationships show no particular ongoing efforts at that particular moment. On average, the co-operation involves some 4 working months at the customer side, with a maximum of 55 (i.e. 5 persons full time).

In more than 60 % of all collaborations, the collaboration has intensified during the last 5 years, and in only 3 cases it has become less intensive. In the majority of relationships, the focal company has initiated the collaboration (23), and only in one case this has been done by the supplier. After the collaboration has started, both parties are equally active in most cases (20), the focal company being the most active in one-quarter of all relations (10) and the supplier only in four cases. Regarding the formal organisation of the collaboration, there is no contract or agreement whatsoever in half of the cases (20), and there are specific contracts for particular projects (like non-disclosure agreements) in 10 cases. In 7 cases there are more strategic, long-term agreements. This low degree of formality is also reflected in the arrangements for the costs involved: only in 25 % of all cases some sharing of costs is involved, and in three-quarters of all cases each party is responsible for his own expenses. This signifies also the fact that in very few cases, manufacturers want to have exclusive rights of the product or process under development; if so, only for a limited period of time. However, this does not mean that the supplier does not get paid for his development efforts: usually, he expenses these in the piece-price of the product.

Also for each of the 9 focal suppliers, the five customer relationships discussed are not a representative sample of their customer base: especially the findings on the intensity of technological collaboration with customers from this sample cannot be extrapolated to their customer relationships in general. However, the sample provides us with a picture of a substantial part of the suppliers' customer base: on average, the five customers together account for some 28 percent of the suppliers' total turnover (ranging, however, from 1 to 94 to %), with individual customer shares ranging from close to nothing to 36 percent.

Because of the explicit focus on relationships involving technological collaboration, it should not be surprising that in just over 50 % of the customer relationships (21/40) the two parties have collaborated in product development, in one case in process development and in 10 cases even in both. Eight customer relationships have not involved any form of technological collaboration, which is clearly more

Appendix D

than for the supplier relationships. Apart from specific collaboration projects, customers are considered to be involved in the technical development of the products concerned in more than 75 % of all relationships; in 25 % even on a very active or dominating level. Two-thirds of the 32 relationships that have seen some form of technological collaboration are characterised by continuous co-operation, either with major resources (7) or only limited resources (15) invested. Additionally, 6 of them involve one major project at that time and one only a small project. Three relationships show no particular ongoing efforts at that moment. On average, the co-operation involves some 18 working months, with a maximum of 120. Although it should be noted that on this issue we have only figures for 21 of the 32 collaborative relationships, it seems that for suppliers, technological collaboration takes (on average more than four times) more resources in terms of time spent than for customers. This is not so surprising, however, because technological collaboration will usually concern a topic in which the supplier is considered to be more specialised or knowledgeable than the customer. It should be taken into account, however, that especially the suppliers have no reason to *underestimate* their efforts, rather the opposite.

In two-thirds of all cases, the collaboration has intensified during the last 5 years, and in only 3 cases it has become less intensive. This follows the pattern for supplier relationships. In the majority of relationships, the collaboration has been initiated by both parties together (22), and only in four cases this has been done by the supplier; in six cases the customer initiated the collaboration. This is a rather different picture than we got from manufacturers, who found themselves most active in initiating collaboration: suppliers see the start-up much more as a joint effort. This difference in opinion is also clear in discussing the levels of activity: after the collaboration has started, both parties are equally active in one-third of the relationships (12), but the focal supplier being the most active also in a similar number relations (11) and the customer in 9 relations. Regarding the formal organisation of the collaboration, there is no contract or agreement whatsoever in two-thirds cases, and there are specific contracts for particular projects (like non-disclosure agreements) in 10 cases. In no case, there are more strategic, long-term agreements. Again, this low degree of formality is reflected in the arrangements for the costs involved: only in five cases some sharing of costs is involved, and in more than 80 % of all cases each party is responsible for his own expenses.

In the remainder of this Appendix, each of the focal companies is described, including the customer or supplier relationships that have been covered in the interviews in addition to the focal relationship covered in the main text (Chapter 5).

D.4 Truck Industry

D.4.1 Scania

Scania produces trucks, buses, and industrial- and marine engines. Trucks form by far the most important business area, accounting for roughly 70 percent of total turnover. Scania is the fifth largest manufacturer of trucks in the world, and the third in Europe, with a 1994 marketshare of around 13 %. In that year, Scania had a turnover of NLG 6 billion (31,800 trucks: 8,700 more than in 1993). Investments in product development average about NLG 175 million per year; amounting to 3 percent of turnover. Three aspects of Scania's truck manufacturing are worth noting: it has a high degree of specialisation (no vehicles under GVW 16 tonnes), it has a relatively high degree of vertical integration, and it has a highly modularised production system. Scania is the only manufacturer that has concentrated itself exclusively on the segment of heavy trucks. It is difficult to achieve standardisation of parts and components between the segments of light and heavy trucks. Not being specialised in one of the two segments entails relatively high costs both in production and keeping stocks. The high degree of vertical integration

is another distinct feature. In the 1950's, systematical make-or-buy analyses led to outsourcing of many simple standard parts. But in the 1960's, the decision was made that the strategic main parts, being motors, gearboxes, cabs, chassis and axles, should be produced in-house (Jaktlund & Halvarsson, 1992: 62). The risk of a high degree of vertical integration is, naturally, that production series become too small compared to a specialised supplier, with an adverse effect on economies of scale. More than other manufacturers, Scania has managed to get around this disadvantage by 'modularisation'. The modularised production system was developed in the 1940's with the aim of reaping scale benefits in research & development, production and distribution through extensive standardisation. Today, Scania uses in total about 20,000 different components, less than most competitors. That Scania is a highly vertically integrated truck manufacturer is illustrated by the fact that the share of purchasing costs in turnover is relatively low; 40 percent. In total, Scania has some 800 suppliers, a number which has increased slightly the past five years. Fifty percent of all purchased goods are Scania design, the rest is designed by suppliers. Most of Scania's suppliers are located in Germany, where 1/3 of all purchases come from; another one-third comes from Sweden. The supply policy is that, where possible, there should be at least two suppliers for a particular item. But in some cases this is not feasible, like in the case of fuel injection pumps. One problem with single sourcing, in Scania's opinion, can be that there is less incentive for innovation.

While the purchasing organisation had been basically the same for a couple of decades, it has gone through different changes the past few years. Previously, the purchasing department (Materials, Purchasing and Planning) consisted of some 175 people, headed by a director that was also member of the Executive Management. It was made up of 5 groups; two production material purchasing groups, and one each for quality issues, production equipment and supplies, and planning & transport. One production material group was responsible for chassis components and sheet metal, plastic and rubber parts, and the other for driveline/powertrain components, and forged, cast and machined metal parts. From the beginning of 1997, the purchasing department as such will disappear and be integrated in the production organisation, and the two production material groups will now be directly reporting to their production sector manager for Chassis & Cabs and Powertrain respectively. A new technical support department, Industrial Development (TX), will bring together units that work with supplier development and other purchasing related policies. The whole purchasing organisation will now consist of 75 people, instead of 175 as before. A similar reorganisation has been carried out at Volvo Trucks in the middle of 1996.

In an attempt to get a better insight into Scania's supplier relationships, we have reviewed - apart from the focal relation with Valeo - the relations with four important suppliers: one supplier for seats, one for electrical harnesses, one for brake valves and related components, and one for steering gear. The relation with the supplier of seats, which is an important but not a single supplier, is over 15 years old. The seats are either adapted for several truck manufacturers, or only for Scania (less than 50 %). The supplier's seats are popular: in some countries, customers ask especially for those seats. By using these seats in its trucks, Scania manages to attract more customers, but it does not market the seat as something special for Scania, since the supplier's nationality may negatively affect sales in other countries. Scania has been collaborating with the supplier in product development, recently in a major project taking place in the context of the development of a new truck model. Although there were high expectations regarding this project, it turned out to be not so successful. The supplier did not always produce useful and economical designs, and the responsible purchaser had too little experience to steer the supplier effectively. The co-operation is highly formalised, with long term agreements, but each party is responsible for his own costs.

The relations with the supplier of electric harnesses (cable-assemblies) is also some 15 years old. The products range from single cables to packages of 100 wires, mostly especially adapted for Scania. The purchasing volume has grown the last 5 years, again due to Scania's growth and a shift away from other suppliers; it currently supplies one-third of Scania's need for electrical harnesses. Many of the supplier's sub-suppliers affect the relationship with Scania, as the latter has told the supplier to buy from specific

sub-suppliers that it had been co-developing, for example, special connectors with. Scania has been co-operating with the supplier both in process and product development, and a major project has been going on within the context of the development of a new truck model, further perfecting the method of so-called 'sequential deliveries'. This means that the supplier is no longer delivering cables and harnesses in batches of identical parts, but in boxes that contain all the necessary different cables for a specific chassis number instead. The development collaboration usually regards standardisation and assembly matters, not the materials for the cables. There is no formalisation whatsoever.

Also the relation with the supplier of large and small brake valves, software and electronic control boxes has existed for over 15 years. Some products are customised, some are standard: Scania tries to buy standard products as much as possible. The supplier delivers to all truck manufacturers, and Scania is one of their several large customers. Volume has increased strongly, again due to Scania's growth and a shift away from other suppliers. Minor co-operation projects regarding product development are taking place continuously. Just as for the co-operation with the seats and cables suppliers, Scania has initiated the collaboration. The benefits are mainly lower costs both for the product itself and its assembly for Scania and, as there is no exclusivity clause, increased sales for the supplier.

The relation with the supplier of steering gear dates back to 1945. Again, some products are customer adapted, some are standard: Scania tries to buy standard products, but that is not always possible. Of the total need of steering gear, Scania buys 60 percent from this supplier and the remaining 40 percent from another foreign supplier. Co-operation in product development (relatively unchanged, no current project), resulting in lower assembly costs for Scania and increased sales for the supplier (no exclusivity).

D.4.2 DAF Trucks

DAF Trucks is one of the medium-sized truck producers in Europe, with headquarters and most production in Eindhoven (NL); axles and cabs are produced in a plant in nearby Westerlo (Belgium). In 1995, DAF produced roughly 22,000 trucks, and turnover amounted to roughly 2.9 billion NLG. Turnover had grown strongly compared to 1994, and was expected to grow also the following year; a remarkable come-back after its bankruptcy in early 1993. Purchasing volume amounts to 75 % of turnover. This share is relatively high in this industry, partly because DAF has totally outsourced the production of smaller trucks. DAF has some 650 suppliers in total, of which the ten biggest suppliers account for 50 percent of total purchasing volume. Let us consider, besides the focal relation with Bosch, relations with four other different suppliers (all fictional names): one that is a supplier of DAF-designed parts (Balco), two that are suppliers of relatively simple components (K&M and Bischof), and one of complex components (Saitzinger). Together with Bosch, the suppliers discussed below account for roughly 20 percent of the total purchasing package. Some of these suppliers are major international companies, producing high-tech components, and with a turnover several times as large as DAF. Others are smaller, mainly national companies that produce relatively simple products.

Balco has been a supplier of metal cast parts to DAF since the 1960s. The cast products are all mono-parts, like cross-beams, differential and pignon housings, brake props, and a lot of small parts. All items are DAF-design (100% customised), and DAF owns the tooling equipment (casting pattern). Increasingly, DAF buys completely finished parts: no further machining (like drilling, or milling) is necessary. DAF takes a rather large share of Balco's total turnover, while it has around ten suppliers of cast iron products, with Balco supplying more than 50 % of DAF's total need. For each single article, however, DAF has single sourcing. Approximately 20 people from DAF have frequent contacts with Balco; this figure is rather high because Balco supplies to both two DAF plants. Among these 20 are some 10 engineers from the development department. At most technical meetings, Purchasing is also present. Balco has a strong reputation in so-called 'nodular' cast iron, which is primarily suited for heavy duty performance. For the development of this type of casting material, and especially in developing and mastering the production techniques involved, Balco has collaborated closely with, and benefited from the assistance of

DAF's laboratory and engineering department. For Balco, DAF is an important customer: it is one of the biggest Dutch industrial companies, with a large expertise in the field of cast iron products that form an important part of the total truck.

K&M is a supplier of (blade) suspensions and stabilisers, which are both forged metal products. DAF buys some 20 different types of suspension-packages, and a similar number of stabilisers, and accounts for less than 10 % of the company's total turnover. The total package of stabilisers and suspension per truck has a value of less than one percent of the total costs of producing a truck. In essence, these suspensions and stabilisers are standard products, but the actual dimensions are specific for DAF. These dimensions are mostly decided by the responsible engineer or designer. Currently, DAF is trying to increase the standardisation of the suspensions it buys. DAF is very committed to K&M, since it is single supplier of suspensions and stabilisers. Because of this commitment, K&M regards DAF as a very important customer.

Before 1990, the truck producer still had four suppliers for these kinds of products, and apart from the aim to reduce stocks, the improved possibilities for technological co-operation were a major reason to reduce this number of suppliers to just one. With K&M, there are frequent discussions on the use of new, alternative materials, possibilities for weight reduction, and other types of metals. Regarding technical problems, DAF thinks it is fruitful to have these discussions with both K&M and its steel supplier involved, as it is easier to trace the root of particular problems: the raw material, the manufacturing of the component, or the final construction/assembly. In principle, DAF is prepared to pay for some of K&M's development costs, if it relates to a customer-specific development. However, unlike in the case of cast metal products, the tooling for forging products like these is usually owned by the supplier. K&M seems a rather important collaboration partner for DAF because of the type of products it supplies (suspensions and stabilisers are key parts) despite its relatively low share in the cost of the total product, the intensive technical co-operation that takes place, and its position of single supplier. In turn, DAF is a medium-sized customer to K&M, but due to the technical co-operation and its dedication to K&M, it could be a relatively important customer.

Bischof is a small producer of drive shafts. The total package DAF buys consists of 500 different part numbers, and amounts to tens of millions NLG. Bischof has been a supplier to DAF since 1993: until then, DAF had been buying 100 % of its need for shafts from another supplier. A part of the volume was switched to Bischof because DAF did not want to become too dependent on that supplier. Compared to the other suppliers, technical co-operation with Bischof is limited: from DAF side only 6 people have frequent contacts with Bischof, of which just one or two engineers. This could be due to the fact that it is only a few years old.

Saitzinger is a manufacturer of transmissions, axles, and steering shafts and controls for trucks, cars and utility vehicles. DAF mainly buys transmissions from Saitzinger; a standard product with some special DAF features. Total purchasing volume amounts to roughly 200-300 million NLG; a transmission represents a few percent of the total production costs of a truck. Saitzinger is a very large company: DAF is responsible for around 10 percent of the total turnover of the division for truck transmissions, which alone employs already more people than entire DAF Trucks. Saitzinger has been a supplier to DAF since the start of the latter in the 1930s, and has always been responsible for the bulk of its need for transmissions. The transmissions as Saitzinger delivers them are basically a standard product, but have specific DAF features. DAF is trying to co-operate with Saitzinger, together with two other truck manufacturers, to develop a range of standardised transmissions. The other two customers are somewhat reluctant, and it is a very difficult process since it relies on the co-operation of (often) strong-headed development engineers. Just like the fuel-injection system, the transmission does not give its trucks a particular competitive edge, and therefore DAF does not need the exclusive right to certain technical developments. Nevertheless, not every truck manufacturer buys its (manual) transmissions externally as some manufacture their own transmissions. Generally speaking, DAF works more closely with this supplier in technical development than most other customers. From time to time, DAF feels like

some of its competitors are having a 'free lunch'. Still, its knowledge of the technologies involved in transmissions seems to be less extensive than in the case of injection-systems. It seems therefore unlikely that the co-operation is just as intensive as with Bosch.

D.4.3 Valeo

Valeo Engine Cooling is manufacturing oil coolers for trucks, industrial vehicles and marine engines. Established 100 years ago, it became part of the Valeo group in 1989, which is an independent French automotive components manufacturer for both the car and the truck industry. It employs 28,000 people, totalled 8 billion NLG in sales in 1994, and comprises 84 plants, R&D and technical centres in 18 countries around the world. Valeo is organised into 10 business segments; the Engine Cooling segment is the biggest (nearly 20 % of turnover), and manufactures radiators, condensers, oil coolers, charge air coolers, electric fan/motor systems, and engine cooling modules. The plant in Linköping that manufactures plate oil coolers, tube & shell oil coolers, charge air coolers, and fresh water coolers. In total, Valeo Linköping (1994 turnover between 25 and 50 million NLG and 150 employees) manufactures some 185,000 coolers. Some production series are quite large, for example, the oil coolers for current truck models. Other series are small, for example, special oil coolers for customers that produce forklift trucks, or spare part series. It has the only R&D centre in the business segment that is working on oil coolers.

The company has a limited number of large customers, mainly within Sweden and/or truck manufacturers. Other customers include marine engine and forklift producers. The R&D department has two kinds of engineers: P1 (design) engineers, who are working for identified customers, and P2 (development) engineers that work on off-the-shelf innovations. Linköping has three design engineers and one development engineer. The development teams are cross-functional, consisting of a design or development engineer, and people from manufacturing, purchasing, sales and quality assurance. Usually, the team consists of 5-6 people, but sometimes also a supplier, or a shopfloor operator sits on the team (customers never). The project leaders report monthly to a group consisting of the managing director and all the functional managers. One of the main technical developments is the shift from tube & shell coolers to plate oil coolers, which has been taking place the last decade or so. The increasing environmental demands lead to a further optimisation of the plate oil coolers.

Two of the four customers that have been discussed, besides Scania, are also truck manufacturers, the other two make respectively marine engines and heavy construction vehicles. The first truck producer buys a minor part of his need for oil coolers from one other competitor, and its current purchasing volume is roughly two-thirds of the volume Scania buys. Technical collaboration has focused, just as in the case of Scania, on new products. The other truck producer is a rather new customer, and started when Valeo managed to break into its supplier base on the basis of price and quality. The customer does not own the tooling, and Valeo is allowed to sell the product in the aftermarket. The relationship provides Valeo with an interesting potential market at the customer's sister divisions (marine engines). As this is the youngest relation, it provides the biggest potential. The marine engine producer buys small series compared to the truck customers, and purchasing volume is slightly below that of the first truck producer. It has also a smaller second source. The order-delivery time is longer than for the others because of more complicated components. Technical co-operation has focused at decreasing the large variety of coolers that the customer used to buy. Technical co-operation with the fourth customer, a producer of special construction vehicles, has produced a special transmission cooler that is built into the axle housing. It is the explicit aim of Valeo to intensify the technical co-operation with these important customers.

D.4.4 Bosch

Robert Bosch consists of 4 business sectors - Automotive Equipment, Communications Technology, Consumer Goods, and Capital Goods - with a total turnover of around DM 34.5 billion. Nearly 45 % of

sales take place in Germany, and the rest of Europe accounts for 34 %. The automotive area accounts for more than 50 % of total turnover (Bosch is the world's largest independent manufacturer of automotive components) and consists of 10 divisions, the biggest of which is the division for fuel-injection systems for diesel engines (K5) with 10 % of the group's total turnover. Bosch has a high market share in injection systems (70 % in the trucks segment over 6 tons GVW). Product development is mainly carried out and co-ordinated centrally in Stuttgart, but increasingly carried out in other countries as well, like the US and India. Real fundamental research is carried out at the Group's headquarters. Diesel engines rate as the most efficient combustion engines. It is a compression-ignition engine, and because it only draws in air, it is able to compress this to a level which is considerably higher than that in the spark-ignition engine using an air-fuel mixture. Any further reduction of fuel consumption and exhaust-gas emissions is dependent on accurate start-of-injection timing, precision-manufactured injection nozzles, fuel-injection pumps with precise fuel metering, modified combustion chambers, precisely-defined fuel-spray geometry, and further increases in injection pressure. These are exactly the areas Bosch is working on in its product development. Injection systems mainly have interfaces with the pistons and the turbocharger. Together, these three elements are key components in determining the performance of the truck-engine. Therefore, Bosch has frequent contacts with piston producers like Kolbenschmidt and Mahle (D), or a UK producer of turbochargers.

The contacts with the various customers differ to a large extent. Contacts with DAF Trucks, for example, take place directly between Stuttgart and DAF. Normally a sales-subsidiary in the country concerned takes care of most direct contacts with the customer, especially when it concerns large customers. This is the case with, for example, Swedish customers like Volvo and Scania, and in the US. In the case of DAF, the distance is not too far, and DAF had a specific wish to directly deal with Stuttgart. Also with smaller customers, Bosch chooses to have direct contacts between Stuttgart and the customer. The disadvantage of direct customer contacts is that it is much more intensive, Stuttgart gets all the problems, and usually local sales subsidiaries have a cultural/language advantage. The good thing about direct customer contacts is that Stuttgart gets more information, and quicker.

We have taken a look at four main customers besides DAF Trucks, all trucks manufacturers: one each from Sweden and France, and two from Germany. The products sold to the different customers are all unique in the sense that the Bosch order numbers are customer specific: no product is bought by more than one customer. However, the basic product/solution is the same; there are only modularised options, and certain fine-tuning that are really customer-specific. Similarly, the quality level is the same for each customer. Most of these customers, except DAF and one of the Germans, buy from Bosch's competitors too, like Lucas (UK), Stanadyne (US) or Nippondenso (J). The share that Bosch will supply of the customer's total need for injection systems are usually discussed at the end of the contract period. Usually, a customer will only use one 'brand' of injection system per engine type; only the Swedish customer is using both Bosch and Lucas systems on one and the same engine. This meant that both Lucas and Bosch had to make compromises in the development of those systems. In general, the customers' customers have no special demands on the injection systems supplied by Bosch, although in the case of DAF there has been a farm equipment customer that had some special demands, and something similar happened once in the case of the Swedish customer. In no case, however, has Bosch had direct contacts with these final users. Joint development with customers can be divided into continuous co-operation in improving existing models, and specific projects that usually take place in connection with the development of a new engine at the customer. All joint development is focused on the product: process development is not so relevant, as the assembly of the injection systems onto the engine is quite simple.

Technical feedback from small customers like DAF is usually faster, but the difference is not so big with regard to the quality of the feedback. In deciding which customer to work with, feedback is not the only criterion however. Economical benefits, and, logically, the willingness of customers to embark on a joint development project are perhaps more important. Bosch will never sign exclusivity contracts with

customers regarding certain models. Bosch has no favourite 'pilot customer', this differs from time to time. Although Mercedes Benz is by far the biggest customer, it is not always the pilot customer. Sometimes small customers manage to be up-front in development, like in the case of a rather new injection system where DAF has been one of the first to use it. Big customers, however, have more resources, and are therefore able to test different systems, whereas smaller customers really have to focus their development efforts. All of the five customers concerned have more or less the same amount of knowledge of injection systems, but the bigger ones have it across a wider variety of systems. In total, some 20-30 development projects are going on with the Swedish customer. The same number applies to the French customer, 2-3 of which are big projects, and one of the German customers. For the other German customer, the corresponding figure is around 15. In terms of time spend on engineering and development, the figure is around 45-50 months in the case of the Swedish, the French and the large German customer, and 35-40 for the smaller German. These figures are clearly higher than in the case of DAF: 3 projects and 33 engineering months.

For each of the large customers, Bosch has on average two team meetings per year internally, to co-ordinate all efforts, except for DAF because of the limited number of people involved. Apart from these customer-teams, there are also 'cross-customer' meetings within K5 to benefit from possible synergies between customer-specific projects. In general, the customer is leading: they have to decide which way to go, Bosch does not want to push them. Only when the customer has no specific ideas, Bosch will help with advice, but usually they have a fairly substantial knowledge about injection systems. Of course, there have been mistakes on both sides which way to go, but these can be corrected. Joint technical development with customers for Bosch is mainly just a means of getting/keeping business with that customer. For the customer, injection systems are a key engine components, and joint development might therefore increase the quality of their engine and their truck: but since Bosch has such a large marketshare, and does not grant its customers exclusivity for certain injection systems models, having a Bosch injection system in one's truck is never a unique selling point.

Product development is more and more targeted on the electronics surrounding the injection system, and the software that is used in it; mechanical issues are becoming less important. This is especially triggered by stricter environmental legislation. The growing importance of electronics and software has also lead to the increased use of development contracts. This is because it is much more difficult now to estimate development costs, and the possible damages of non-functioning parts have become bigger. Finally, the customer needs to share a lot of data with Bosch, which has to be put into the software system as parameters. This information is very easy to exchange, and therefore confidentiality has become a much bigger issue. There are differences between the customers in this respect too; DAF is for example less formal than the German customers. With regard to development costs: only specially developed proto-types are charged for, mechanical engineering and development is included in the product price. Software/electronics development costs are so high that these are paid up-front; a pre-calculation is made, but final payment is based on real costs. Basic assistance in engineering/development/application is not charged for.

D.5 Telecommunication hardware

D.5.1 Ericsson Radio Systems AB, Cellular Systems American Standards (RMOA)

Ericsson Radio Communications (BR) is one of the five business areas of Telefonaktiebolaget LM Ericsson². It is the largest business area, with 40 % of total sales and one-quarter of the total workforce of 69.000 people, of which 30.000 are located in Sweden (1994 figures). Headquarters of BR are in

²As of 1 January 1997, Ericsson has been reorganised into three major business segments. The organisation described here refers to the situation in the previous years.

Kista/Stockholm, where also the major company within the business area, Ericsson Radio Systems AB (ERA) is located. ERA, which develops and manufactures base stations for mobile communications systems, consists of three business units that each produces stations according to different standards, aimed at different markets: RMOJ (Japan), RMOG (GSM and NMT systems, mainly Europe), and RMOA (systems for North America, Asia and Oceania). RMOG is by far the biggest unit, and RMOJ the smallest. The headquarters of RMOA are in Kista, employing some 600 people. Base stations, simply stated, convert radio signals from the mobile communication net to signals that can be transmitted through the 'normal' telecommunication network and vice-versa. As a product, base stations are around 15 years old: competitors to RMOA are Motorola, Nokia, AT&T and to some extent RMOG (competing standard). Each base station is built of a number of transceiver units; 10-15 on average, but it depends on the number of subscribers in that area. In total, RMOA makes some 150.000 of these units per year. Currently, purchases account for some 85 % of the production costs of a base station, which has increased from 60-70 percent several years ago. Roughly one-third of all purchases come from internal Ericsson suppliers. The purchasing department is very much involved in the technical development at RMOA. However, there is no standard plan or schedule for the department when to do what in the development process, as "no two projects are alike". Sometimes, purchasing is not at all involved in the product development process, mainly when it regards internal Ericsson suppliers like Ericsson Components or other Ericsson Radio units. In those cases, the commercial conditions have already been established before. In the case of external suppliers, purchasing is always involved in the discussions that take place around the development project. It should be noted, however, that only a few of the really important components of a base station are bought externally. Most of the components (some 80 %) that go into the base station are standard. This is a conscious strategy, in order to reduce costs and supply risks. However, the costs of standard components account for less than 25 % of the total costs: the specially adapted components are relatively very expensive.

Five important suppliers that supply specially adapted components are: GEC Plessey (applications specific integrated circuits, ASIC's), Ericsson Components (Radio Frequency power components; see 3.4.2), Ericsson Telecom (cabinets), Texas Instruments (digital signal processors), and Åges (aluminium castings). Only in the case of Texas Instruments, it regards a product that - in the near future - could be sold to other customers as well, as the two parties to standardise the design of these so-called DSP's (which are actually a kind of mathematical processors). Texas Instruments (Semiconductors division) and Ericsson have a partnership agreement signed at the highest corporate levels. Only Plessey and TI supply to competitors of RMOA. Telecom and RMOA together developed the modular cabinet system, which can be used both for the normal fixed telephone switching systems and the base stations. Earlier, Ericsson Radio used to produce this and other mechanical products itself.

Plessey, Ericsson Telecom and Texas Instruments are single source for these specific products. In the case of Plessey, this is because the development costs of Application Specific Integrated Circuits are very high, which makes it unattractive to have several suppliers as that will increase the development costs per circuit. In the case of Ericsson Telecom, however, RMOA feels it becomes too dependent and is aiming to attract a new supplier, in the US (for logistical reasons). Actually, this applies to Plessey as well, and RMOA is looking for another possible co-operation partner when it comes to new ASIC's: already, it buys 6 or 7 different ASIC's from Plessey. Similarly, RMOA wants to decrease the share of the total need for aluminium castings that Åges is supplying. RMOA pays all the development costs Plessey makes for the ASIC's, and this applies also to Ericsson Components and Åges. Components probably adds a percentage to the product cost too. In the case of Ericsson Telecom, the development costs are shared. RMOA is willing to pay these costs as it is (on the Radio level) a big customer for these cabinets, and because it wants to own the design of the component. It also wants to keep the piece price as 'clean' as possible.

D.5.2 Ericsson Radio Systems AB, Printed Circuit Board Factory

Nearly all the PCB's bought by Kumla physically pass through Kumla, only some go directly from the external supplier to the internal customer, as in the case of an American supplier that supplies to the Lynchburg base station facilities. The customers see the deliveries from Kumla often as 'ship to line' deliveries. Some Ericsson customers have their assembly being done by a subcontractor; in that case that subcontractor buys the PCB's together with Kumla. Kumla has cross-functional teams working for each business area of the BR division, more or less competing with each other on lead-time and the like. Each team consists of one purchaser, 1 quality controller, marketing, 2 engineers, and a half-time planner. At the purchasing department in Kumla, there are three purchasers each with its own group of suppliers. For each specific PCB type, Kumla has just one or two suppliers if it concerns a small volume, and 2 in the case of large volumes with 2-3 back-up suppliers running similar products. In the case of the large-volume telephone PCB's, there are 6-7 suppliers for approximately 10 different types of boards.

Within Ericsson, there is a co-ordination group for the procurement of PCB's. This group maintains a so-called LOPPS; List of Preferred PCB Suppliers. This list distinguishes different rating levels, from not-approved to fully certified (no incoming inspection). As suppliers can deliver different kinds of PCB's, the rating is done for each product. The LOPPS list contains also information on Ericsson's part of the supplier's total turnover (at the level of Kumla, the business area, and the whole of Ericsson). The LOPPS list does not only apply to the business area BR, but to the whole of Ericsson. All Ericsson companies should thus only buy from LOPPS suppliers. Closely related to the LOPPS list, Purchasing uses a vendor rating system that includes 18 criteria, of which especially 'Profits' and 'Education' are noteworthy. Ericsson prefers to have profitable suppliers, so if the profitability of the supplier is above 10 %, the supplier gets additional points. Although in first instance it may seem contradictory that a customer wants its supplier to be highly profitable, this can be explained by noting the importance of investments and continuity. Regarding the criterion of education; Ericsson has an internal goal of 4,5 % of working time being spent on training: if the supplier spends more than 3 % he gets the maximum 5 points.

For this manufacturer, only the focal supplier relationship with Cityprint could be discussed completely.

D.5.3 Ericsson Components

Ericsson Components is the one but smallest business area of Ericsson, with 1995 sales of NLG 1.9 billion and 5,500 employees, 1500 of which in Kista (on a total of NLG 24.5 billion and 85,000 respectively; all 1995 figures). Ericsson Components supplies materials and components to other Ericsson business areas, but also to external customers (OEM's and distributors). The operations are organised in four divisions: cables, energy systems (like DC power systems for powering, cooling and controlling telecom systems), microelectronics and distribution. The microelectronics division, the smallest, employs about 1300 people, and has a turnover between 250 and 500 million NLG. It is organised into 2 groups of profit-responsible business centres that are roughly equal in size; a group of three business centres that work with 'Radio Frequency' components, and a group of four business centres that work on 'Access' components (like optomodules and interfaces for switches). The first group's main internal customer is Ericsson Radio (mobile telephony); the second group's main internal customer is Ericsson Telecom (public networks). Apart from this, the microelectronics division provides Ericsson companies with techniques and methods for design of microcircuits. Focusing on the Radio Frequency (RF) business centres, each of them is responsible for one product family: RF integrated circuitry (mainly for handheld mobile phones), ASIC's, and RF power transistors. In the case of RF power transistors, the majority of sales goes to Ericsson Radio and the rest are external sales, to OEM's like Motorola, Siemens, Alcatel, and to distributors. Production lies around a few million pieces per year. Some of the products are standard, some of them are specials/customised. Production series run from 1 to 200 thousand a year. Components has two silicon plants in Sweden, and there is one assembly plant in California. Development takes place in the US too; currently only 5 people of the business centre work in Kista, and 100 in California.

Within the microelectronics division there is some sort of matrix organisation. Horizontally, there are the business centres that are primarily focused on product management, and which are profit responsible. Vertically, cutting through the different business centres, one finds the functions like HRM, Sales and Strategic Product Management, in order to have synergies between the different business centres. Strategic Product Management (SPM) is something like a R&D function; identifying the needs of customers for the years to come as opposed to the business centres that are more focused on the needs of today. The matrix organisation is especially relevant in creating one 'face' towards customers, which may differ for different products from different business centres.

Most product development in RF power transistors is related to the hardware, and especially how the silicon is processed. Developing a new process takes roughly 18 months (and is mainly done in Sweden), but when it is in place it is relatively simple to develop new transistors (in the form of a new silicon package, or a new layout); it might take something like 3 weeks of engineering effort. All development costs are put into the product price. For this supplier, only the relationship with the focal customer could be reviewed.

D.5.4 Cityprint

Cityprint is a producer of printed circuit boards, especially in PTFE (teflon). Turnover is around 30 million NLG, and the company has 140 employees. Cityprint only manufactures boards, it does not put components onto the board. PTFE is a strongly growing market, with for the moment only 4-5 competitors world-wide. All these competitors are primarily focused on small series, and have come from military applications; Cityprint is the only volume producer.

Cityprint has a quite strong separation between Sales and Production. Sales is the 'bottleneck' for all contacts between technicians and customers, because Sales is formally (even legally) the only customer of Production. Sales is nearly always the only customer interface. This has been done a.o. to avoid uncontrollable price discounts promised by technicians. Within Sales, there are now some technicians that take care of drawings, customer complaints etc. The other sales people take care of the commercial and more simple technical issues.

All the five customer relations that we have analysed are relatively new; Ericsson and Nokia are the oldest customers, dating from 1989. To all five customers, Cityprint is increasingly giving advice regarding dimensioning, materials, and processes/finishing (that the PCBs go through at the customer). Sometimes, a perfectly good PCB still shows problems in the assembly process: Cityprint then visits the customer, to find out how the assembly-yield can be improved. Cityprint has some quality managers that come from assembly companies. It should be stressed that Cityprint does not discuss the actual layout of the PCB with the customer, because it does not know the technical details of the function of the PCB in the customer's product. In this market, technical information is highly confidential, and it is 'not done' to talk to customers about what the other competitors are doing. Contracts with these customers last one year, specify types and numbers of PCBs to be delivered, but no explicit share of total need at the customer.

Nokia and Combitech are the customers that are most frequently visited by technicians; Ericsson and Continental buy more simple products, and Space is still at the stage where the contacts run only through sales. Except for Space, deliveries take place daily by airfreight. Delivery accuracy is very important for Continental and Combitech, because both of them have outsourced their assembly activities, so there is little flexibility. Ericsson and Nokia have large buffer stocks. All products for these customers are packaged according to a standard method (with some adaptations in the case of Space), but every customer can make specific demands, especially in the case of small series/specials.

Continental Microwave buys different types of PTFE PCBs for consumer satellite dishes. Relatively simple product; unit price is the lowest among these five customers (set this level at 100). Frequent product modifications, and therefore little stocks. Continental places heavy emphasis on cost reductions.

Cityprint has been giving advice mainly with regard to the size of the boards delivered to Continental; that is where the cost reduction opportunities are in this case. Cityprint is single supplier.

Nokia buys PTFE PCBs used in mobile telephone base stations. Unit price level: 150. Batch-size from 100's to 1,000's. Nokia used to purchase only locally, but when it increased its sales it started looking for another supplier. The same applies to Ericsson Radio, and Combitech. Both Nokia and Ericsson place strong emphasis on the size of PCBs and production yield. Cityprint has been giving advice regarding size of the boards, and finishing processes. Cityprint is expecting to get some spin-off from this co-operation, in the area of finishing and special 'masks' (equipment used in the production of PCB's).

Saab Combitech buys PTFE PCBs for 'transponders': radio devices in cars as part of traffic management systems. Two-three different types, based on quality and national standards. This relatively new application promises to be a world-wide market, and production will start in 1996. Unit-price level: 110. For Combitech, price is an important issue. Cityprint has been giving advice on dimensions and finishing, with the aim of lower costs/price. Even before Cityprint came in, Combitech has been using one additional, UK supplier.

Saab-Ericsson Space buys a special, new PTFE, used in spacecraft/equipment. Very small batches; very special applications (a.o. metal backings of the PCB). Price unimportant; unit-price level 200-1,000. Space places most emphasis on the functionality of the product. It uses two additional suppliers. This is still a very young relation - Cityprint has got two orders of test-boards until now - and Cityprint is largely doing what the customer is asking them to do. Space did not want to use nickel under the chemical-gold finishing, but Cityprint suggested to do it anyway. Sales has only visited Space once. Cityprint expects spin-off regarding the application of metal backings.

For all five customers, Cityprint has no special expectations regarding important new technical developments, except some expectations in the case of Space.

D.6 Plastics components

D.6.1 Perstorp Components AB

Perstorp, through a series of take-overs and mergers, has become a very diversified group. With total turnover around NLG 3.2 billion, it comprises 8 different business units. The business unit Components³, which represents 18 % of turnover, making it one of the three largest business units, produces noise control components and interior trim for the automotive industry. Components consists of three regional business units: North America, Europe, and Developing Countries. Perstorp Components Europe consists of companies in Great Britain, Germany, France, Spain and Sweden; Perstorp Components AB, with four plants in Sweden (Åmotfors, Högsäter, Skara and Gothenburg/Västra Frölunda), and one in Gent (Bel). Perstorp Components AB's customers include Volvo Car, Saab Automobile, Volvo Trucks, Scania Trucks, NedCar, and some French customers.

Purchases of production materials equal around 50 % of turnover including internal sales. This is excluding production equipment and moulding dies. Basic chemicals are the most important production materials bought, amounting to roughly 85 % of purchasing value. More than two-thirds of all purchases comes from non-Scandinavian Europe. Total number of direct material suppliers is around 300, around 60 of which account for 50 % of total purchasing volume. The purchasing department in Gothenburg only takes care of the negotiations and contracts, after when the different factories are responsible for the call-offs and logistical co-ordination: they also get the customer call-offs directly at the factory. Due to each plant's specialised product range, the purchases for every factory differ. Perstorp has some 30 engineers working in application development, and 5 engineers that work with basic research. There are plans to expand the basic research part, but this requires substantial resources, which is quite difficult in the

³ In 1996, Perstorp Components has been sold to Collins & Aikman. Since the facts and events described refer to the period before that, the name Perstorp is still used here.

current situation. Product development can be initiated in two different ways; either Perstorp is involved by a customer in the development process of a new car model, or Perstorp takes the initiative and makes proposals to its customers to replace older products. Customers are placing most emphasis on cost reduction, and then on weight reduction and environmental issues.

The product development 'liberty' of Perstorp is mainly limited to the design of the back side of the interior panels (aiming at low production costs, and easy assembly) as the design of the front is given. Even regarding the use of material that is not visible for the car passengers, final customers have some demands regarding burning properties and other technical aspects, but Perstorp does not have to use a specifically approved supplier for those materials. Product innovations initiated by Perstorp itself can take much longer time than a joint project with a car manufacturer. In the case of ESM, Expanding Seaming Material (a kind of foam that is injected at some places in the car body), the development took some 5-7 years before it was accepted in the market: this is even a rather fast innovation, as the automotive industry is rather conservative. Another complicating factor is that Perstorp does not want to be the only acoustic component producer using a certain technique or application: when customers see that a particular product cannot be supplied by two or more suppliers, but just by one, they will not buy the product. For Perstorp, it is therefore sometimes necessary to give production licenses to competitors. Finally, different customers have different ideas regarding the technical solutions for certain functions in the car - also with respect to Perstorp's products. The truck industry is a somewhat different customer than the car industry: a broader variety of products, bigger sizes and smaller series. Perstorp has not been spending a lot of effort on this segment, also because it takes some special resources. However, as the luxury level of trucks is growing, the similarities with the car industry are increasing too, so maybe it will become a more important customer segment in the future.

Apart from ICI, the selected suppliers are a German supplier of (coloured) thermoplastic granulates, a Dutch supplier thermoplastic granulates, a Swedish supplier of steel sheets, and a British supplier of carpets. ICI and the steel supplier supply (probably) just one of Perstorp's competitors, while the others deliver to 2-4 competitors. Perstorp's Swedish competitors Borealis and Plastal also buy from the German and Dutch granulate supplier. All these five supplier relationships are handled by 4 to 6 people from Perstorp: one purchaser, one logistical officer per plant, 1-2 persons at each plant dealing with technical issues, and possibly a development project leader, and, on rare occasions, a financial manager. Daily problems regarding deliveries are handled as much as possible by the different plants; the purchasing manager gets statistics regarding rejections and delivery accuracy from each plant every month, and combined, these figures give some indications which issues to work on. From the suppliers' side the amount of contact persons ranges from 7 for ICI to 3 for the granulate suppliers. For Perstorp, there is only one sub-supplier which has a noticeable impact on the products it buys from these suppliers, and that is the carpet producer's supplier of yarn. Purchasing volumes are all heavily dependent on Perstorp's sales to its major customer, Volvo Car Company, except in the case of the steel supplier, whose materials go into products that Perstorp sells to a broader customer base.

The German granulate producer has been a supplier to Perstorp since the 1960s. In total, Perstorp buys some 25 million NLG worth of plastic granulates in almost 100 different grades, and the German is the biggest supplier among a total group of fifteen. This relationship is typically one at arm's-length. The relationship with the Dutch granulate producer started in the 1980s. The plastic granulates Perstorp buys are not unique, but bought by several customers. This is a supplier that Perstorp is beginning to develop a closer relationship with. The supplier is becoming rather 'aggressive' in this respect, and is working with 'customer focused' project teams. One of the results is that the supplier is now delivering in 500 kg packages, in a returnable/reusable packaging. Some of these findings are applicable to all granulate operations Perstorp has, but the supplier is not afraid of Perstorp abandoning them for a possibly cheaper supplier, because they are 'approved' by the final customers of Perstorp. It is also a matter of investing a closer, more long-term oriented relationship.

The relationship with the Swedish steel sheet supplier is some thirty years old. The sheets that Perstorp buys are put together in pairs, with a material in between that makes that there is no resonance in the steel. This plate material is then sold to component manufacturers which make oil pan covers or hammerhead covers from it. The two companies have done some technical development together, mainly regarding the hardening process of the steel. This process had to be adapted especially for Perstorp, because its customers need to mould or spotweld the sheet material which was difficult without the adaptations, because of the laminating process that the steel had undergone. Problem was that the final customers could not exactly specify the technical demands, so the supplier and Perstorp found out the necessary properties by means of trial and error.

The relationship with the carpet supplier exists since the 1970s. Final customer Volvo Car specifies the exact colour and number of fibres in the carpet/cloth, but it does not care much about the back side of it. The supplier and Perstorp have co-operated in developing the barrier properties of the back of the cloth, without Volvo by the way, necessary to prevent the plastics moulded on the back from pouring through. This is not a very smooth relation: there have been a lot of quality problems, and Perstorp has suggested to Volvo several times to switch to another supplier. At some point in time, the carpet supplier even closed one of its factories, causing delivery problems for Volvo, while no one was informed about it. Within a year, Volvo has planned a switch to another supplier, while Perstorp would actually have preferred to stay with the British supplier, also because the new one is in some respects a competitor of Perstorp. Volvo usually has a lot of patience with non-performing suppliers, because of the substantial investments in the relationship involved, and because of the risks in setting up a new relation. It will first give various warnings, and later improvement suggestions starting at the product level and then at the management level. The British supplier is heavily trying to save the relationship, by lobbying, reducing prices, and increasing quality, but too late it seems.

D.6.2 ICI Polyurethanes

ICI (Imperial Chemical Industries) is one of the world's largest chemical companies, with a turnover of around 25 billion NLG in 1995 (+ 12 % compared to 1994), and a 2.3 billion NLG profit. It consists of 4 main businesses: Paints, Materials, Explosives, and Industrial Chemicals, which is the biggest. ICI Materials brings together ICI Acrylics, ICI Films, and ICI Polyurethanes (9 billion). ICI's fast-growing polyurethanes business is the second largest producer in the world of polyurethane chemicals and systems. Polyurethane (PU) is a foam can be used for insulation, structural strength, adhesion, abrasion resistance, comfort, load bearing, and solvent/oil resistance. The foam is created when mixing together isocyanate (MDI or TDI) and liquid polyols. Polyurethanes are a very versatile product, and are sold to very different customer segments, like Construction, Automotive, Appliances, and Footwear. ICI produces mainly standard or special variants of MDI iso-cyanate and mixtures of polyols and catalysts, so-called 'blends'. The blends and the MDI can either be sold separately (mainly to large customers, especially in to the construction sector), or together in what is called a 'polyurethane system' (mainly to the automotive and footwear segment).

Within Polyurethanes, fundamental research takes place mainly in Belgium (where HQ are too), while applied development is being carried out at some 15 different locations, amongst which Shepton Mallet. Earlier on, there was little co-ordination between the various R&D locations and plants, leading to a situation where everybody was more or less developing its own formula's. Since 1992, however, R&D is organised in a more structured way. It is now possible to distinguish three levels of R&D within ICI Polyurethanes; Technical Service, Development and Research. Technical Service is a function present at every production site, and its organisation corresponds with the different customer regions. It comprises different specialists that specialise in particular techniques, and work directly with customers. Customer Service is more involved in logistical and financial discussions with customers; Technical Service is the first to be confronted with the request of a customer for a new feature of product. If necessary, this request will be handed to one of the fifteen Development Centres (one for each of the 5 customers

segments in each of the three regions Asia/Pacific, Europe, and America) that have close relations with each site. One of the Technical Service managers in Shepton Mallet, for example, reports to the Automotive Development Centre in Belgium. The Development Centre will try to develop the new product, and then picks out one customer with whom it tries out the solution. Later on, if the product is successful, it will be spread to other customers.

Most technical co-operation takes place with customers that buy PU systems; these customers are also the most dependent on ICI's skills and knowledge. In general, ICI does not conclude exclusivity agreements with its customers regarding certain newly developed products, mainly because it would be very easy to cheat on these agreements: just by changing the formula little bit, you could still have a similar product in function, but which is legally speaking totally different. In some cases, the parties might agree on a short lead-time advantage for the first user. Regarding the costs of the technical co-operation, ICI used to work with time-sheets so that it could keep track of the hours spent on each customer, but this was stopped when it turned out to be too complex and too costly to administer. Sales are not very concentrated: there are some 3,000 customers in total, roughly 500 of which account for 50 % of sales.

ICI used to be a very technically oriented company, but since some 20 years it has become increasingly commercially oriented. And while some five years ago, technical collaboration with customers was mainly focused on purely technical innovation, the focus is now much more on achieving cost reductions through weight reduction, cycle time reduction and the like. Generally, it is ICI's impression that in this co-operation, the customer's purchasing function plays very much a backseat role; the developments are totally driven by the demands of the final customer, and cost considerations. In that sense, Purchasing does not really play the role of relationship manager.

Besides Perstorp Components AB, the four selected customers are: Perstorp UK (automotive acoustic components, about four times the size of 'Sweden'); the in-house seat producer of a German car manufacturer (same size); a UK producer of automotive components (same size as Perstorp Sweden), and a UK seat supplier of a Japanese transplant (about twice the size of Perstorp Sweden). All five customers, except the UK component producer, buy goods that are customised to some extent.

Only with the German seat supplier, there is a written contract: the two Perstorp companies and the UK seat supplier have no contracts at all, but all comes down to gentlemen agreements. Occasionally, there will be contracts for model life-time. Prices are usually fixed for one-year periods, but sometimes formally linked to price trends for raw materials. Share-of-need contracts are very rare.

Compared to Perstorp Sweden (and Perstorp US), Perstorp UK is more innovative - mainly because they have very demanding customers. Therefore, this customer is also the most promising in terms of technical development among the five discussed here. Currently, there are five ongoing projects (most of them are related to one final customer in the UK): two in cost-down issues, and three on 'brand-new' innovations. Regarding the latter three, there are contacts with Perstorp's US and Sweden operations. Earlier, ICI and Perstorp had global meetings together to co-ordinate these kinds of projects and to disseminate information, but these were abolished by Perstorp. It is not always possible to transfer new product ideas even between different companies in the same group, as the final customers may be quite different, for example in the weight of the cars they produce. With Perstorp UK, ICI has more contacts with the commercial department than in the case of Perstorp Sweden. Although considerable time is spent on dealing with Perstorp Sweden, more is spent on Perstorp UK.

The German car manufacturer has in-house production of seats because it thinks it is more in control of costs in this way. This relation started when ICI bought a German company in 1987, just in order to be able to sell to this customer, which buys a very specific kind of PU. The customer buys also from two other PU producers, and has a high-quality focus. With this customer, there are 3 projects going on, mainly in the development of new seats. This is commercially speaking the most promising customer of these five.

The UK component producer is a customer that has always been reluctant to co-operate with ICI, although at the moment there is one project going on.

The relationship with the seat supplier in the UK dates from 1984, when ICI started to supply PU for headrests. These are made out of a rather stiff/solid PU variant. Since headrests account for just a small volume, it was decided that the product formula would be based upon the formula for seating PU; vice-versa is not possible. Since 1995, ICI is also supplying PU for seats. With this customer, there are two ongoing projects at the moment: one in seating, the other one in frame strengthening.

D.7 Food and beverages

D.7.1 Pripps Bryggerier

Pripps is Sweden's biggest producer of beer and softdrinks. Until 1995, when it was sold to Norwegian Orkla (producer of a.o. Ringnes beer), it was owned by the Volvo group. The company has two breweries in Sweden, in Bromma (Stockholm) and Västra Frölunda (Gothenburg). Total turnover in 1994 amounted to around 1.1 billion NLG (including some 200 million NLG in beer taxes).

Of Pripps' total turnover of 900 million NLG excluding taxes, some 1.6 billion regards purchase expenses, which equals a purchasing ratio of 45 %. Roughly two-fifths of purchases regard raw materials like sugar, barley, and syrup. A similar amount is spent on intermediate goods, mainly packaging material. The rest regards promotion and distribution material, etcetera. Additionally, Pripps buys for several tens of millions NLG production equipment. Over the past few years, purchasing costs have increased relative to turnover because the end-customers have not accepted the price increases that Pripps was forced to accept from its suppliers. Especially in 1995, purchasing costs rose sharply because of the further devaluation of the Swedish crown, and price increases in raw material. In total, Pripps has some 1,000 suppliers, 150 of which are important. Roughly 20 of them account for 80 % of total purchasing volume. In many of its supplier markets, Pripps is facing monopolies or oligopolies.

Sweden accounts for almost half of total purchases, which is quite high, and this can be explained by the fact that it regards mostly voluminous products for which it is not very efficient to transport over a great distance. Pripps has now, for example, PET bottle blowing machines at its own production site. Swedish suppliers have recently also become more interesting because of the devaluation. Still, Pripps has done some major reallocations since the current purchasing manager joined Pripps in 1989. Since Pripps has a close collaboration with most of its suppliers, it is difficult to shop around, also because it takes a long time before a supplier is well integrated into Pripps' production system: the high-speed production process demands constant and high quality.

The purchasing department consists of 6 people in total, who are each specialised in certain products. After the merger with Orkla/Ringnes, there are further possibilities to increase the specialisation of the different buyers, when the purchases of the two are being combined and centralised. The buyers will have to have a combination of technical and commercial skills, but should not be too technically oriented. In that case, according to the purchasing manager, they would decide too quickly and not play the market the right way. They would also too easily send signals to suppliers what Pripps wants and plans to do. Previously, Purchasing used to be just signing contracts. Now, it is much more active during the whole life-cycle of a product, and it often functions as the motor in introducing new items. Purchasing has to be available all the time for the internal customers and the suppliers, as it is purchasing that makes the final deal. For that same reason, investments by suppliers can only be rewarded by the purchaser.

Until 1990, yearly discussion with suppliers were always about price increases of around 3-5 %, due to inflation. Only in the case of certain technical developments, such discussions were avoided (f.e. the reduction of the amount of aluminium used in cans). In the beginning of 1990s, customers in general started to put pressure on suppliers with regard to costs and prices. A lot of suppliers had also began to focus more on costs themselves. As a result, from now on the discussions were about cost reductions instead of increases. In 1993 however, this 'traditional' method of pushing for lower prices had run out.

Pripps felt that they could not keep this pressure on their suppliers for another 3-4 years, so they decided to adopt a new approach. The focus is now on long term partnership, in which the benefits will be shared by both parties. Keeping the benefits that arise from closer co-operation entirely to oneself will slow down the process of continuous improvement. Pripps has set up a programme for the development of such partnerships, and during 1994 it signed up agreements with suppliers of corrugated board, cans, sugar, and six-pack cartons. The envisaged advantages of partnerships are threefold: reduction of capital invested in stocks at the customer; optimisation of administrative procedures (ultimately, the only activities that should take place are delivery by the supplier, and payment by the customer) and joint technological development. Most activities up till now have centred around the third aspect, but the first two will receive increased attention. Pripps' most important technological co-operation with suppliers has taken place with regard to trays of corrugated board, and cartons for six-packs.

Apart from the relation with Munksjö, we have taken a look at a supplier of cans, one for PET bottles, one for sugar, and one supplier for carton six-packs. The can supplier is one of the major players in the European can market, and cans account for just over 50 % of the company's turnover, the rest is mainly in glass and plastic, PET. The relationship started when the steel can for beverages was introduced in the mid-1960s. There is a share of need contract, and the supplier currently provides some 90 % of Pripps' need of cans amounting to several tens of millions NLG, which accounts for roughly 10 % of the supplier's Can Division's total sales. The supplier delivers cans to all of Pripps' suppliers. In this relation, there are $\pm$ 10-15 people involved from Pripps' side, sometimes including external advertising agencies, which is at least double the number compared to the other relations. The products are customer-specific for Pripps because the labels are printed on the cans by the supplier. The design of the decoration on the can is important, because for example the size of letters can affect the amount of start-up waste. The marketing department should try and use standard colours when designing new labels, in order to keep these benefits. For example, the printing pattern of cans cannot be too complicated, otherwise there will be too much spillage. The aluminium can may be sold back, but that will make up for only 35 % of the cost of the spillage. If this spillage can be reduced by 50 %, it would mean savings amounting to several million crowns. Pripps and the supplier have been co-operating in the field of coatings that are applied to the can, mainly with the aim of saving costs, for example, by reducing coating layers. The can supplier uses external suppliers for ink and (inside) lacquers, with whom it also co-operates in R&D, but Pripps has no direct contacts with these suppliers.

From the PET bottle supplier, Pripps buys standard (full-blown) returnable PET bottles and one-way pre-forms, which are blown into shape at Pripps' facilities. The supplier, which is marketleader in Europe, has a pre-form plant located in France, and the full-scale bottles (which in the case of Pripps account for the biggest volume) are delivered from Norway. The relation started in 1990; pre-forms were introduced in 1993. Current transaction volume several millions NLG, which is less than 1 % of the supplier's total sales. The supplier is not delivering to Pripps' competitors, as these are mainly using local suppliers. Pripps has no direct contacts with the supplier's suppliers of plastic granulate. Pripps has one other PET supplier, which supplies a small part of the pre-forms and a major part of the full-scale bottles. Minor technical collaboration is continuously taking place, among others in process development regarding the pre-form bottles.

The third supplier delivers sugar (in liquid form) since the establishment of Pripps. Current transaction volume amounts to tens of millions NLG, which is roughly 3 percent of the supplier's total sales and equals 90 % of Pripps' need. This product is semi-customised for beverage customers like Pripps. The supplier delivers to all competitors, as it is the only sugar supplier in Sweden. Pripps buys also some sugar from the UK in solid form. Therefore, it still has facilities for mixing the sugar with water; if not, it would become too dependent on this supplier. The supplier buys its sugarbeets from farmers, who cannot grow beets year in year out on the same ground. They change from time to time, for example to barley. Perhaps it could be interesting to have direct contracts with the farmers, so that they produce

alternatively sugar and beets for Pripps. No technical collaboration takes place between Pripps and this supplier.

The fourth supplier used to supply multi-packs to Pripps, but since 1995 - when the company was sold to a larger corporation, and got a new CEO - the supplier has decided to focus on simple board and carton, and not on multi-packs any longer. The supplier now sells the carton to the group, which turns it into 6-packs. Pripps still has direct contacts with the supplier as the group's carton supplier. Pripps thinks it is a wrong choice, because it does away with exactly those production steps that add the most value. Pripps wants to increase its knowledge about carton and paper, and look more deeply into the supply chain, but the problem is a lack of time and resources. Sales volume is around 3-5 million NLG (less than 1 % of the group's total sales). The products are fully customised. Pripps has two other suppliers for six-packs. The supplier has been supported by Pripps to enter the multi-pack business, and they did a lot of co-operative development of the six-pack, while most other breweries were satisfied with the standard available multi-packs. One major issue has been the thickness of the six-pack carton. Usually, the carton would have a folding system which requires a certain thickness. Pripps and this six-pack supplier have developed a thinner version, which is glued together. Additionally, this type requires also a smaller piece of carton than the other type. In general, most new/potential suppliers are surprised by Pripps' low six-pack costs, which are unique in the industry. Pripps did not request exclusivity for this new six-pack, as it argues that this would only increase costs also for them. The developments in the field of six-packs are closely related to the design of trays. One aspect is the amount of decoration; if you have decorated cans, and then decorated six-pack cartons, perhaps you do not need a decorated tray. A second aspect is that a tray that has 4 six-packs on it, does not have to be as strong as the normal 24-can tray.

D.7.2 Friesland Dairy Foods, Production Long Life Products

Friesland Dairy Foods (FDF) is an internationally operating company in the dairy industry⁴. It employs roughly 7,000 people, and turnover in 1994 was around 4.2 billion NLG: total purchasing volume, including milk, amounted to 3.5 billion NLG, which amounts to a purchasing ratio of ± 85 %. The company is organised into different business units which are involved either in production or sales. Production Long Life Products (PLH) is one of the production units, and produces long life dairy products like sweetened condensed milk, evaporated milk, coffee creamer, milk powder and baby food, which are put on the (world-wide) market by other business units. It has a turnover of around 750 million NLG, and 850 employees. Total purchasing volume at PLH amounts to roughly 250 million NLG, of which one-quarter is being bought for other business units. For this, it has around 300 suppliers of packaging materials (more than 3,000 articlenumbers), and 850 for nuts and bolts, and production equipment (nearly 15,000 article numbers). For the rest, the goods being purchased vary from tinplate (FDF has some in-house can production), and packaging materials like solid and corrugated board, systems packaging, bottles and plastic, to finished dairy products that are being bought from other dairies (farmed out production). Roughly, the following categorisation can be made: packaging materials (62 %), raw materials and additives (20 %), technical materials (10 %), finished products (5 %) and services (incl. marketing, 3 %). The biggest 25 suppliers account for about 70 % of total purchasing volume, while roughly 80 % of total purchasing volume comes from domestic suppliers.

FDF has a separate business unit Research and Development Leeuwarden, which plays an important role in the development of packaging material. Within this R&D unit, there is a group of 7 people involved in the development of packaging material. The manager describes the work of his group as: 'delivering specifications'. FDF is probably one of the dairy companies with the biggest technical expertise in this field. It is also one of the few that does a great amount of testing. Other companies often follow the ideas of FDF regarding packaging because of its size, relations, knowledge, and image.

⁴ On 9 September 1997, it was announced that FDF will merge with three other dairy companies: Coberco, Tweek Provinciën and Zuid-Oost Hoek. Main motive: scaling up, and a stronger position versus the retail sector, especially in cheese products.

Apart from TDV, four other suppliers have been considered that are important in terms of packaging development: respectively of solid board, plastic canisters, closure caps and glass bottles. All, except the one for plastic canisters, are domestic suppliers. From the first supplier, FDF buys printed solid board for boxes. The supplier is part of a large international paper and packaging group. Purchasing volume in 1994 some 8-13 million NLG. The supplier is virtually a single supplier to FDF. Boxes need to be delivered quickly, Just In Time, and in a lot of different varieties as they have to correspond with the brand products inside. Solid board is in that case an ideal product, since corrugated board is a far less flexible product: minimal batch sizes are larger, and corrugated board equipment has a fairly long start-up time where it is also necessary to work from thick to thin qualities. With solid board, it is much easier and quicker to change qualities, but it is also more expensive. Previously, FDF was buying a huge variety of boxes: more than 20 different sizes, in 5 different qualities and with more than 200 hundred different printing designs. Together with this supplier and some of the sales units, PLH has set up a major project to reduce the substantial costs that are associated with the great variety of boxes and designs, which are largely the consequence of the large number of brands and countries FDF sells to.

From the second supplier (D), PLH buys a plastic 'pouring-can' for coffee milk and cream, a product that is unique in the Dutch market (in similar versions, it has been on the market for a longer time in Germany). This product has been developed in close co-operation between FDF and the supplier. The purchasing volume is rather small, but strong growth is expected. In 1992, one of FDF's sales units was interested in buying the pouring-can: it offered consumer-convenience, and it looked better on the table than the old glass bottle, which compensates the higher production costs. FDF was not yet sure whether the product would succeed in the marketplace, so the make-or-buy decision resulted in a buy: meaning in the dairy industry that the customer buys a filled product, packaging and dairy product together. The can was produced on the basis of an existing (Japanese) concept with a pouring-opening, and delivered by the current supplier. In the meantime, another business unit had become interested in the product too, but it wanted to have other colours, and a logo printed on the can. Shortly after the can was introduced on the market, FDF's product-information telephone line was red-hot and the company had to recall large quantities of the cans: they were leaking along the sides. As it turned out, the heat used when printing the logo onto the can 'melted' the sharp edge of the pouring opening. Problem was: the moulding-die for the plastic can had already been made, and changes would be very costly. Finally, a preliminary solution was found in putting some vegetable oil on each individual pouring end, after it had been to the printing company. In spring 1995, the moulding die was finally adapted at a substantial cost. The original design of the pouring-opening has been changed, and has got a 'model-protection', and the supplier sells this product only to FDF. Sometimes, if FDF spends a lot of efforts in developing a new packaging material, the supplier and FDF agree to add a margin to the price for other customers, which goes to FDF as a kind of license fee: that option was not chosen here. No specific development contracts have been made.

In reaching the final solution, FDF has been talking not only to the can supplier, but also to the supplier of the plastic granulates. The can supplier, however, was not a very good source of assistance to FDF: it appeared to know little about these kinds of problems, which was perhaps partly caused by the fact that maybe the first concept was at the limit of what was technically possible. Apart from this, the supplier is a very hierarchical company, and for FDF it was very difficult to get past the marketing and sales people and discuss with technical specialists. FDF has now installed a filling line itself, to take over the filling of the can from the subcontractor. In other words, FDF has gone from buy to make.

The third supplier delivers small metal closure caps to PLH: these are actually produced in the US, but the contacts run through a Dutch subsidiary. In 1994, the purchasing volume was very small but has grown quite strongly since. Together with this supplier and others, FDF has been developing a reclosable coffee milk bottle, with a small metal twist-off cap (similar to the cap on the Heinz ketchup bottle, but smaller). The fourth supplier (total turnover around 500 million NLG, of which 80 % in packaging glass) delivers glass bottles and pots. Purchasing volume roughly 7 million NLG. Some of the technical

collaboration taking place between FDF and this supplier occurred in the context of the previous relationship concerning the caps. The development activities of the glass supplier in that project were focused at the development of a die for the new bottle, which required some special attention for the screw-thread at the bottleneck.

D.7.3 Munksjö Förpackningar

Munksjö is a public company; 30 % is owned by international institutional investors, and since 1995 another 30 % is owned by the Irish paper and packaging group Jefferson Smurfit Group Plc, which is the biggest producer of corrugated board in the world. The Munksjö company consists of five business areas: envelopes, hygiene, paper, paper pulp, and packaging. Munksjö Förpackningar (MF) produces corrugated and solid board packaging material, and has expertise in offset (high quality), post print (traditional way) and pre print (mainly suitable for large volumes) printing techniques: most board is post printed⁵. Printing is an important activity in board production, since it adds a lot of value to the product, makes the difference between a standard bulk item and fully customised products. It is where many of the technological developments take place. The company employs some 430 people, and has locations in Nybro (headquarters, production and printing) and Norrköping (board production and post printing facilities). MF is the fourth biggest company in Sweden in the corrugated board segment, and the only one in Sweden that is capable of producing corrugated board containing 100 % recycled fibre. Around 90 % of total production consists of this so-called 'M-liner', the rest is Kraftliner that contains 75 % recycled fibre, and 25 % virgin fibre) The 100 % recycled fibre content is a very strong sales argument, and has a positive image effect also for the customer.

Around 90 % of all purchases are raw materials such as flute (the internal 'wave' layer), and liner (the outer layer). Other purchases include ink, glue, plastic wrapping, and transport services. Most of the raw material is produced by sister company Munksjö Lagamill. Due to the increasing demand in the paper industry, and especially for the qualities produced at Lagamill, in 1995, prices have been rising some 50 % in 18 months. This has led to a growing purchasing share in turnover, but also to efforts of MF to pass this increase on to its customers. MF tries to not bind itself to contracts that fix prices for a long time. Even when there is an annual contract with a customer, the fixed price period is usually shorter.

MF also owns 45 % of the Norwegian company Nor-Reg, which manufactures packaging equipment. In that way, MF is able to offer its customers total packaging solutions. If customers use the board of other producers in Nor-Reg's equipment, MF will charge for the services it performs, but it is very useful to have one supplier both for the board and the equipment as it will prevent the board and the equipment suppliers blaming each other for the customer's problems. In that sense, MF has a similar business idea as Tetra Pak: sell a system, and earn money on the packaging material.

New packagings are developed by the Development Department, consisting of four people that are specialised according to the different customers. The important customers are rather active with regard to the development of corrugated board (good examples are Astra, Ericsson, and Pripps), but MF argues that it is a bad sign when customers really start to develop things on their own: "That is our business; we have to take the initiative." Customers do not explicitly pay for development costs incurred by MF.

Apart from Pripps, four customer relationships have been reviewed: with an industrial bakery, an ice-cream producer, a manufacturer of plastic bags and a paper producer. With the bakery, a producer of hot dog rolls, MF has a relationship since 1993, delivering boxes similar versions of which are sold to other customers too. Sales volume amounts to few million NLG. There has never been any

⁵Post printing is usually cheaper, but pre printed corrugated board has a higher quality and can be cheaper in some situations as it takes less time to produce.

substantial co-operation with this customer to develop new packagings. On one occasion, MF was simply too late: the customer had already decided to buy another brand of packaging equipment, and then the chances of developing a new packaging together are very little. This customer actually had the same problem as Pripps: its main corrugated board supplier had 'fallen asleep', and MF got in by actively marketing its 100% recycled fibre board.

Sales to the ice-cream producer (customer since 1975) are three times the volume of the previous relation. MF delivers different transport packaging boxes, some of them with holes in it for quicker freezing: similar boxes are supplied to other customers in this segment. These boxes were developed in collaboration with the customer, which was very active in that process. MF also supplies packaging machinery to this customer, and has a special account manager in Stockholm for this customer.

The producer of plastic bags for shops and the like (customer since around 1975) is a customer in the order of size of the bakery. MF supplies the boxes containing these bags, and the packaging machinery. This customer has successfully served as a reference project for attracting other customers. MF has similar customers, but they do not buy the same kind of boxes. The boxes were developed by MF and the customer together, with MF being the most active partner.

The fourth customer, a paper producer, buys discs, which are put on the ends of large paper rolls. Around 1993, the customer and MF have developed new qualities for these discs, which were subsequently also adopted by other customers.

D.7.4 Thomassen & Drijver -Verblifa

Thomassen & Drijver-Verblifa (TDV) is manufacturing packagings: tins for food and other products, beverage cans, metal boxes for cigars (and the like) and twist-off caps for glass bottles and pots, and some related products like plastic cutlery. For the production of aluminium and tinplate food cans, there are three facilities (each employing some 400 people). One in Lint (B), and two in the Netherlands: in Deventer, consisting of a head-office, and two factories for the production of smaller undecorated tins in large series, and Hoogeveen, where they manufacture mainly small series of larger, decorated tins. TDV is a member of the Continental Can Europe group (1994 turnover: 4.2 billion NLG), which in turn is owned by the German conglomerate VIAG. Within the CCE group, TDV's production of tins is part of the (one-but-biggest) segment Metal Packaging; turnover in this segment amounts to roughly 1.2 billion NLG, and metal packagings are produced at some 16 plants in different countries in Europe⁶.

Within the dairy segment, TDV's cans are used for two kinds of product: dried/powdered dairy products (milk powder, powdered infant food, and the like), and liquid products (cheese, butter, evaporated and condensed milk). Most of the cans for powdered dairy products are large, mostly decorated, produced on customer order and in smaller runs. Therefore they are produced in Hoogeveen, while most of the cans for liquid products are smaller, mostly plain, and produced on stock, and therefore produced in Deventer. Printing is one important means for TDV to create added value in its products. Increasingly, however, customers want to reduce the number of different colours used in the printing. This is especially relevant when designing new labels or redesigning existing ones. Printing is an extremely important feature for the positioning of the customer's products. Through their different prints (and sometimes different forms and sizes) dairy cans of different customers are far less interchangeable than f.e. in the case of vegetable cans.

Product development is taking place at the same locations where production is taking place. At which facility a specific project is carried out is dependent on which customer or supplier or which internal department initiates the project. This physical proximity of development near production is also due to the fact that much of the product development has to be co-ordinated with the production capabilities of

⁶ In March 1997, Metal Packaging has partly been sold to Pechiney and investment group Doughty Hanson & Co. The new joint venture, Impress Metal Packaging, will be the one but biggest metal packaging producer in Europe. Since then, TDV is called Impress Metal Packaging BV.

the factory that is going to manufacture the new product, implying the need for test runs etcetera. Basic research is mostly carried out in Deventer and Germany, since the R&D staff is located there. CCE Metal Packaging is planning to increase its efforts in basic R&D in the near future. Sometimes, suppliers come with new product ideas. This regards mainly the suppliers of steel and tin, the suppliers of lacquers are less active. New product ideas often come up more than once, and are turned down several times before they are actually successful. TDV emphasises that it is important to involve customers in an early stage of the development of a new can. This has been the problem, for example, with the X can (a metal can with a plastic lid) that was developed with too little participation from customers, and consequently the product has not been very successful. Customers wanted other dimensions, and other materials. One objection of customers regarded the 'tamper-proofness' of the can: some producers are rather afraid of sabotage/poisoning of their products in the store. However, one customer - the one least expected to - finally decided to buy the X can. In general, the dairy segment is a relatively conservative market for metal packaging. Nestlé can be considered as a trend-setter in packagings for dairy products in powderform; Nutricia has the same position in the market for baby and infants food. FDF is somewhat of a leader in evaporated milk packagings. During the last few years TDV has become more active in listening to customers and developing new products according to their wishes. This has much to do with the fact that in the early 1980's, TDV had a monopolist position in the Dutch dairy industry, and now it is faced with more competitors, especially in the liquid segment. Other competitors are the in-house can production facilities of dairy producers, like FDF and Nestlé, but these manufacturers seldom sell to third parties.

FDF plus the additionally selected four customers (all located in the Netherlands) represent a substantial part of CCE Metal Packaging's total European sales volume within the dairy sector. The contracts with these customers resemble gentlemen's contracts, with yearly price negotiations, and often a specified share-of-need that can be adapted during the year. TDV has some 10-12 people that have frequent contacts with each of these customers: in a typical case 4 sales people, 2 production managers, 1 person from lithography, 1 financial administrator, 2 from Customer Service/Container Performance (dealing with issues like weight reduction, interaction between the can and the contents), sometimes people from product development, and 1 or 2 senior managers. The number of contact persons at the customer range from 7 to 15 at FDF. Since these customers directly supply to consumer markets, there are no customers' customers that have a specific influence on the relationships TDV has with them: general market demands are translated by the customers into specifications regarding the can they buy from TDV. Co-operative product development is taking place nearly all the time with these customers, but from time to time there will be specific, more intensive, projects. It is very difficult to estimate how many time is spent on these co-operation projects (except for the Customer Service and Technical Service departments), although it would be very useful to know for commercial discussions with the customers concerned. Technical co-operation has grown because of increasing competition in a maturing end-market, which puts TDV under pressure to focus more on the customer than on the product itself. There is hardly no formalisation of these co-operation projects; the parties concerned are very careful with spreading confidential information. The technical co-operation projects aim at 'combined competitiveness of both TDV and the customer', and also (for TDV) at decreasing the risk of substitution of cans with glass packaging.

With the first customer, one of TDV's biggest, co-developments mainly regard downgrading (thinner walls, thinner seams), easy opening ends, and 'necking' of cans in order to decrease costs. Contacts are mainly with development, and purchasing and plant management, which are closely integrated at this customer. The second customer buys roughly half the volume of the first one. Co-developments are going on regarding cost reductions, and alternative decoration techniques. While these two are dairy producers, the third customer is primarily a pharmaceutical company, producing baby and infant food. Sales volume again about half the volume of the second one. Delivers among others to Japan, which leads to very strict demands on the quality of the cans delivered by TDV. This is TDV's co-development

customer for the X can. The fourth customer is also a producer of baby and infant food, with nearly the same sales volume as the previous customer. Co-development in the development of a can with a specially designed wall that results in weight reduction. This project is managed by a steering group, which is co-ordinating different working groups.

D.8 Power plants

D.8.1 ABB Stal

ABB Stal can supply customers with everything ranging from a turn-key power plant to a single turbine. Industrial turbines form the most important segment. Purchased goods as percentage of turnover has increased steadily at ABB Stal; from 40-45 % in the early '80s, around 60 % in 1990 to 68-72 % now. Within the whole ABB group and its different business areas, there are activities to promote procurement development. There are commodity groups which work cross-functional and cross-country (mainly Europe) to improve quality, lower costs and rationalise the supplier base. Suppliers were never asked why they did something, and they were never asked for suggestions how to do things differently. The suppliers have reacted differently to Stal's new purchasing policy; some are convinced, some confused, and some even distrustful. For the whole of Stal, the total supplier base has been reduced substantially, while at the same time turnover increased substantially. The reduction of suppliers per article is therefore even stronger. In most areas, Stal is striving for single sourcing.

In the early 1990's, Stal also started to try and buy more in large assemblies. By trying to create pyramids of suppliers, Stal saves time as it has to deal with less suppliers. This time can be used for more strategic issues. There are not always suppliers available who can take care of co-ordinating such a pyramid, so sometimes such a first tier supplier has to be created. Usually, the first tier supplier is an electrical components manufacturer. Despite the fact that these components usually form a small part of the complete assemblies, they are very important as they control the assemblies' functioning. Stal is now carrying out a project - ATP 96 (Advanced Turbine Programme), started in 1993 - for the development of a new generation of turbines. The aim is to increase the efficiency and the power output, but above all to make the steam turbines more cost competitive. It will be built around a modularised concept to allow ABB to tailor the steam turbine to the demand of the customer, in a better way than in the past. This development project is the first with early involvement of suppliers. Earlier on, even in the case of the completely outsourced heat exchangers, Stal was dictating suppliers what to develop. One of the procurement issues in the project is target costing, where on the basis of the estimated sales price of the end product and previous experience, a cost target is set for procured components.

Increasingly buying complete assemblies and involving suppliers earlier in the development process means that engineers should not make all the detailed drawings any longer, but design in terms of functions. As a consequence, cost calculators, logistical managers and purchasers have to work in a different way, and there will be an increased need for communication: internally and externally with the supplier. Geographical proximity will therefore become more of an issue, but finding suitable Swedish suppliers is hard. Most of the suppliers supply to other industries too, and the company wants to increasingly use their competencies, which benefits from giving them more work and responsibilities. Stal also tries to get away from its old practice, where every small design change was directly introduced into the production. It increasingly tries to combine several small changes, and introduce them as a package - which is more simple also vis-à-vis suppliers. It is important to observe that most purchasers at Stal have a technical background, as the discussions with suppliers are often about technical matters (although technical knowledge is not that necessary everywhere at Stal). And from having been a mainly clerical function for close to 20 years, purchasing is now increasingly part of cross-functional teams that work on technical and commercial issues together. Recruitment of new purchasers is mainly done internally.

The suppliers that have been analysed in detail deliver, respectively, generators and control equipment, turbo-gears, blades and vanes, and forged turbine discs. All of these are rather important ('strategic')

components of the total turbine. Together with ABB Installation, these four selected suppliers account for about 15 % of Stal's total purchasing volume. With all of these suppliers, Stal has been co-operating both in product and process development. The co-operation is in all cases mainly aimed at cost reductions, with the ultimate goal of increasing sales; which is obviously also the motivation for the supplier. Except in the case of ABB Installation, there are also contracts with these supplier that contain clauses on technical co-operation.

The relation with the Swedish generator supplier (single source) involves the highest purchasing volume of the five relations, and involves also the most efforts from Stal's side in collaborative development. The generators come in 3-4 different sizes, depending on the power output, with highly varying prices. In the relationship, some 25 people from Stal, and some 50 from the supplier are involved. This figure is so high because of the tight quality restrictions - the generator is directly connected to the electricity grid - and the 100% test runs because of that. The gearbox is an internal component, and its performance is less critical to the final result than that of the generator. By being present at the testruns, also in the case of less frequent gearbox testruns, Stal still keeps some knowledge about these components, and in that way becomes not too dependent on these suppliers. In some cases (see also the turbine discs) the customer may ask for another generator supplier than this one; for example in connection with local content regulations, or when a customer already has other turbines with other generators in it. If there are extra costs involved, these are usually paid for by the customer. This practice seldom applies to gearboxes.

The relation with the French supplier of turbo-gears involves roughly half the volume of that with the generator supplier. Turbo-gearboxes reduce the speed of the turbine to the generator speed. Piece price varies a great deal again, depending on the power output of the generator. The basic design of the gears for all power outputs is the same, only the centre pignon and the size and width of the gear is different. Both the turbo gears and the 4-pole generators are standard products, with only some specific Stal adaptations in connections/fixtures. The supplier's share in Stal's total need for gearboxes has increased since 1990 (now well over 50 %), when it sold them a license for producing these gearboxes. There are still 3-4 other possible suppliers. Both with regard to gearboxes and generators, Stal and the respective supplier are now carrying out standardisation activities, primarily aimed at lead time reduction. In the case of gearboxes, a new product family will be developed with less varieties. Especially in the case of the generators, it should also simplify and reduce the amount of contacts between the two companies.

The relationship with the UK based supplier of blades and vanes involves half the volume of the relation with turbo-gears. This supplier accounts for 50 % of Stal's total need for blades and vanes, and is now the preferred supplier for new development projects. Technical development is focused at new materials and new designs. The tooling costs are rather high, which makes it very difficult to change suppliers for existing turbine types. Different from the other relations, the supplier is the most active in the co-operation. Specific to this co-operation is that apart from the goal of possibly increasing sales, the supplier is probably also motivated by the prospect of increasing his knowledge through working on new complex designs.

The fourth (UK) supplier makes nickel based turbine discs for gas turbines; purchasing volume is about half of that for the blade and vane supplier. The supplier's holding company has its own mine and delivers different metals to the supplier; Stal has no direct with this holding company. Because of the high raw material content, the contract with the supplier allows for periodic price increases, which are absorbed stepwise by the holding company, the supplier and finally Stal. Tooling, in the form of dies, is owned by Stal. Stal has no other suppliers of turbine discs, which may seem risky but will be positive (according to the responsible purchaser) in the long run. ABB is not a really big customer to the supplier, but it is regarded as a 'valuable' customer.

Stal usually has something like 4 meetings a year with all foundry (forged and cast metal) suppliers to 'clear the table', but this is not so frequently with other suppliers for the gas turbines, since there are not so much changes as to make this discussions necessary. Stal wants this supplier to know what it

part does, and therefore it gets pictures of the complete turbine and generator. In this specific case, however, the disc has no crucial interfaces with other suppliers' parts. One part that interfaces with the disc is the so-called 'welding flange', on which the supplier does some machining work. Sometimes this causes problems, when it is done on in places where it should not be done - like places where welds have to be made later on. Currently, there are discussions between Purchasing and the design department whether or not to let the supplier do more machining work. Purchasing argues that the supplier knows much more about forging and machining than Stal does, but on the other hand complete outsourcing would mean that Stal loses all knowledge in this area. Generally, the idea is that the supplier should have room for ideas, which means that the drawings provided by Stal should not be too detailed.

D.8.2 Stork Wärtsilä Diesel Projects

SWD Projects is part of Stork Wärtsilä Diesel, a company jointly owned by Stork (NL) and Wärtsilä Diesel Group (SF), which develops, produces and installs diesel engines and diesel power plants⁷. Projects is the unit which is responsible for installation of the diesel power plants, and has roughly a 250 million NLG turnover, and 65 employees (1995). On average, SWD Projects does some 30 installation projects annually. SWD has some 15 competitors, depending on the power output, and all of the suppliers mentioned below deliver to these competitors too. Customers are mainly focused on the price of diesel power plants, instead of operating costs. SWD's engines are quite economic on fuel, but their price per kWh used to be quite high although that is decreasing now too. Within the whole of SWD, there are four purchasing departments: Projects, Materials Management (Zwolle, where the diesel engines are produced), Marine, Service and Special Products (mainly military products). At Projects, there is a division between Strategic Purchasing and Project Purchasing. Project Purchasing (6 people in total) is situated directly under the two product groups. Strategic Purchasing (2 people) resides under Application and Engineering.

The work of Strategic Purchasing includes among others supplier visits/quality audits (documented by video's, that are available to people at Projects that want to get an idea of that supplier). However, Projects is a company of rather independent people, and it is hard to have them work according to standard procedures and policies. A Purchasing Action Plan, drawn up by Strategic Purchasing, with an emphasis on closer and long-term co-operation with suppliers, using blanket contracts and monitoring with 'Delivery Performance Indicators' in connection with Supplier Quality Assurance, is regarded quite sceptically by the other people - especially the project managers and their operational purchasers. According to the Strategic Purchasing manager, there is a lack of instruments and support to implement an carry through a more strategic approach at SWD Projects. Project purchasers want to 'score' for each project by getting lower prices than quoted, and therefore obstruct the implementation of long-term relationships. Most of SWD's purchases, 70-80 %, are non-catalogue, customised items. Although SWD has been developing new diesel engines (like the 38 model), most development is related to modifications and standardisation. Technological co-operation with suppliers is therefore also mostly limited to modifications, and 'packaging' standard solutions in new ways (f.e. combining different units, like the separator and the booster).

In total, there are 120 major suppliers, of which we selected, besides Holec Projects: a Finnish supplier of generators, a Swedish supplier of diesel fuel separators, and two German suppliers of 'booster modules' and 'E-package' respectively. The first three suppliers are about the same in size regarding purchasing volume: the fourth one is double that size (all in 1995), which is half the size of the purchasing volume for HP. The Finnish supplier used to be a Wärtsilä supplier, before it started delivering to SWD in 1992. It is one of the suppliers that SWD has a blanket contract with, and it has installed a specific production line for diesel generators. SWD has also indicated to the supplier that the level of standardisation will increase, and it has started to produce more in series. It should be noted that the co-developments with

⁷ Since Spring 1997, the company is called Wärtsilä Nederland.

this supplier are mainly triggered and fuelled by the needs and demands of the whole Wärtsilä group. The supplier of separators (for fuel treatment) is one of two sources, and is losing business to the other that is taking larger volumes at lower prices. Previously, there would be one separator for each engine, as diesel power plants can exist of several diesel engines. Together, SWD and the supplier have been developing a module, with one large separator, that can serve a total power plant with different diesel engines at the same time. The first German supplier delivers booster modules, which heat up the heavy oil-fuel before its led into the engines. The supplier will do a lot product redesign/development work in connection with SWD's efforts to standardise its product offerings. There is one minor innovation; for the first time, the booster module will feature an electrically operated fan. Both the booster module and the separator supplier are in the process of developing more integrated units, with a larger number of functions. With the other German supplier, that is delivering the E-package since 1982, SWD is working on standardisation issues, mainly with regard to one new engine type. The supplier has increasingly become a partner for the large E-package contracts as well, partly replacing HP.

D.8.3 ABB Installation

ABB Installation in Sweden (headoffice in Västerås) is divided into 5 regions. Norrköping is a local office for the region East, which encompasses roughly 300 customers. ABB Installation is only operating in Sweden, and is divided into two areas; electrical installation work and switchgear. The switchgear consists of different modular groups of components that are put together in cabinets, or 'electric cubicles'. The cost of the total electrical package equals close to 10 % of the total price of a turbine set. In total, Installation receives some 100 orders per year; 75 small ones for parts and the like, and 25 big ones. Main competitors are AEG and Siemens, but also a variety of small engineering firms that are mainly focusing on smaller projects.

ABB Stal and the additional four customers discussed represent just a very small part of Installation's total turnover. The four customers include three paper mills and a steel mill: final customers as opposed to ABB Stal that is an OEM customer selling the product to final customers. With none of these four there has been any form of collaborative product or process development. However, this does not mean that these relationships are less intensive than the one with Stal: especially the steel mill is more time-demanding than Stal. This is due to frequent changes in the production process both at paper and steel mills, which involves a lot of re-designs in electrical installations.

D.8.4 Holec Projects

Holec Projects (HP), part of the Begemann Group, is active in engineering & contracting, and industrial installation, in markets like power generation, - transportation and distribution, petro-chemical sector, infrastructure, public transport, and construction. HP has a NLG 122 million turnover, and employs 650 people. The company consists of four units: International Contracting (IC), National Contracting (NC), Automation, Commissioning, & Engineering (ACE), and Industrial Installation (II). ACE provides the expertise IC and NC need to carry out projects at their respective customers. IC is responsible for all purchasing issues, including the procurement of local installation contractors/workers and local purchased materials. The choice of sub-suppliers is to a large extent determined by the final customer. Holec Systems & Components (a former sister company) is an important supplier of components to Projects, but there never has been any obligatory shopping'.

HP's primary business is in power generation, power distribution & process control, and renewable energy (hydro and wind power). For these activities, the market consists primarily of public authorities, petrochemical plants, industrial plants, and the water industry. Accounts include 'prime movers' or OEM-customers (diesel and turbine manufacturers), Shell, and several 'heavy' industries and public authorities. Prime-movers often function as a kind of 'back-seat' for Holec, in the sense that the final customer usually makes his decision on the basis of a comparison of the prime-movers, but sometimes, the situation is turned around, and the customer has a preference for HP, and then HP can take the lead of

the project. Regarding installation projects, HP offers a wide variety of services to its customers: consultancy feasibility studies; detail engineering; project management; material management & procurement; supervision & site management; commissioning on site; service, spare parts, and maintenance; and instruction & training, in house or on site. In this context, the term 'EPC' contract is often used, meaning Engineering, Procurement and Contracting. It implies that the supplier is responsible for the design and detail engineering of a project, all the materials and logistical co-ordination, and the final installation. Especially the engineering part is the part of HP's activities with the highest 'value added'. EPC contracts for power plants are usually being carried out by consortia, in which Holec Projects - depending to a large extent on the country where the project takes place - can either be the leader, or only one of the parties, in which case it is usually only responsible for the electrical part of the project, the so-called 'E-part'. For each project, there is one project manager responsible for all activities related to the project, including commissioning, testing and after sales. Apart from SWD, HP does not have any collaboration in product development with the customers we reviewed.

Appendix D

Appendix E

Mini-cases: background and sources

Table E.1: Overview mini-case companies

	turnover	number of employees	purchasing ratio (% of turnover)	number of (initial) purchasers	R&D expenses (% of turnover)	number of R&D people
Philips Medical Systems	-	9500	70	-	-	-
Fokker Aircraft*	NA	NA	NA	NA	NA	NA
Océ-vander Grinten	3000	12000	80	45	-	1100
Rank Xerox Manufacturing (Nederland BV)	2000	2100	80	20	NA	NA
ASM Lithography	920	1100	55	-	10	300
Fluke Industrial	650	-	25	-	9	-
Hollandse Signaalapparaten	-	2500	35	20	-	650
Philips CE Hasselt**	-	1200	80	10	-	145
DAF Trucks	2894	4900	70	60	5	500

(based on figures 1995; amounts in million guilders; NA: not applicable; - = data not available; *: Fokker Aircraft has gone bankrupt in March 1996; **: Philips CE Hasselt is actually located in Belgium, just over the Dutch border)

Additional interviews:

J.H. P. Brons (Philips Medical Systems Nederland BV)
B.T.M. Cuypers (Hollandse Signaal Apparaten BV)
W. Orbons (Océ-van der Grinten)
T. van Zwam (ASM Lithography)

see Appendix F
950822
970328
950418

Students' projects:

(see Literature list for complete references)

Philips Medical Systems
Philips CE Hasselt
DAF Trucks

E. Sie, see also Appendix F
L. Yeh
H. Adriaans, N. Jacobs

Appendix F

Overview of interviews

LM Ericsson

JanTufvesson	vice president Procurement, Microelectronics Coordination LME	941103,960725,960801,961114,970312
Britt-Inger Eriksson	manager Procurement LME/Y	961114,970312
Christer Sparreskog	director of External Technology Provisioning LME	961114
Leif Lasson	purchasing director RMOG/ERA	950817

Food For Thought

manager purchasing department, Production Long Life Products	(a.o.) 960916, 961018, 970131
purchaser packaging material, Production Long Life Products	(a.o.) 961018, 961025, 970717
manager packaging development, Research & Development	(a.o.) 961018, 970131, 970717
logistics advisor, project leader ReduX	971110
senior brand manager Food Nederland	971110
managing director Food Export	960724, 960916
business development manager GreenPack	970718
account manager Food For Thought, GreenPack	970718
manager Supply Chain, Labda	970528
sales and marketing manager, Close Cap	970709
project manager, sector organisation	970716
manager product development, United Glass	970306

Appendix F

Philips Medical Systems

(workshop)	purchasers XRD, development engineers C/V Geometry Segments	960920
(workshop)	development department C/V Geometry Segments	961017, 961029
Hans Brons	purchasing manager XRD	(a.o.) 9511xx, 960920, 960930, 970122, 970506
Rob Schuckman	senior buyer XRD	(a.o.) 960930, 970122
Joep Janssen	development manager Cardio Vascular	(a.o.) 961014, 970122
Carmen van Vilsteren	project leader Cardio Vascular	(a.o.) 970122
Jaap Alfrink	senior buyer XRD	961029

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Appendix G

Supplier Involvement Portfolio

From the discussion and analyses in section 7.4, it has become clear that the main problems at Philips Medical Systems' XRD business unit (PMS) in involving suppliers and the purchasing function are related to the area of Project Management. The main problem in terms of Project Management concerns the lack of agreement and understanding between Purchasing and Development with regard to the possible roles of suppliers in product development. Therefore, a procedure has been developed for distinguishing different supplier roles in the product development process. The main purpose of the procedure is to define different categories of suppliers based on their (potential) contribution to a development project, and to indicate the moment and extent of involvement for these different categories - one of the main activities within the area of Project Management. The procedure is centred around the so-called 'Supplier Involvement Portfolio', referring to the different categories of suppliers. The procedure may serve as a common ground for both purchasers and development engineers for discussing, planning and carrying out - together - product development in collaboration with suppliers. The procedure has been laid down in an internal manual for PMS (Van Weele *et al.*, 1997), which is intended for anyone who deals with suppliers in a development project, but particularly for use by Purchasing, Development and the supplier. In this appendix, the main contents of this manual are reviewed.

G.1 Introduction

The aim of the Supplier Involvement Portfolio is to provide support for setting priorities with regard to the involvement of suppliers in a development project, so that it can be carried out with limited development capacity (time and money), maximum yield and making maximum use of the supplier's expertise and capacity.

The Supplier Involvement Portfolio distinguishes four types of collaboration relationships with suppliers in a product development project on the basis of two variables: the degree of responsibility for product development that is contracted out to the supplier and the development risk. The order in which suppliers are needed in a product development project, and therefore the order in which they have to be involved, depends on these two variables. The contribution that a supplier can make within a product development project in terms of better product/process quality, lower costs and reduced development time varies from one module or technical building block¹ to another. This depends on the difference in expertise (knowledge, know-how and experience) between PMS and the supplier. On the other hand, the necessary collaboration with suppliers in a development project costs time and money, in the form of guidance, co-ordination, communication, etc. PMS thus wants to be able to balance the benefits (the supplier's contribution) and the costs (time and money for guidance) of the collaboration with the suppliers in a development project.

¹ A building block is a separate physical unit but can include one or more functions, one or more technologies and can be an assembly or a mono-part.

Each of the four types of collaboration relationship that are referred to in the Supplier Involvement Portfolio differs in terms of information exchange, communication structure, project structure, evaluation possibilities and the type of agreements that must be concluded. In addition, in every type of collaboration for each phase of the Systems Management, different activities and output are expected from the supplier by Purchasing and Development.

An additional purpose of the Supplier Involvement Portfolio is to increase the collaboration between Development and Purchasing so that right from the initial phase of a development project it is possible for the various relationships with suppliers to be jointly:

- identified;
- prepared;
- planned;
- brought about; and
- guided/maintained.

G.2 Use of the Supplier Involvement Portfolio

The Supplier Involvement Portfolio is explicitly intended for usage in combination with other development and purchasing procedures². The Supplier Involvement Portfolio assumes that the core development activities have been defined: in other words, it does not extend to the Development Management issue of 'Develop-or-Buy', it takes decisions taken in this area as given. The collaboration relationships that the Supplier Involvement Portfolio refers to build on this at the project level, in a cross-functional context. These collaboration relationships from the Supplier Involvement Portfolio also have an effect on various steps in the purchasing process, such as the supplier selection and contracting. The following sequence of taking decisions is crucial for PMS when collaborating with suppliers in a product development project.

Issues to be resolved prior to the use of the Supplier Involvement Portfolio

1a. Core/non-core decisions: Which building blocks form part of the core activities of PMS and will we therefore definitely want to carry out ourselves, and which do not? The answer to these questions must be based upon the company strategy in which the areas of competence that form the added value of PMS are described and may or may not be defined explicitly.

1b. Contracting out or in-house: For which building blocks do we want to contract out the development and at what level in the product structure (modules, complex components, simple parts) do we want to contract out the development? The answer to this question also determines the level at which the building blocks are later purchased on a regular basis. The answer to this question can also be derived directly from the core/non-core question and the current opportunities on the supplier market. By answering this question about contracting out, one will obtain the 'desired' level of contracting out.

Issues for which the Supplier Involvement Portfolio can be used

Working on the basis of the 'desired' level of contracting out - the answer to the contracting out question (1b) - one must nevertheless consider for each building block in each development project whether it might not be better to make a different decision, for example, because there are no (known) suppliers or because the current supplier/suppliers have no capacity available. It is thus determined at project level to what extent the 'desired' level of contracting out is really feasible.

² PMS' procedure for planning and managing product development projects, Systems Management, is described in section 7.4.

2a. Project management: Which supplier should we select and when and at what point should the supplier be involved in the development process?

2b. Collaboration: What is the best way for us to collaborate with the supplier?

It is in finding answers to these two questions by using the Supplier Involvement Portfolio that the main collaboration takes place between Purchasing and Development.

Issues influenced by the Supplier Involvement Portfolio:

3a. Supplier selection and choice: Which supplier shall we give the development assignment to? The answer to this question must be based upon a selection process that is based upon criteria that take into account the contracting out of development and are not only focused on the contracting out of production.

3b. Contracting: What has already been agreed with the relevant supplier and what (other) minimum agreements must we make with regard to the development and regular production?

G.3 The Supplier Involvement Portfolio

The Supplier Involvement Portfolio, depicted in Figure H.1, distinguishes between four different types of collaboration relationships with suppliers in a development project on the basis of two variables. The vertical axis indicates the degree of development responsibility that is contracted out to the supplier. The horizontal axis indicates the development risk. These two variables have been chosen because research at PMS had shown that they are determining factors for the point in time and the extent (intensity) of the required supplier involvement in a development project. For explaining this, we need to look at the way the Supplier Involvement Portfolio has been developed.

Figure G.1 The Supplier Involvement Portfolio

Inspired by the example of Océ-van der Grinten, as described in section 3.4.2, the application of the purchasing portfolio for supplier management in development was tested in an ongoing development project, the 'Genius' project³. There was, however, one important difference between the portfolio tested in our case, and the one used at Océ, and this regarded the definition of the horizontal axis, 'Risk'. PMS was already using the original Kraljic portfolio in normal production buying for differentiating purchasing and supplier strategies, and in that version 'Risk' only regards the availability or supply risk of a purchased part; it does not include the development or design risk as it does in Océ's version. In order to prevent the organisation being confronted with two portfolio's, one for normal production buying and one for managing supplier relations in product development projects, using different horizontal axes, the decision was made to test the applicability of the original purchasing portfolio.

The portfolio was tested in the Genius project by comparing the ideal process of involving different suppliers in the project, based on interviews with purchasers and engineers how it should have been done, with how this process would have taken place if priorities were set on the basis of the portfolio. This resulted in two major findings:

- it turned out to be inapplicable as it did not result in the right priorities regarding the timing of supplier involvement in a development project; and
- the moment and extent of supplier involvement were not directly coupled with each other - early involvement did not automatically imply a greater role for the supplier.

The inability of the purchasing portfolio to set the right priorities is caused by the fact that the parameters financial importance and supply risk neglect some of the other aspects that determine the different needs for supplier involvement in a development process - at least at PMS. It is interesting to consider some examples. Two mechanical parts in the final product under development in this project both ended up in the leverage quadrant of the portfolio. One of them, however, was so crucial for the total concept of the end-product that the responsible supplier should be contacted in a much earlier stadium than the supplier of the other part. Other items that ended up in different quadrants should have the same priority. While most of the differences or similarities unaccounted for in the Océ portfolio-model could be related to the amount of development that was to take place regarding a particular item, it became also clear that in some cases, it was necessary to involve suppliers early even for items that needed almost no development at all. This was the case, for example, for parts that were more or less commonly available in different versions, but where the choice for the one version or the other has an important impact on the specifications and design of other components ('external complexity').

So, it became necessary to introduce another criterion for differentiating between different moments of supplier involvement, being the *development risk*. Together with the criterion of degree of supplier responsibility, this resulted in the so-called Supplier Involvement Portfolio. In order to find out which collaboration relationship is suitable, the position on both axes of the portfolio or matrix must be determined. These collaboration relationships, or the different quadrants of the Supplier Involvement Portfolio are applicable for the duration/period of a development project, and with a supplier of a given building block. The approach to be adopted when using the Supplier Involvement Portfolio is as follows:

1. Determine the degree of responsibility that the supplier holds for the development;
2. Determine the development risk; and
3. Position the relevant building block in the Supplier Involvement Portfolio, which results in the appropriate type of collaboration relationship and the sequence in which the suppliers must be involved.

³ The Genius project concerns the development of a new stand for specific cardio-vascular X-ray systems, and it was started in January 1995, lasting until late 1997. It is a relatively large project with roughly 17 engineers involved, 7 of which are from C/V Geometry Segments. One initial purchaser has been assigned to the project.

Step 1: Determining the vertical axis, the degree to which development is contracted out.

In principle, the 'desired' degree to which a company wishes to contract out the responsibility for the development arises from the core/non-core discussion and the decision about contracting out. This 'desired' degree to which the development is contracted out ultimately involves the contracting out of non-core activities on the basis of functional specifications at as high a level as possible in the product structure. Central questions for the degree to which development is to be contracted out are:

1. Considering the firm's strategy regarding core technical competencies, into how much detail should it go in developing specifications?
2. Are there suppliers with more relevant product or production knowledge than the manufacturer has for this particular part?
3. Are there suppliers that can carry out the development faster / more efficient than the manufacturer?
4. To which extent does the manufacturer need the development capacity (man-hours) of the supplier to meet the project targets?

Choices have to be made at the building block level, while taking into account the current purchasing situation such as the possibilities that exist within the supplier market. It is also important to take into account the overall distribution of building blocks over the normal purchasing portfolio that PMS uses for strategies in normal production buying - the Kraljic portfolio. It is important to make sure, for example, that there are not too many building blocks in the 'bottle-neck' quadrant, otherwise the company may face too much risk regarding its supplies. This shows clearly that the degree of responsibility to be allocated to the supplier can only be jointly determined by those who have an overall view of the consequences of splitting up a system and of making changes to it, i.e. by Development, and by those who are in a position to assess the opportunities on the supplier's market, or who know the distribution over the purchasing portfolio, i.e. Purchasing.

The approach to doing this can be described as follows:

1. Define each building block and determine, within the relevant development project, the 'desired' degree of responsibility for the development that is to be given to the supplier. Here it is assumed that the non-core activities are contracted out at as high a level as possible in the product structure on the basis of functional specifications, i.e. entire building blocks and the supplier is given a high degree of responsibility for development (level IV);
2. Identify the potential suppliers for collaboration for each building block. If there are no (known) suppliers, adapt the definition of the building block or the desired degree of supplier responsibility for the development so that they can do the development, or find suitable suppliers through market research and/or by motivating them to develop the knowledge and products the manufacturer needs (Supplier Interface Management);
3. Finally, examine the entire collection of building blocks to see if a 'desired' distribution has developed over the regular purchasing portfolio. If this is not the case, adapt the definition of the building block or the desired degree of supplier responsibility for the development.

Each time it becomes apparent that there is no capable (known) supplier or that an undesirable distribution over the regular purchasing portfolio is arising, this should be a reason for Purchasing to carry out more long-term oriented market research (not project-dependent) to make sure that PMS is not confronted with the same problem in a subsequent development project.

Appendix G

A distinction is made between four levels at which the responsibility for the development of a building block can be contracted out: I. technical (or purchasing) specifications, II. detailed design, III. global design, and IV. functional specifications.

re. I

On the basis of technical specifications the supplier is given responsibility for setting up its production process (Design For Manufacturing) and for the manufacturing itself. In order to achieve an optimum design for the supplier's production process, the prototypes are ordered from and produced by the production supplier. If the products concerned are standard products, the setting up of the production process has already been completed and the technical specifications will therefore be 'ordinary' purchasing specifications.

re. II

On the basis of a detailed design the supplier is given responsibility for setting up his production and assembly process (this means Design For Manufacturing and Design For Assembly; DFM and DFA) and for the ultimate production and assembly. In order to achieve an optimum design for the supplier's production and assembly process, the prototypes are ordered from and produced by the production supplier. This differs from level I because assembly has to take place; in this case, however, there are no mono-parts or standard products.

re. III

On the basis of functional specifications and a global design of a building block the supplier is given responsibility for:

- the detailed design (technical specification/drawing);
- construction and testing of a detailed design;
- supply of prototypes;
- setting up of production and assembly processes (DFM and DFA); and
- usually, the ultimate production and assembly, on condition that performance is in accordance with market conditions.

Because the supplier carries no responsibility for the global design, it cannot be held responsible for testing the global design of the building block. The supplier can, however, be made responsible for the components which make up the building block, i.e. for testing the detailed design.

re. IV

On the basis of the functional specifications of a building block (which include specifications of the interfaces) the supplier is given responsibility for:

- the global design (concept and feasibility studies);
- the detailed design;
- testing of the (global and detailed) design of the building block;
- the supply of prototypes;
- setting up of production and assembly processes; and
- usually, for the ultimate production and assembly, on condition that performance is in accordance with market conditions.

When determining the level at which the responsibility for development is to be contracted out (see previous section), a considerable knowledge of the supplier's market is required. Similarly, a considerable amount of 'development knowledge' is required in order to determine the development risk. It is thus only possible to position all of the building blocks in the Supplier Involvement Portfolio if both fields of expertise, Purchasing and Development, are working together.

Step 2: Determining the horizontal axis, the development risk

The development risk for each building block - the horizontal axis - is determined by the score of the questions from Table G.1 when added together. If the questions are answered by more than one person, the total must be divided by the number of persons answering the questions.

Table G.1: Questions to determine the development risk

1. To what extent does this building block make an essential new contribution to the functionality of the overall system, as compared with previous systems?	1 known	2	3	4	5 new
2. To what extent does this building block determine the technical specifications and the design of other building blocks?	1 very little	2	3	4 interfaces	5 many
3. To what extent does the development or ordering time for (components from) this building block determine the throughput time of the entire development project at PMS ('is it on the critical path?')	1 not critical	2	3	4 very critical	5
4. How many different technologies are used in this building block? ('internal complexity')	1 few	2	3 different technologies	4	5 many
5. To what extent are the production technologies components of this building block and/or is the application of these new for PMS?	1 not	2	3 new	4	5 entirely

Step 3: Positioning in the Supplier Involvement Portfolio

By determining the values on the horizontal and vertical axis, step 1 and step 2, it becomes possible to position the building block in the Supplier Involvement Portfolio. This gives rise to the different types of collaboration relationship and the sequence in which suppliers are to be involved. In section 3.4, it has been argued that there are two fundamental decisions regarding supplier involvement in a development project: the extent of involvement and the moment of involvement. In this project management tool for PMS, the moment of involvement is a result of two other 'decisions' or aspects: the extent of involvement and the degree of development risk. First of all, there is a need for the involvement of those suppliers who are going to develop building blocks from the Strategic Development quadrant. Following this, the involvement of suppliers from the Critical Development, then Arm's-Length Development and finally Routine Development quadrants will subsequently be required.

G.4 Type of collaboration relationships

This section describes the various different characteristics of the collaboration relationships that are referred to by the Supplier Involvement Portfolio, see also Table G.2.

Strategic Development

Strategic Development is characterised by a high development risk and a high degree of supplier responsibility for the development. Using functional specifications as a starting point, the supplier is asked to prepare a 'global design' of the building block. It is for this reason that the supplier of the building block from the Strategic Development quadrant is the first to be involved in the PMS development project. A supplier must have been chosen prior to review 1/2 and the collaboration must have commenced.

The collaboration with the supplier is, at first, very close and interactive. This is because, particularly at the start of the collaboration, there is a large amount of information that has to be exchanged. During the creation of the 'global design' there is a need for a type of collaboration relationship in which PMS and the supplier use each other as 'sparring partners'. Regular verbal explanation is needed so that both parties can explain to each other what is desirable and what is possible. Among other things, this is necessary in order to ensure an appropriate balance between development capacity, costs and planning schedules. The verbal explanation is of particular importance for the transfer of know-how and experience. The collaboration must be such that PMS and the supplier are both working towards the same goal.

The process of information exchange must involve 'two-way traffic':

- functional specifications (set by PMS) and the global design (set by the supplier) have to be explained;
- the two parties must discuss any problems and solutions that arise as a result of (a lack of) experience; and
- both parties must understand the implications of changes in interfaces.

The communication structure must be suitable to facilitate this type of information exchange. Given that the information exchange must not delay the development project, there is a need for 'rapid' communication. The communication lines must be short so that, for example, development engineers from the supplier and from PMS can communicate directly with each other.

In order to ensure that the communication does not take place 'at cross purposes', a good project organisation needs to be chosen. This project organisation should ensure that consultation and agreement takes place internally between the different levels/departments and that there are no misunderstandings between the supplier and PMS. A steering group, for example, could meet periodically to discuss all changes and developments relating to the building block in question. In this steering group, there would be representatives at least from the Purchasing, Development and Project Management departments, both of the supplier and PMS, the representatives having the responsibility for distributing information that relates to the changes and developments to the relevant people in their own department/organisation. This cross-organisational steering group would therefore exist alongside the supplier's or PMS' internal project team. Another option would be for PMS to take part in the supplier's project team so that the supplier becomes the 'driving force' in the development. A further possibility is to place two or more suppliers of building blocks that have a lot in common in one steering group, so that there could be some joint development of a group of related building blocks.

Despite the fact that this collaboration is based on mutual dependency, that it is an uncertain, risky process and that the various parties must trust each other's ability to function, it is essential for the collaboration to be based on good, clear agreements. In order to prevent mutual trust from being damaged in any way, these agreements must be made before the collaboration is entered into. This may form an integral part of a development assignment (contract) in which agreements are made about what PMS will provide (specifications) and what the supplier should provide or deliver (in terms of product cost, quality, development time) and, perhaps even more important in this type of collaboration, what is to happen if the agreements are not adhered to. The evaluation of the 'soft' factors in the collaboration is very important in the case of this type of collaboration so that it can be improved upon in a subsequent development project (consider, for example, speed of response, openness, etc.). An evaluation should take place for each phase of the development project; the 'soft' factors will be of importance at the start of a project and the evaluation will become more and more business-like as the project progresses.

Critical Development

In the case of Critical Development the collaboration relationship is characterised by a high development risk and a low degree of contracting out of development. Often this involves possible interfaces, connecting pieces and transmission mechanisms, but also near-standard purchasing parts, many of which determine to a large extent the 'global design' of other building blocks. The proportion of the development that is contracted out to the supplier is small, or sometimes even nil, when no development is needed at all. Nevertheless, PMS needs information about the relevant products at an early stage in the development project because these products determine the further progress of the development project. There is often a need to obtain sufficient information about what is and what is not possible with regard to different solutions for technical problems, so that choices can be made and the development of other building blocks can go ahead. Because of the need for this information, PMS needs to focus on the technical specification of these products at a relatively early phase of the development project.

The collaboration with the supplier is geared mainly to obtaining the right information. It is important that Purchasing and Development work together in order to initiate and carry out market research early in the project. This market research based on the identified 'white patches' (unknown technologies, suppliers, products) must ensure that the technical risks that were defined at the start of the development projects can be solved or are covered before review 2/3. In the case of a Critical Development relationship, with regard to the allocation of regular production, very little assurances can be given to the supplier who is being asked to carry out a part of the development work. That is why it is so important in this relationship that agreements are made beforehand about the financial compensation for the development requested.

The information exchange is fairly one-sided: PMS asks the supplier for information. The supplier is involved in the development project for 'counselling' purposes. For this reason, the agreements that have to be made with a supplier in most cases relate only to the compensation for the development efforts (tests requested, test models or prototypes), because at this point in time it is often not yet possible to say whether the supplier in question will be given the regular production. After these agreements have been made with a supplier by Purchasing and Development jointly, the communication structure is made up (almost automatically) of the contact between the designers from PMS and those from the supplier. In the existing project structure, in the project team, all parties are kept informed about the progress/the outcome of the Critical Development.

Whereas in the Strategic Development relation it is a matter of arranging the feedback between PMS and the supplier in the steering group (because the communication is considerably more complex), in the Critical Development relation it is a matter of arranging consultation and agreement internally at PMS, to monitor the progress of the project. This can be done very well in the project team, and there is no need for a separate project organisation.

Arm's-Length Development

In the case of Arm's-Length Development a large part of the development is contracted out to the supplier, but the development risk is considerably lower than it is in the case of strategic development. The difference with Strategic Development is that the development is contracted out in a more formal manner, the collaboration is considerably less 'close'. On the basis of functional specifications and a global design, the supplier is asked to carry out the development independently. After the transfer of the functional specifications and the global design, the information exchange takes place upon the initiative of the supplier. It has to be made clear to the supplier that PMS works on the assumption that the supplier will ask for information if there is something he does not fully understand or if he feels that any detail is missing. For this reason, it is of great importance that the agreements are made beforehand and that they are clear so that the supplier will not be afraid to ask for information for fear of losing the assignment. On the other hand, the agreements are important for PMS in view of the fact that PMS is more likely to be kept up-to-date about any changes in terms of cost or time that may jeopardise the planning schedule.

Because the supplier develops independently and the relationship is much more distant than in the case of strategic development, it is very important that there is a communication structure that is clear to everyone so that proposed changes in costs, prices, planning schedules and specifications reach the 'right' person quickly. Both PMS and the supplier must appoint a contact person who is responsible for the communication between the two companies and for the distribution of information in each of their 'own' companies. Sub-teams, or 'Purchasing Teams', must be set up to arrange the consultation and agreement in one's own organisation. This project structure is necessary in order to monitor the progress of the development of those building blocks and so that the supplier's questions can be answered satisfactorily. The difference between this and a steering group (as in the Strategic Development relation) is that the supplier is not represented in a sub project team, the purchasing team, whereas in a steering group it is represented.

In this form of collaboration an evaluation of the development results in terms of time, quality and costs is important to enable improvements to be made in any future collaboration. It is important that the causes of faults are evaluated and recorded so that the next time better goals can be set.

Routine Development

Routine Development is characterised by low development risk and little or no responsibility for the development being held by the supplier. PMS draws up technical or purchasing specifications and asks the supplier for advice as to whether there are any improvements that can be made to these, taking into account the production and assembly capacity of the suppliers. The primary tasks for PMS include the co-ordination of all changes and monitoring to ensure that all prototypes are on time so that the construction and testing of the (system) prototypes at PMS is not delayed. In view of the fact that the building blocks from the Routine Development quadrant are the last to be dealt with in a development project, the delivery time of the prototypes comes under pressure when the development of the previous building blocks has taken longer than planned.

For this reason it is important that agreements are made in addition to those incorporated in the supply contract. These agreements relate to the compensation for making the prototypes and the dates for the delivery of the specifications by PMS and the delivery of prototypes by the supplier.

The collaboration consists mainly of the two parties keeping each other up to date about any changes in planning, costs and specifications. Because we are dealing with a larger group of building blocks here, the information exchange both to and from the supplier must take place mainly in writing (by fax or electronic mail) to optimise communication costs. With regard to the communication structure, one contact person must be appointed to take on responsibility for arranging consultation and agreement between the supplier and his own internal organisation. Distribution of information internally can take place via the existing project structure, in the project team and what is known as the Purchasing Release Team. From phase 3 onwards, this team deals with all changes fortnightly and, if need be, weekly. The evaluation of the collaboration relationship must be in proportion with the degree of collaboration and, in the case of routine development, it must therefore not be too extensive. One important evaluation criterion is the timeliness of the prototypes in relation to the timeliness of the specifications/drawings.

Table G.2. Characteristics of the different collaboration relationships

	Strategic Development	Critical Development	Arm's-Length Development	Routine Development
Collaboration	close collaboration as 'sparring partners', joint development	focus on obtaining information	'at a distance': independent development by supplier	informing each other about changes
Information exchange	'two-way traffic'	'one-way traffic', at the initiative of PMS	'one-way traffic', at the initiative of the supplier	everything in writing (fax or electronic mail)
Communication structure	'multi-level'	once agreements have been made, primarily between technical teams	via teams	via purchasing/sales channel

Project organisation	steering group in which PMS and supplier are represented, in addition to project team	via technical teams	via sub project teams, purchasing teams, per building block	project team and PRT
Agreements	focus on what should be done if the agreements are not adhered to	compensation of development performance	aims in terms of costs, quality and throughput time	delivery schedules and compensation for prototypes and start of production
Evaluation	for each phase, definition of factors for evaluation; 'soft' at first and later more business-like	periodic evaluation, mainly in terms of time and quality	'hard' quality, time, cost targets, deviation from these	limited, mainly timeliness of prototypes

Some examples taken from the Genius project may give an indication of the different kinds of collaboration relationships that occur. A building block that ideally should fall in the Strategic Development quadrant, is the *'rotation module'*, including the drive mechanism. The development risk is high, primarily because an essential new contribution is made to the functionality of the entire system by this building block, but also because of the fact that the development time is fairly decisive for the total development time of the project and because the building block is made up of components that use a fairly large number of different technologies. In addition, the 'desired' level of contracting out is IV, which means that the development is contracted out on the basis of functional specifications. Based on the knowledge of the supplier's market and of the suppliers that existed at the time, it was not possible to contract out at this level, so a lower degree of responsibility for the development was contracted out (i.e., level II).

For the *'pedestal'* (stand) it can be said, just as for the rotation module, that the desired level of contracting out was higher than the level that was ultimately opted for (the desired level was III or IV, instead of II). The difference with the rotation module is that the pedestal is better suited to contracting out on the basis of functional specifications using Arm's-Length Development because the development risk is considerably lower than it is for the rotation module. The development risk is lower because the new contribution being made to the functionality of the overall system as compared with previous systems is far less essential than it was in the case of the rotation module.

In an ideal situation, before an Arm's-Length Development is entered into with the supplier, decisions will have to be made about motors and drive mechanisms, for example. Decisions also have to be taken about the interfaces. A number of suppliers will therefore have to be involved for the critical developments, before it is possible to proceed with the Arm's-Length Development. An example of Critical Development are bearings. In this case the desired level of contracting out compared fairly favourably with the level achieved. The development risk is relatively high due to the risks that result from the new requirements which the bearings have to fulfil since essential new contributions are being made to the functionality of the system (for example, with regard to the speed of rotation). On the other hand, the level at which the responsibility for development is contracted out is minimal (level I). On the whole therefore, the supplier of bearings must be involved in a development project at a fairly early stage so that information can be obtained about whether it is possible to fulfil the new requirements. If in that way, the development risks can be made acceptable or even eliminated, it becomes possible to proceed with the development of the building blocks that depend on these bearings.

Examples of Routine Development are the potentiometers and the flexible hoses. Both have a low development risk and are contracted out at level I. Potentiometers are standard products that are purchased on the basis of purchasing specifications and flexible hoses are purchased on the basis of technical specifications (drawings). For these products the most important thing is to be available on time for the construction and testing of the system prototypes. The supplier of the flexible hose is therefore involved so that, by supplying prototypes, it is able to adapt the technical specifications to suit its own production capacity if necessary.

About the author

After having grown up in the Northern province of Friesland, Finn Wynstra moved to Rotterdam in 1987 to pursue his studies in economics at Erasmus University. In the subsequent period he has also been actively involved in various student associations, such as the economics faculty's study association. Parallel working experience has included three summers as a staff member in a mountain cabin in Jotunheimen (Norway), and two years as a student assistant at the department of Industrial Organisation of the Faculty of Economics. After spending half a year of studies in Uppsala (Sweden), Finn returned to Rotterdam to graduate in 1993, based on a study into subcontracting practices of the Friesian mechanical industry that he carried out at the research department of the provincial council of Friesland.

Finn Wynstra started as a doctoral student at Eindhoven University of Technology in Spring 1994. His research project on the involvement of purchasing in product development was partly carried out at Uppsala University, and with the support of the research foundation of the Dutch Association of Purchasing Management and various Swedish governmental organisations. Apart from research activities, Finn has been actively engaged in developing and teaching courses in the area of purchasing and supply management and organising study trips for the Uppsala Executive MBA Programme.

In 1998-1999, Finn Wynstra is continuing to work at Eindhoven University of Technology as a research officer and will combine this with visiting lectureships at Linköping University (S), University of Bath (UK) and Kellogg Graduate School of Management at Northwestern University (US).

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1. Purchasing Involvement in Product Development

J.Y.F.Wynstra

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Propositions

accompanying the doctoral thesis
Purchasing Involvement in Product Development

by
Jan Ysbrand Finn Wijnstra

Eindhoven, 10 September 1998

1.
Proposition no. 13 is true.

2.
The involvement of the purchasing function in product development has primarily been studied within the context of separate development projects. This does not acknowledge the possible contribution of purchasing to manufacturers' long-term product development strategies.

This thesis, p. 5.

3.
Since existing research in the area of purchasing involvement in product development resembles a loose heap of facts and ideas, it is not possible to speak of a coherent knowledge base:

'Science is built up of facts, as a house is built of stones. But an accumulation of facts is no more science than a heap of stones is a house' (Henri Poincaré).

This thesis, p. 5.

4.
Recent research has demonstrated that supplier involvement in product development does not always lead to reduced development time, reduced development costs and improved product quality. This does not imply, however, that supplier involvement is a wrong strategy. It rather emphasises the problems and difficulties in managing this involvement in the right way.

This thesis, p. 56.

5.
Since the essence of manufacturer-supplier collaboration in product development is not the involvement of suppliers as early as possible but rather at the appropriate moment, it is better to replace the widely-used term Early Supplier Involvement with *Timely* Supplier Involvement.

This thesis, p. 47.

6.
While most sociologists have given up the idea of the 'makeable society', many industrial engineering and management scientists still adhere to the idea of the 'makeable firm'. This is a clear sign that the latter science is not yet as mature as the first one.

7.
Essentially, all problems in the field of industrial engineering and management science are related to human behaviour.

8.
Christopher Columbus calling the natives he discovered in America 'Indians' is a typical example of a researcher who is trapped in his original research hypothesis and does not fully appreciate what the empirical findings actually tell him.

9.
The firm belief in the positive effects of research project planning on project throughput time is at odds with empirical findings that in uncertain, high-velocity situations, extensive project planning simply wastes time, as opposed to an experiential strategy of building intuition and flexible options.

Eisenhardt and Tabrizi, 1995: 101-105.

10.
The researcher who keeps both feet on the ground never gets any further.

11.
Claiming that a large-scale survey yields better information about companies than a single case-study is similar to claiming that a series of one-night stands produces more reliable data about partners than a long-term relationship.

12.
Pursuing a PhD research project is much like preparing a difficult Chinese dish:

'Do not ask how I am going to make it. I will only know that when I'm finished'.

(Master Chiu, in *Eat Drink Man Woman*, directed by Ang Lee, 1994).

13.
Proposition no. 1 is untrue.

After: Gödel, Escher, Bach - D.R. Hofstädter, 1988.