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PROXIMITY MATTERS?

Geographical aspects of changing strategies in automotive subcontracting relationships:
the case of domestic suppliers to Volvo Torslanda assembly plant

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Abstract

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This study analyses the significance of geographical proximity in the restructuring process of a domestic subcontractor system in the Swedish automotive industry, using the Volvo Torslanda assembly plant as a case. The focus is on: i) the organisation of buyer-subcontractor relationships, ii) time-related delivery strategies, iii) the significance of geographical proximity. The findings provide an empirical contribution to the general understanding of the geographical buyer-subcontractor relationships in the automotive industry.

The case covers the development of the domestic subcontractor system in the 1990's and is subdivided into three parts: i) the 40 most important domestic subcontractors in 1996/97, ii) the development of the Arendal supplier-park project 1997-1998, and iii) an analysis of Hydro-Raufoss Automotive Plastics AB, a Norwegian subcontractor, 1993-1998.

Up until 1996/97 geographical proximity played a marginal role in the organisation of domestic subcontracting. The system was in the initial stage of an organisational restructuring, showing the first signs of an emerging subcontractor hierarchy. The average delivery frequency increased from weekly to daily deliveries during the 1990's, facilitated by a good infrastructure.

Proximity became an important strategic factor with the development of the S80-model, launched in 1998. The main reason was the accelerating use of sequential production on the Volvo assembly line, which directly integrated the production processes of Volvo and its subcontractors. To better respond to the tight time schedule, a number of subcontractors established operations in the new Volvo-led supplier-park, five minutes from the assembly plant. In the introductory phase, there were no explicit plans for subcontractor co-operation. Instead, the park served as a "delivery-point" where incoming components were sorted in sequence and delivered to Volvo on an hourly basis. An exception to this was Hydro-Raufoss, which had developed from a delivery-warehouse into a complete production unit.

The launch of new models offers an opportunity to implement structural changes in the subcontractor system. Whether the recent change in Volvo's ownership will also have a bearing on this is, however, a moot point.

Keywords: automotive-industry, Hydro-Raufoss Automotive, just-in-time, location, proximity, sequential deliveries, subcontracting, supplier-park, Sweden, transportation, Volvo

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At last, the end of a long journey is reached. The trip has not always taken the shortest route, but on the other hand, I have learned to keep up even when I have felt completely lost in the deep forests of aims, questions, references, theories and models. Now it is over, and I will take the opportunity to thank all of you who have contributed to my work.

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Göteborg, 17 november 1999

Anders Larsson

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1. Introduction

1.1 Background

Imagine an automobile assembly plant with thousands of different components that have to be put together in the right order to make up the finished product. Thousands of employees are needed for the assembly process. Not just to physically add the parts to the body but to supply materials, co-ordinate the production, maintain the equipment and much more. At the same time, the company is committed to very high quality standards, every car that comes out of the factory has to meet the customer's expectations.

This alone obviously requires planning and co-ordination on a high level. The exercise becomes even more complicated if we take into consideration that the majority of the value of the components is manufactured by outside suppliers. To make it even more difficult, the assembly firm has decided on a strategy that focuses on minimisation of unnecessary materials in the production process. It means, among other things, that inventory levels and safety buffers held at minimum levels. Furthermore, suppliers have to deliver several times per day directly to the assembly line. This might sound like an impossible mission, a two thousand-piece jigsaw puzzle that has to be laid every day, but it is a reality for most firms and their suppliers in the automotive world.

This thesis is about one particular automotive supply system, namely the one used by the Volvo Car Corporation assembly plant in Göteborg, Sweden. The conditions for controlling the supply system are particularly demanding, because in addition to what has been said above, the assembly plant is located almost 700 kilometres from the European economic centre, in terms of important suppliers as well as markets.

One significant element, which has put the automotive industry in the forefront of new purchasing and production practices, is the complexity and size of the production system. A relatively modest producer such as Volvo has to manage several hundred suppliers located across Europe, as they deliver continuously from weekly to 30 minute intervals depending on the product. In order to organise supplier relationships in a more efficient way, assembly firms have led the development towards fewer suppliers who deliver directly to the assembly-firm. These selected suppliers are supposed to co-ordinate the flow of components from the former direct suppliers, creating a new hierarchical structure with many features similar to the Japanese model of buyer-supplier organisation.

There are a vast number of aspects involved in the continuing restructuring process of the global automotive industry and its suppliers. One fundamental process is the new production and purchasing philosophy which has been gradually implemented during the last decade. The concepts most commonly known are probably "just-in-time" (JIT) production and different forms of quality-programmes.

These have been the tools used to restructure the automotive supply-chain towards what Womack, Jones et al. (1990) termed "lean production". The major components of this development have been a combination of minimised inventories, production to customer orders and outsourcing of responsibility for production and development to suppliers. This has been inspired by the Japanese experience, but the final outcome has been adapted to local conditions.

The restructuring process has created new conditions for suppliers, not only in terms of new products and increasing R&D responsibility, but also within the field of logistics. With inventories held at minimum levels and a growing number of product variants to be produced directly to customer orders, the physical co-ordination of the supply chain has come in focus as a strategic competitive factor for the entire business.

So, in a situation where time-based competition and supply-chain management have become increasingly important for automotive producers, what is the situation for an assembly plant (and company) based in the EU-periphery? The majority of the purchase-value of a car produced at the assembly plant in Göteborg originates from first- and second tier suppliers located on the European continent, mainly Germany. This means longer transport times, lower flexibility and higher costs compared to competitors.

The relatively peripheral location is nothing new to Volvo, but the conditions for maintaining a competitive time-efficient supply system are changing rapidly. With many of their strategic suppliers located on the European continent, increasing levels of outsourcing and demand for frequent and reliable JIT-delivery will place the question of geography and proximity on the Volvo agenda. This process is currently reshaping the geography of the supply-system, and this study will try to provide an empirical example of how these new conditions have been handled and spatially manifested.

The restructuring process among the Volvo suppliers has implications outside the supplier-system boundary as well. The automotive industry is one of the most important manufacturing industries in Sweden in terms of employment. This is even more accentuated for the south-western region where the bulk of both assembly and supplier activities are located. Earlier studies regarding the impact of the automotive industry on employment and regional development have, in most cases, been based on official statistics or other classifications in order to produce some sort of general statements about the importance and characteristics of automotive suppliers.

This study is one way of adding to this knowledge from a more detailed, empirical viewpoint. Findings from the investigation of the Volvo suppliers may provide new insights and angles to an already well-debated and analysed industry, but one still big enough to be regarded as a major engine for the regional economy. This position is undoubtedly being influenced by the globalisation processes within the industry. One obvious factor is the recent (spring 1999) purchase of the Volvo passenger car business by Ford, which in a longer perspective most likely will involve changes in purchasing and consequently have influence on the supply-system.

The local and regional impact of the forces of globalisation is more easily seen in the supply-system where multinational supplier-groups have been very active in acquiring Swedish-owned suppliers. By focussing on the suppliers to one particular assembly-plant these changes can be discussed and analysed in more detail. A case-study may provide a more complex picture of the forces involved in the current restructuring process.

Producing a passenger car can be regarded as a complex exercise in technological development, production organisation as well as in logistics co-ordination. The geography of the industry has to a great extent been analysed through "globalisation" glasses, where questions regarding global sourcing, "world cars" and the diffusion of the Japanese model of production have been in focus. Several authors have realised in recent years that technological and organisational trajectories are much too company and place specific to be lumped together under one label termed "the global automotive industry" (Freyssenet and Lung 1998). In this perspective, this work is an attempt to focus on the specifics of Volvo and its suppliers, in order to add to the understanding of the complex forces behind the changing geography of automotive suppliers.

1.2 Introduction to the research problem

One can study automotive supply restructuring in a multitude of ways. In terms of geographical scale, the problem ranges from the global trade of goods to individual actors within one single company or production unit. Important factors of explanation depend on the approach taken, including topics such as: the product, technological development, workplace-conditions, employment generation or regional importance. This thesis will study the geographical restructuring of the Volvo Torslanda suppliers in Sweden using two main aspects of buyer-supplier relationships:

- *Technological relationships.* This aspect of buyer-supplier relationships is concerned with questions regarding the technological aspect of the product and its development. One basic assumption is that new forms of buyer-supplier relationships in the automotive industry require increased levels of co-operation in the product-development process. This creates a new structure where a small number of large suppliers will establish themselves as first-tier suppliers.

The major technological development will take place between these large suppliers and the assembly-firms, where the suppliers are expected to take more responsibility for product development and co-ordination of the sub-suppliers upstream in the production process.

As the first-tier suppliers grow and widen their knowledge base, the relationship with assemblers will become more interrelated and built on mutual trust and understanding. Technological and business information have to be transparent to a greater degree if new components are to be developed jointly between supplier and assembler. In the process of selecting new suppliers, price-based competition will lose in relative importance to factors such as product development capacity and long-term commitment.

In figure 1.1, technological relationships are represented on the vertical side of the matrix, labeled important or less important. A supplier at the "important" end of the vertical axis is characterised by products which are developed in close co-operation with the customer, hence the importance of the technological relationship. This is taking place parallel to routinised every-day transactions, but the rationale for using a supplier in this group is their ability to provide knowledge and capacity on a high technological level.

- *Transport relationships.* This aspect of buyer-supplier relationships is represented on the horisontal side of the matrix, and has its focus on questions associated with the physical flow of products in the supply chain. Parallel to the development within the areas of product development and manufacturing, the demand on deliveries increases dramatically. Automotive assemblers require that first-tier suppliers deliver several times per day, in many cases in the same sequence as the cars appear on the assembly-line. This is combined with strategies towards minimum inventories of incoming components, thus producing a system that is extremely dependent on reliability in deliveries, especially in the last stage from the first-tier supplier to the point-of-assembly.

  A high level of importance regarding transport relationships on the horisontal axis is often associated with frequent deliveries and sequential JIT-production, while a position on the left side of the axis implies that the production process of the buyer and suppliers is connected in such a way that delivery-precision is not of critical importance.

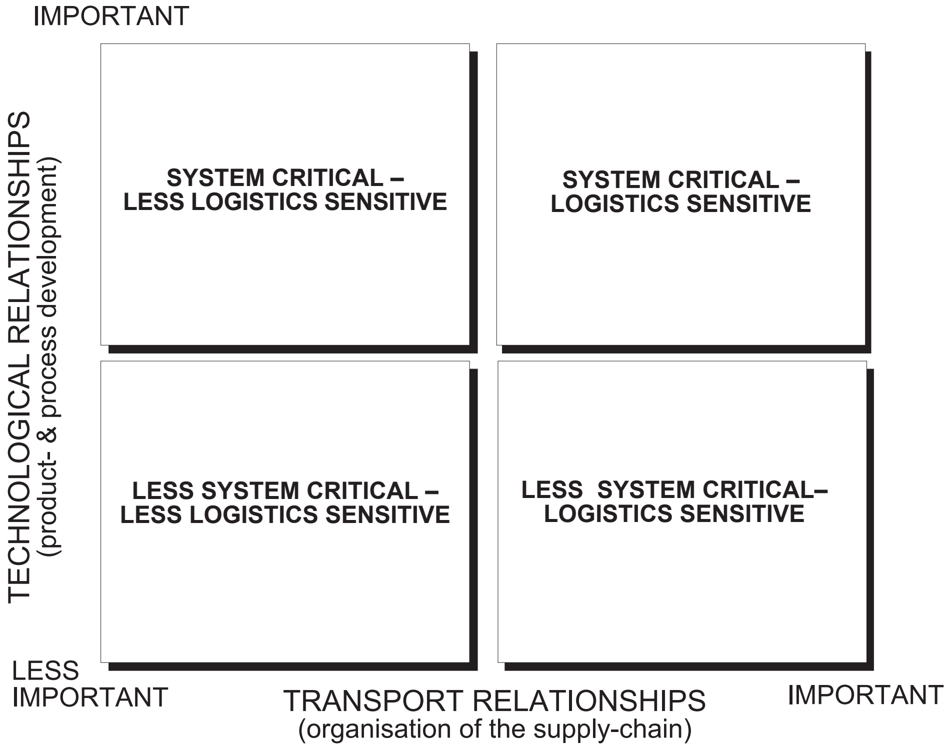


Figure 1.1: Typology of suppliers based on the importance of technology- and transport relationships. *Source:* Author

The matrix illustrates the way in which the changing geography of buyer-supplier relationships will be approached in this work, and should *not* be interpreted as a theoretical proposal to be verified or rejected. It is important to emphasize that the boxes in the matrix are archetypes. Within each category, different variants exist, from the extreme to cases which may overlap groups. In the following, the terms technological- and transport relationships will be used to structure the conceptual as well as the empirical analysis and presentation.

If we take into consideration the technological- and transport relationships, it is possible to distinguish four categories of suppliers with different locational strategies. At this stage of the study, the categories are only used as points of departure for the continuing discussion in the following chapters. It is important furthermore to emphasize the function of the matrix as a pedagogical tool, rather than a model for quantitative analysis.

Starting at the top right box of the matrix, we can place suppliers with a "cutting-edge" technology and organisation, specialising in certain segments. The companies often have a strategic function in the production process. These firms are important to the parent firm both as their product-development partners and as major logistics actors since products are involved in sequential just-in-time production arrangements. Suppliers in this category function as co-ordinators of both product development and deliveries from several tiers of underlying sub-suppliers.

Companies or production units in the bottom right box are characterised as having a high degree of importance towards the customer in terms of their transport relationship, while the main product development facilities are located elsewhere. The production volume and delivery requirements make it important to be located close to the customer. A large parent firm will probably be able to put pressure on the supplier to relocate due to the high logistics/transport costs involved. One strategy is to locate a new warehouse facility close to the customer and use it as a "delivery point". This form of spatial organisation allows for spatial proximity towards several customers, without having to relocate the traditional manufacturing facility.

Moving towards the left side of the matrix reduces the importance of logistics and physical deliveries. Suppliers in the upper left box would show the same characteristics as those discussed first, but with the important difference in physical delivery requirements. The supplier may be large enough (sometimes bigger than the parent-firm) to organise itself in space. Production and delivery functions are not sensitive to delivery frequency and speed, since the the product is not as voluminous or variant-dependent so as to be subject to sequential deliveries, and consequently less inclined to move to the right in the matrix.

In the bottom left box, we can find a supplier with a product of a general type, designed for a variety of markets. The value and technological content of the component is relatively low. There is no incentive for an assembly-firm to engage in any long-term relationship since the product can be purchased on the market from several different independent sources. This type of firm could be expected to move down in the supply-pyramid and become a second- or third-tier supplier, or to leave the automotive business for other business-sectors.

To sum up the discussion so far, we have put forward a number of hypothetical supplier-types with different locational strategies. The most demanding in terms of geographical proximity is the need for physical deliveries according to tight time restrictions. Important technological relationships may require proximity as well, but then linked to personal interaction in the process of the transfer of knowledge.

1.3 Aim, research questions and limitations

The aim of this thesis is to *analyse the significance of geographical proximity in the restructuring process of a domestic supply-system in the Swedish automotive industry, using the case of Volvo Torslanda assembly plant.*

In order to meet the general scope, the following research questions will form the basis of the work:

1. What constitutes the organisation of buyer-supplier relationships at Volvo Torslanda assembly plant over time?

2. To what extent have time-related delivery strategies been adopted by Volvo, and what has been the content of these strategies?

3. What has been the significance of geographical proximity in the restructuring process of the domestic Volvo Torslanda-suppliers?

4. In what areas can the Volvo case study contribute to the general understanding of the geography of buyer-supplier relationships in the automotive industry?

The theoretical part of the work is concerned with buyer-supplier relationships in general, although most of the discussion is focused on the manufacturing industry. This limitation is due to the fact that the aim of the study is closely connected with physical flows of material which are less prevalent in service industry relations. It should be pointed out that the concept of *relationships* between suppliers and their customers will be used in terms of their relative change, not being measured and quantified. In some parts of the empirical analysis, supplier relationships are actually measured (e.g delivery frequency), but the general results and conclusions are based on the relative change over time.

In the formulation of the aim, the term *restructuring process* is used to summarise a number of tendencies within the automotive supplier business. These are not directly penetrated in the study, but discussed extensively in chapters 4–6 as a background to geographical restructuring processes.

The automotive sector is one of the most researched and debated within the area of supplier restructuring, and this provides a wide range of literature and examples with which to relate the theoretical discussion. The limitation to the automotive industry might affect the degree of generalisation in the results, a question that will be more thoroughly discussed in section 1.6 below. On the other hand, a concentration on one industrial sector provides a basis for more an in-depth discussion and analysis of forces behind supplier restructuring and its spatial connotations.

The empirical part of the work consists of three different, and partly overlapping studies. Firstly, a study of the 40 most important (in terms of purchased value) Swedish suppliers to Volvo Torslanda between 1996-97, secondly an investigation of the supplier-park established by Volvo in 1998 and finally a case study of one supplier company. This choice is mainly a result of earlier studies and contacts with key persons within Volvo. The main reason for the concentration on domestic suppliers is connected to the intensive research methodology used. For a more comprehensive discussion on methodological problems see chapter 1.5.

1.4 Structure of the thesis

The thesis can be divided into five main parts. Chapters 1–3 form the *first part*, including background a and theoretical frame of reference. There is, furthermore, a presentation of different definitions and concepts regarding subcontracting as a phenomenon. This part is intended to work as a conceptual base for the rest of the work and will provide a ground for a further discussion of the Volvo case. In relation to the research questions presented earlier, this first part of the thesis is mainly associated with the last question and the general discussion in the concluding chapter.

The *second part* consists of chapters 4–6. The first of these chapters deals with questions associated with technological relationships, while chapters five and six have their focus on questions connected to the transport relationships between buyers and suppliers. This part of the work contains a discussion of major concepts within the restructuring of the automotive supplier industry. Included here is also a presentation of other studies on the geography of automotive supplier relationships. The aim of the second part is to discuss concepts and processes central to the empirical study. It refers chiefly to the first research question and will form the backdrop against which the Volvo case will be analysed.

The *third part* of the thesis, chapters 7–8, is an introduction to subcontracting in Swedish industry in general, and the automotive industry in particular. This is completed with a presentation of Volvo and the context of the empirical investigations. This section is closely linked to the first research question, to describe and analyse the changes in supplier organisation at the Volvo Torslanda plant over time.

Chapters 9–13 form the *fourth part* of the work and include the empirical material from three different levels of the Volvo Torslanda domestic supply-system. Chapter ten is an analysis of technological relationships vis-à-vis the largest domestic suppliers to Volvo Torslanda. The following chapter concentrates on transport relationships. Chapter twelve is a study of a supplier-park project located adjacent to the Volvo Torslanda plant and chapter thirteen narrows the scale even more with a case study of one single supplier company. All of the chapters in this part of the thesis are focused on the second and third research questions presented earlier. Time-related questions are more accentuated in chapters eleven and twelve, while the question of proximity forms the basic problem through the entire empirical section.

Part five of the work consists of the concluding chapter, where a tentative model of different supplier-types and their geographies is presented. The purpose is to discuss the general aim of the thesis and analyse the Volvo-case in the light of the automotive industry. The findings will also be discussed in terms of their possibility to contribute to the understanding of the automotive industry in general.

1.5 Methodological considerations

Methodological approach

The methodological questions in this work are divided into two parts. This section discusess general problems in connection the methodology used in the thesis, while specific issues regarding the empirical investigations are presented in chapter 8.2.

In order to study the complex process of automotive industry restructuring, this thesis will use a number of different theoretical and methodological approaches as starting points. There is no single framework to be used as a theoretical base, to be tested and verified in the writing process. It is more appropriate to characterise the work as an empirical exploratory study where different approaches are used as analytical frameworks depending on the question and geographical scale. Analysis at company-level requires a different methodological approach compared to an entire national system of suppliers, although the basic research question might be similar.

One important inspiration has been the work of Andrew Sayer (Sayer 1992) on critical realism, especially its methodological aspects. It provides a theoretical foundation for the use of multiple methodological approaches based in empirical research. Sayer means that observation and knowledge are "theory-laden" rather than theory-neutral or theory-determined (Sayer 1992:83). Explanation is characterised by the distinction between abstract "thoughts" and concrete "real objects", and a realist researcher is engaged in a conceptualisation process where mechanisms of causality are context dependent (Lawson and Straeheli 1990).

The abstract–concrete dichotomy provides the possibility to do theoretically informed case studies based on the interplay between theoretical conceptualisation and teh empirical study of real objects. The important point is that *theory acts as a guide* in the research process and consequently different theories can be used within a realist framework.

Sayer (1992:243) illustrates the differences between realist and positivist research by an example of practical research design in terms of *intensive* or *extensive* research. The first alternative deals primarily with problems concerning a single case or a small number of observations, while the latter handles more traditional studies of general patterns and representative samples. It is important to point out that this distinction is not merely a matter of scale (Pratt 1995), the respective strategy implies basically different assumptions about the degree of representation and generalisation. The use of an intensive research approach will produce causal explanations of certain events or objects which do not necessarily have to be representative, but give an insight into relationships and processes which are normally hidden behind generalised groups or averages in extensive studies.

This study uses the realist framework in order to be able to understand and partly explain processes in the automotive supply industry. Basic concepts such as subcontracting and just-in-time are studied and reinterpreted with reference to the concrete reality in the form of supplier firms in different settings. (Kalsaas 1995) has studied similar problems within the automotive industry using a realist approach, providing the possibility to develop concepts during the research process.

Research method

The distinction between intensive and extensive studies is relevant to this study in two ways. Firstly because the causal links to be studied, namely automotive buyer-supplier relationships, can not be found in official statistics. These are gathered and presented according to industry, without taking into account where companies or production units are placed in the value-chain. If the aim is to explore the dynamism and geography within these relationships, an extensive type of study will by definition have to make assumptions about what generally constitutes an automotive supplier. The use of an extensive design will allow for a deeper understanding of the forces behind the restructuring process in question.

Consequently, the latter type of study will not be able to make general conclusions about buyer-supplier relationships, or even such relationships in the automotive industry. In this particular case, the alternative route is to use and re-classify official data in order to come as close to a representative selection of automotive suppliers as possible. Given the problems associated with the re-definition of official industrial statistics into functional groups such as automotive buyer - supplier relationships, this study will apply a research design which is basically intensive in its aim to understand processes and relationships rather than general patterns.

In order to come to a better and deeper understanding of the geography of new supplier relationships in the automotive industry, the following study will focus its empirical investigation on suppliers connected to the Volvo Torslanda assembly plant in Göteborg. Data has been collected on three different levels; the national supply-system of Volvo; the Arendal supplier-park and the firm Hydro-Raufoss Automotive Plastics. These objects of study have been studied with different research methods, such as open-ended interviews, semi-structured telephone-interviews and postal-surveys. This will be discussed more thoroughly in the sections below.

Selecting the cases

The empirical investigations within this thesis can be divided into two main parts based on the methods used to collect information. Interviews with managers at Volvo and supplier firms were one source of information, while a more standard type of telephone-based questionnaire constituted the second type of method to gather information. In this section we will focus on the gains and shortcomings of interviews and case studies, while the problems of conducting surveys with questionnaires will be addressed later in this chapter.

One single case was selected as the object of study, namely *the domestic system of suppliers to the Volvo Torslanda assembly plant.* This can be divided into several sub-levels using what Yin (1989) terms an embedded case study. Data on the national supply-system was collected via a standardised questionnaire using telephone interviews. This will be discussed in the following section. This data is complemented by more detailed studies of the Volvo-led supplier-park project in Arendal adjacent to the Torslanda facility, and finally a case-study of the firm Hydro-Raufoss Automotive Plastics.

The decision to focus the study on the case of suppliers related to one single production unit (Volvo Torslanda assembly plant) was based on the need to be able to make a detailed intensive study within a realistic period of time. Excluding other automotive companies such as SAAB and Scania limited the possibilities for comparison and more general conclusions, but on the other hand made it possible to concentrate the analysis to the strategies and trajectory of one organisation.

This, at the same time, creates a methodological problem since one of the main tendencies in the automotive supply sector is the rapid internationalisation. This is especially evident in the case of Volvo with its international supply-base and the recent purchase of Volvo's passenger car business by Ford. The exclusion of suppliers located outside Sweden will limit the possibility to analyse the important international aspect of the Volvo supply system.

The influence of foreign companies is, at least partly, illustrated in the study of the supplier-park in Arendal and in the case of Hydro-Raufoss. It is important to keep in mind that the findings in this work are limited to the situation and conditions in Sweden.

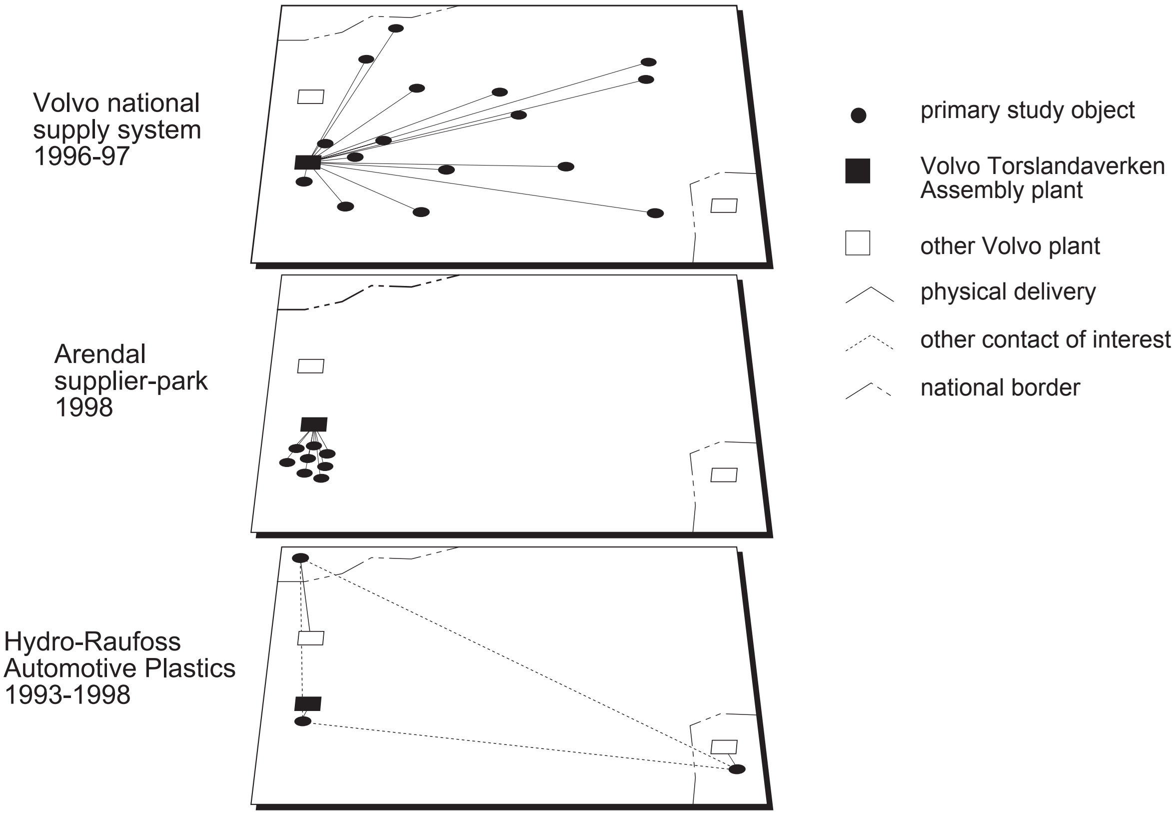


Figure 1.2: Illustration of the units of analysis and time-periods covered by the empirical investigation. *Source:* Author

One important aspect of how the study of suppliers to Volvo is subdivided is the need to follow the process of restructuring while it is actually changing. The study of the domestic supply system cover the period 1996-97, when the new production strategies belonging to the S80-model had not yet been manifested in any spatial restructuring. The transitory stage of the late 1990's is covered by the study of the Arendal supplier-park as well as the company study of Hydro-Raufoss Automotive Plastics.

Both the supplier-park and the Hydro-Raufoss examples were selected as "critical cases" (Yin 1989:47) in order to focus on the basic research question of the relationship between geographical proximity and new forms of production organisation in buyer-supplier relationships. By studying the supplier-park it was possible to analyse the forces behind the formation of a new space, where several suppliers to the Volvo Torslanda Plant are active and located closely together, and at the same time only minutes from the assembly plant of the customer.

The selection of Hydro-Raufoss Automotive Plastics was guided by its position as the first Volvo Torslanda supplier to be engaged in sequential just-in-time production and deliveries combined with a location close to the assembly plant in Göteborg. This was taken as an indication that the company could provide useful information about the processes behind time-related restructuring in the automotive industry.

To conclude, we can see that the selection of cases for the study is focuses on suppliers to the Volvo assembly plant in Göteborg. The geography of buyer-supplier relationships is then studied on three levels: the national, the supplier-park, and the single firm. In order to obtain data from these different levels, a number of methods or techniques were used, these will be discussed in more detail in the following sections.

Using personal interviews as a method for data acquisition

The use of an intensive research design has involved a number of personal interviews with managers, entrepreneurs and others that could provide useful information for the project. Interviews have major advantages compared to questionnaires in the fact that they involve a direct personal face-to-face contact, giving the opportunity to get direct access to information from the persons who participate in strategic decision-making. But the other side of the coin is that the information from personal interviews is dependent on the interpretation of the researcher, and thus a result of the degree of trust that has been built up during the process (Schoenberger 1991).

This section will discuss the use of personal interviews, which have been an important source of information throughout the work. The first stages in the project involved a series of interviews with Volvo managers from several parts of the organisation such as production, logistics and strategic purchasing as well as with a number of Volvo suppliers. These were all open-ended, unstandardised interviews, which mostly worked as a dialogue in the form of a one-hour conversation. Some interviews, especially in the initial phases of the project, could turn into more of a lecture from the respondent. This is discussed by Schoenberger (1991:182) in terms of a control problem.

On the one hand, a very dominant respondent could take control of the interview and lead it in directions that are irrelevant for the research problem. On the other hand, a too strict strategy might limit the flexibility of the interview-method. In the majority of cases, this was used as an opportunity for the respondents to elaborate to a certain extent. The "taking-over-the-interview" behaviour was often caused by an urge to tell an interested outsider about their work, rather than lecturing an academic on how things were supposed to be in the "real world".

Several authors distinguish the good interview situation as one characterised by mutual trust; rather a dialogue or conversation than a one-sided interviewer controlled situation. Healey and Rawlinson (1993) refer to the term "sympathetic understanding", while Schoenberger (1991) uses "collaborative dialogue" to describe an ideal interview condition. To create this atmosphere of mutual trust is partly a question of personal social skills and partly based on good preparation.

The most significant result of the interviews in the early stages of the thesis was the further contacts into the large Volvo-organisation, and in the case of suppliers, a number of contacts which turned out to be important for the firm case-study. It could be characterised as a process of learning and networking with company interviews as the driving force. It was also through a series of interviews with the purchasing department that the possibility was opened up to use the internal supplier-list as a basis for the phone-based questionnaire of the national supply system.

The major problem with personal interviews is that results are open for interpretation. During the interview and at the stage of putting together the notes or the recording of the conversation, a good level of knowledge of the firm and the industry is essential in order to evaluate answers and pose additional question on the subject. It is also important to have in mind that the language of academics and practitioners is different in many areas and it is especially important is to avoid an excess of theoretical discussion since most business-managers can not be expected to follow the economic-geographical academic debate.

Here a mention should be made of the work by other scholars at the department (Ellegård 1983; 1989; Alvstam and Ellegård 1990; Lorentzon 1998), which have influenced my thinking on how to conduct Volvo-related research.

One particular problem which has not yet been discussed is the importance of *the double hermeneutic* Sayer (1992), which highlights the fact that the observer and the observed have different frames of reference which influence the way they perceive and explain concepts and ideas. This can be a problem where for example managers use expressions and concepts that have different meanings in academia and business.

Connected to this discussion is the problem, especially in the supplier-interviews, where the informant would suspect me of reporting to Volvo. If this problem is not discussed openly it might distort the answers in the entire interview, since the supplier does not want to reveal "sensitive" information to the parent firm but at the same time wants to be helpful and give information. To avoid this situation, much attention has been put into presenting the researcher, the project aim, and how it is financed independently of Volvo. It has furthermore been stressed that results would not be published in such a form that single companies could be identified.

Using questionnaires and telephone interviews

As mentioned earlier in this chapter two types of methods were used during the data collection. Personal interviews were seen as too time-consuming in when studying the Volvo supplier system on a national level, and therefore a combination of interview and questionnaire was chosen as the primary data collection method for the national study.

The technique was based on telephone interviews with key-persons at the respective supplier production unit. Healey and Rawlinson (1993) discuss the growing popularity of telephone interviews as a relatively cheap and time-efficient method. However, more work is involved in building a trusting relationship compared to face-to-face interviews. The authors recommend telephone interviews when there are a small number of simple questions to be answered. It is especially important that the respondent have immediate access to information otherwise is there a risk that answers will be based on "guesswork" or not reported at all.[1]

In order to introduce the project and the context in which the information was to be used, all of the selected suppliers were contacted by telephone in order to arrange a time for an interview. After the initial contact was taken and a key-person was identified, the questions were faxed to the respondent before the interview was conducted. This gave the person a good feeling for the field in which I was interested, and furthermore it gave time to prepare and collect additional information.

The questionnaire, which was faxed to each supplier was standardised and had only one open question (see appendix 1). It was intended to be used together with the telephone interview. One problem with this approach was the cases where respondents filled in and returned the questionnaire in order to avoid an interview. These responses were carefully studied and if any uncertainty appeared, the respondents were contacted by telephone.

One important aspect of telephone interviews is the possibility of achieving a higher response rate compared to postal surveys. The experience from this study is that the first telephone contact was the most important in terms of the response rate. It is not as easy for a business manager to refuse a telephone inquiry to participate in a study, as it is to ignore a written document. This strategy depends on the availability of the key person at the time of the telephone call, but with modern communication tools such as mobile phones this is relatively easy to overcome. One example from the study was a supplier from a small town who had re-routed the phone and answered at the Charles de Gaulle airport in Paris, obviously not prepared to answer any questions but able to set a later date for an interview.

1 For examples of company or industry studies based on similar methodology see: Ivarsson (1996) and Jordan (1992).

As discussed in the previous section, the way the suppliers interpreted my relation to Volvo was of great concern for the amount of information and detail they were prepared to give away. I became aware of this at an early stage of testing interview questions, and therefore put great effort into explaining may position as an independent, university-funded, postgraduate student. Results had to be presented in such a way that single suppliers could not be identified, this was an important issue for many suppliers. This was also the most important restriction from Volvo for using their supplier-list as an address database.

Even though I had a supplier list from Volvo, the interview process, including identification of key-persons, setting dates for interviews, doing the interviews, analysing answers and finally contacting again for additional information took a considerable amount of time. This resulted in a problem where the first interviews were conducted in late 1996 and the bulk during the following year. In order to make data comparable, information on time-related information was to cover either 1996 or 1997. This period did not involve any major changes in sales or organisation for Volvo and therefore it is assumed that information for the two years is possible to combine into one data set.

1.6 The automotive industry in a general context

This thesis will draw its empirical findings from the *automotive industry* in general and Volvo and its domestic supplier base in particular. The advantage of such a strategy is the depth and richness of detail that a case study provides. At the same time, there is a methodological problem concerning the possibility of generalising from the results. One way to avoid carelessness in the generalisation of the results from this study is to point out the context in which the automotive industry is positioned. The following section will discuss several dimensions which characterise and position the automotive industry in relation to other industrial sectors.

There are few products and production systems that show the same advantageous conditions for the restructuring of supply-chains as the automotive industry. It is at the same time a high-value product sold in a mass-market with a highly consumer-driven production and development process. Combined with this is the high degree of subcontracting and division of labour which emphasises the importance of co-ordination and a rapid diffusion of end-customer demand regarding quality and time upstream in the value-chain.

The automotive industry displays a combination of product and process characteristics associated with a mass-market product together with highly flexible features. This is especially valid for cars in expensive segments such as Volvo, where customisation and exclusivity are important marketing strategies. The end-result is a product and production process with a rather unique combination of high-volume, high-value and high-flexibility which is not possible to generalise directly to other industries. But, on the other hand, these features have contributed to the fact that the automotive industry plays a leading role in the implementation of new strategies for supplier restructuring, and thus provide the most extensive example of the spatial aspects of supplier restructuring processes.

In figure 1.3 below the automotive industry is compared to other industries in terms of the position in the value-chain which, in most cases, also reflects the degree of complexity of the product. The actors in the automotive industry are positioned at the top end of the chain, with their special conditions for production and product. An assembled car consists of thousands of components, while the end product of a steel-mill, for example, is produced from only a handful of inputs. Process industries such as many chemical plants might be vertically integrated in local petrochemical complexes delivering only a few specialised products. Generally one can say that the further up in the chain you go, the more complex the product. The box labelled specialized producers of finished products, contains e.g. ball-bearings, metal-manufacturing products, paper and board or specialized chemical products. These are indeed very different from a car or a computer in terms of the scale of production, complexity, production-process, amount of capital involved, number of variants, types of customers and relationships to suppliers.

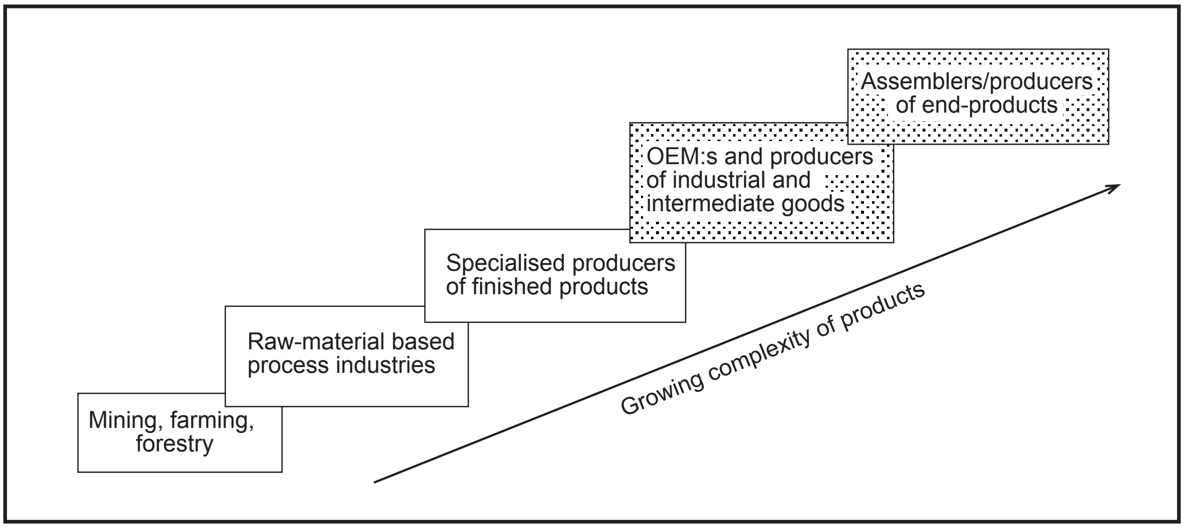


Figure 1.3: Stages in the value-chain. Shaded boxes indicate the area of interest in this study. *Source:* Author

This is shown in the case of the German chemical production (Bathelt 1998) where the conditions and growth trajectory appear to create very limited prerequisites for flexibility and supplier restructuring. The study shows, however, that product categories with a high degree of customer relations and segmented markets had significantly higher degrees of flexible arrangements.

Industries based on raw materials, such as basic chemicals, pulp and steel, almost without exception selling their products as input to commercial customers, thus reducing the degree of end-customer demand compared with producers of finished goods. These industries are, at the same time, very different from the automotive industry in terms of their competitive focus. Many industries in this category are competing with their process rather than their relatively standardised end-product (Bathelt 1998).

Another aspect of this is the type of production process, exemplified by mass production in the case of the automotive industry or single large projects such as power-stations at the other extreme. Even within the automotive sector there is a significant difference between passenger cars, trucks and buses in terms of product value and production volume (Elsässer 1995). Higher unit values and lower volumes mean that JIT production à la passenger-cars does not necessarily have to be applicable to trucks. In this context, it is important to point out that there is a significant degree of variation between different companies even within the passenger-car sector (Freyssenet and Lung 1998). This is discussed in more detail in chapter four.

One of the main features of automobile supply chains is the combination of high value, high volume and often extremely high demand for frequent deliveries of customer-ordered products. This puts the time-dimension in a strategic position, which is unique for automobile manufacturing. The main difference from other less complex products might not be the time-demand in itself, but the actual number of inputs and the value of many critical components. Fewer and relatively standardised inputs give less incentive for JIT-deliveries and inventory management strategies since the process is much more simple to control, and probably already subject a high degree of rationalisation.

Another aspect of time is the temporal constraints in the manufacturing process. Very complex and high value products such as aircraft (Eriksson 1995) or power-plants are produced in small numbers and with considerably less routinised assembly-processes than the automotive-industry. These circumstances produce long lead-times from order to finished product which consequently give less importance to frequency and JIT-related supplier arrangements.

At the other end of the spectrum are the raw material process industries, such as pulp, concrete or petrochemicals. Buyer-supplier relationships within these sectors are often characterized by very few inputs and continuous production flows where purchases are made in bulk on a long-term basis or via the international market (e.g.

crude oil). This stands in stark contrast to the auto-industry where suppliers are many and most components are tailor-made for each car-model.

The conditions for supplier restructuring may also be linked to the tradition of supplier co-operation within different industries and the argument that small and medium sized enterprises are more adaptable to new network-type co-operation arrangements. Johannisson (1998) discusses this in terms of entrepreneurialism versus managerialism, where the former is characterised by trust relations and continuous network restructuring, while the later consist of formalised contractual relations and hierarchical organisation.

The automotive industry contains, in this perspective very large-scale enterprises with formalised hierarchies and consequently is less adaptable to new network-type supplier relationships. So, to figure 1.3, where the industry/product and its place in the value-chain is seen as the basis for the creation of different buyer-supplier relationships, we can add the dimension of scale. Overcoming the problem of size and flexibility by using trust-based supplier relationships, is one of the main driving-forces behind the success of the Japanese automotive industry. Something that has been observed, and implemented by the automotive industry worldwide. This "japanization-process" has put the automotive industry in the forefront of flexible supplier relationships within the large-firm sector.

One final aspect to be discussed here is the market side. The supplier structure is linked to the power structure within the industry or sector. One dominant actor has a significantly different set of supplier power-relations to take into consideration, compared to those in an industry with many more or less equal competitors. In a monopoly position many local suppliers may be extremely dependent on one customer, and consequently have a limited possibility to negotiate. On the other hand, if there is constant competition between producers, suppliers do have the opportunity to rely on several customers, although businesses might be built up around one main customer. It is important to emphasise that competition and co-operation can be used simultaneously as strategies depending on the position in the value-chain. Assembly firms usually compete with an outward agressiveness on the market while upstream relationships are characterised by a spirit of co-operation.

Closely linked to questions about the market is the specificity of Sweden as location in relation to other car-producing regions on the European market. Volvo and SAAB are active within high-end segments, where customers will most likely demand punctual deliveries of their customized cars. We can assume that the demand on supply-logistics is higher if you are located in Scandinavia compared to central Europe. Transport time from many suppliers is relatively long and involves at least one ferry-crossing which is repeated when the finalised product is transported back to the main markets.

The uniqueness of the Volvo-case being characterised by luxury-cars, demanding consumers and a remote location, actually makes it interesting to study from a more general point of view. All of these factors imply a need for higher performance in supply systems and logistics co-ordination relative to manufacturers located in continental Europe. Scandinavia might work as a pilot-case for future supply-systems' rationalisation projects in more centrally located markets.

To conclude, we can observe that the assembly of automobiles shows specific features which limit the degree of generalisation from the case studies in this thesis. Firstly, it displays a unique combination of large-scale production and high-value finished goods on an extremely competitive and customer-driven market. Added to this is the complexity of the production process in combination with a high degree of sub-contracting of specialized components.

In the light of this it is important to see that the automotive industry, with its special context, provides a relatively extreme picture of buyer-supplier relationships. Therfore, generalisation to other industries, sectors or geographical contexts should be done with caution.

2. Time and space in the organisation of industrial production processes: some theoretical considerations

2.1 Introduction

Economic geography can, in a very general sense, be described as being concerned with the spatial outcomes of economic activity. This chapter will discuss and comment on some of the basic theoretical developments in economic-, and especially industrial-, geography in the last century. It will start with the first attempts to understand the spatial aspects of economics and the search for regularities in the man-made "economic space". Although some of these early theoretical works are of a relatively uncomplicated nature, they serve as very good examples of the basic economic-geographical problems that seem to have a tendency to come back in fashion. The simplification made might serve as a starting point for a discussion of how space and time is treated in location theory.

The basic concepts related to in this chapter will be centred around inter-firm relations, especially how to link organisational changes both within and between firms and their spatial outcomes. In relation to the dimensions introduced in the matrix in chapter one, the presentation in this chapter is mainly occupied with the vertical organisation/technology axis. The discussion is presented in a more or less chronological order, primarily in order to highlight the growing complexity of industrial organisation and hence the theories that explain this development.

In the last two decades we have seen a growing awareness that traditional, market-based economical explanations only provide a part of the answer to why the spatial landscape of production looks the way it does. Approaches with a greater concern for the behaviour of individual decision makers and the importance of long term non-market relations have challenged the traditional set of explanations as well as the scale of geographical studies.

The aim of this chapter is to give a theoretical background to the research question in this thesis. Although phenomena such as "just-in-time" and subcontracting only recently entered the research agenda, it is important to give a brief historical background to the present ideas and problems. The question of subcontracting as one of several forms of inter-firm organisation will be discussed in more detail in Chapter Three.

2.2 Early theories of industrial location

The first theories of industrial location were developed and presented over a century ago. Reflecting the conditions and level of industrial development a that time, focus was on agriculture and basic raw-material industries. Several of the early attempts to include geography in an economic context were made by German economists. J.H. von Thünen presented his theory on how to locate agricultural production to supply a central marketplace in 1826 (Dicken and Lloyd 1990).

In 1909, another German economist, Alfred Weber, presented his work "Theory of Location of Industries" (Weber 1929). Even though Weber was not the only one working with these questions[2], he is regarded as somewhat of a founder of industrial location theory. The basic assumption in Weber's theory was that the best location for an industrial activity is where the transport cost is minimised. Having in mind the type of raw-material based industries that were predominant at the time, this was quite logical. Weber calculated a material index which could determine whether location close to the raw material source (in the case of extensive weight loss in the production process) or the market (in case of a marginal weight loss) was most appropriate. The price of transport was assumed to be constant and the cost shows a linear proportionality to weight and distance.

Transport costs together with labour were termed *regional factors* and were seen by Weber as the only factors that could decide location by their own force. To these were added *agglomerative and deglomerative factors* which can be described as the advantage or disadvantage of being located together with other industries. A line of thought that has become important in the modern debate on industrial restructuring, as we will come back to in later chapters.

What Weber initiated was a theory based on quite simplified assumptions about reality, but with a discussion that comprises much of what would be considered as location theory during the following 40 years. Factors such as transportation, labour, agglomeration and division of labour were not new to economists at the time, but when put together in order to calculate the best possible location of industry they formed an important theoretical starting point in economic geography.

One of the most fundamental criticisms of Weber's theory is the assumption that firms are acting under conditions of perfect competition (Hodder and Lee 1974, pp. 75-77), and its concentration on minimisation. Other authors developed the theoretical framework by adding more aspects of real-life into it. The work of Palander, Hoover and Lösch contributed to the theory of spatial location and at the same time developed it into two different schools of thought, the least-cost approach and a more dynamic view with the focus on locational interdependence (Smith 1981).

[2] Several other German economists were interested in these questions, among others Wilhelm Launhardt. See: Dicken and Lloyd (1990)

Walter Isard presented his work *Location and Space-Economy* in 1956 in an attempt to bring different approaches together and form a general theory of economic activity (Isard 1956). Up to this point in time industrial location theories had basically been occupied with the question of putting a spatial aspect into economic theories, creating and working with an abstract *economic space* into which reality had to be more or less "squeezed" to fit.

This process of refining the abstract economic space continued, but as we shall find out in the coming sections there are alternative ways of looking at industrial location, both in terms of influential factors (such as human behaviour, regulation, technology, decision-making) and the scale and focus of geographical studies (e.g. firms, inter-firm relations, regions or global issues). The limitations that Weber saw in his own work in the early twentieth century are a striking summary of the problems that new and challenging approaches started to consider almost 30 years later:

> " But what happens if we take into consideration the deviations due to labour and the labour orientation which rests upon them? The discussion of these deviations has thus far been based upon the assumption that the labour locations were given and that the differences in their wage level were constant. Does the mechanism of local distribution which we have considered thus far give us any clues for determining the local distribution of such differences of wage levels, for the causes creating the labour locations, and finally for the rules determining their development which have so far been eliminated by the assumption of an unlimited supply of labour at equal cost? Apparently non whatever. This is the great gap in the analysis so far." (Weber 1929:225)

The realisation that industrial location and economic geography is much more complicated than a mathematical calculation on a homogenous spatial surface led to the growth of several different approaches. Smith (1981) distinguishes between three main directions of critique: (i) a behavioural approach, (ii) industrial organisation and spatial structure and (iii) a structural approach. The industrial organisation approach might be see as a part of a behavioural critique of the traditional location theory. But in the context of this thesis it is important to make the distinction between human behaviour in firms and the effects of changing industrial organisation on decision-making and location.

The focus of the rest of this chapter will be on the latter approach. Questions about industrial organisation and geography will be discussed both from a behavioural and a structural point of view. We will start with a look at inter-firm relations, especially transaction cost economics and how these ideas have been used to explain industrial organisation and its spatial structures.

Before we go on to some of the emerging approaches in economic geography since the 1960's, there is a need for a short summary of the discussion so far. How has time and space been used in the early theories on industrial location?

The most common remark on the classical theories is their oversimplification of reality. Although they were aiming at explaining and predicting the location of economic activity in society, they reduced the real world into homogenous surfaces or points. Location problems became a matter of mathematical calculations, where human behaviour or the surrounding structure only involved problems. In order to fit reality into the theoretical models, a large amount of simplification was needed.

If we want to know something about the geographical aspects of subcontracting, we need something more than the classical location theories. We may be able to calculate the spatial distribution of subcontractors over a surface and maybe see patterns, but to in order to go deeper into the problem and discuss the process behind the spatial pattern we need to look in another direction.

With the classical location theorists as a foundation, we will focus our interest in theories on how production processes are organised inside and more importantly between firms. This is made in order to find explanations to how new production-strategies will affect the locational conditions for firms involved in one or more production processes.

2.3 Agglomeration and inter-firm relations

The idea that the co-ordination of knowledge, information and division of labour is best done within a geographically limited area has been on the industrial geographical agenda since the beginning of the century. Alfred Marshall presented his work in 1920 where he used the term *agglomeration economies* to describe the advantages of industrial activities being located in close proximity to each other.

There is a wide variety of types of agglomerations depending on variables such as: firm size, urban or rural location and type of industry (Malmberg, Sölvell et al. 1996; Malecki 1997). In general though, the basic rationale for agglomeration is the possibility for gaining external economies through linkages in the localised production system. These external economies can be exemplified by the build up and use of a common pool of skilled labour, increased and enhanced linkages between local suppliers and customers and the advantage of sharing infrastructural facilities (Dicken and Lloyd 1990; Malmberg, Sölvell et al. 1996).

One common differentiation between types of industrial agglomerations is between those containing firms in all types of industries and those with firms belonging to the same-*urbanisation economy* or closely related-*localisation economy* industries (Dicken and Lloyd 1990). This distinction is used by Malmberg, Sölvell et al. (1996) to present a useful categorization of approaches to agglomeration. In figure 2.1 the urbanisation/localisation aspect is combined with a functional aspect into a matrix of different forces of agglomeration.

The authors argue that the most traditional theories, or models of explanation have been taking their point of departure in the efficiency of transactions. But lately there has been a change towards the lower part of the matrix with more emphasis on the agglomeration as an environment for learning, innovation and creativity. We will come back to this discussion later and instead continue to discuss the upper right-hand corner of the matrix. This is done mainly because it corresponds to models and explanations regarding subcontractors and the automotive industry which is the main focus of this thesis.

	Agglomeration of economic activity in general	**Spatial clustering of related firms and industries**
Transaction efficiency and flexibility	Manufacturing belts Metropolises	Regional production systems Industrial districts
Knowledge accumulation	Creative regions Entrepreneurial regions	Learning regions Innovative milieux Industry clusters

Figure 2.1: Forces of agglomeration and spatial clustering. *Source:* Malmberg, Sölvell et al. (1996:89).

One relatively recent aspect of regional development and the importance of spatial industrial clustering is the industrial districts/flexible specialisation debate. An industrial district is according to Scott characterised by:

> " ... a proliferation of many different producers, all locked together in a mutual interdependence through their transactional relations. Because of the geographical proximity of producers to one another, the velocity of circulating capital through the system is accelerated and this increases the advantage of agglomeration. ..... They [the industrial districts] are invariably surrounded by dense residential districts housing their main workforce." (Scott 1993:25)

This school of thought built on the work of Piore and Sabel (1984) and the French regulationist school (Lipietz 1986; Phelps 1992). The argument is that Fordism since the early 70s is being challenged by a new flexible – post-Fordist – *mode of* *accumulation.* This flexibility is based on new technological and social conditions, including tendencies towards closer spatial and organisational integration of the production process in industrial countries (Scott 1988; Schoenberger 1988; Obenhauser 1990; Storper and Scott 1992; Scott 1993).

This means, in terms of geography, that we can expect a revival of the traditional industrial districts with small firms in highly localised formations. The rationale behind these new industrial districts is that small firms can, by working closely together with an intense specialisation and division of labour, not only gain external economies but also an increasing flexibility and possibility for innovation. It is this ability to become "flexibly specialised" that gives such a new industrial district an advantage in relation to older regions or large firms with a more rigid form of organisation.

Subcontracting relations is an important aspect of the new industrial districts. The very essence of its advantage is the division of labour and co-operation between actors in a production system located closely together. At this point it is important to distinguish between genuine small-firm often rural constellations exemplified by the industrial districts of the Third Italy (Brusco 1986), and those which are coupled to metropolitan areas and sometimes to large firms as important customers (Scott 1988). The latter type of agglomeration might be more accurately placed within the regional production systems heading in figure 2.1. The work by Scott can be seen as a geographical extension of transaction cost economies, discussed in chapter 2.6.

Storper and Harrison (1991) propose a framework for the study of industrial production systems focusing on regional development. Their classification has two basic dimensions: the type of input-output system and the governance (power-relations) of the system. These two factors form a matrix of production systems as described in figure 2.2 below.

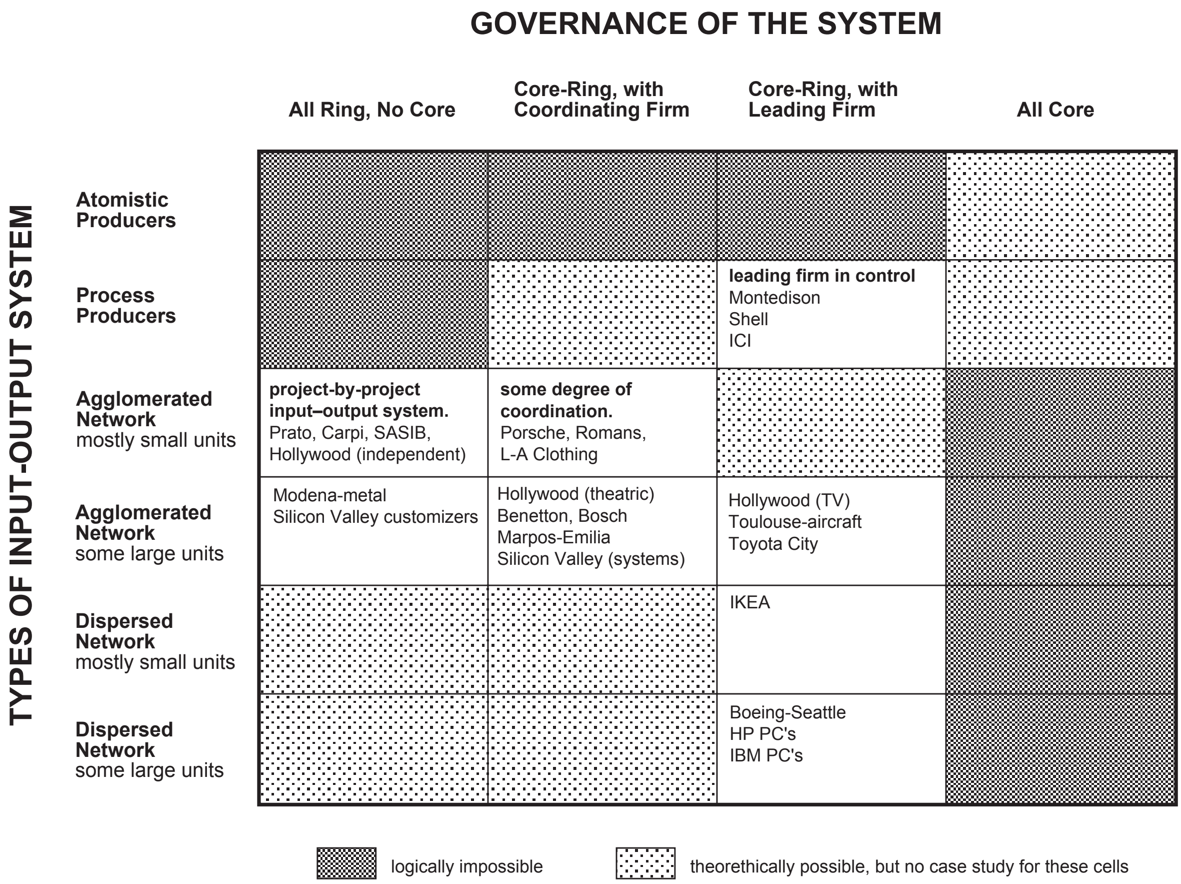


Figure 2.2: Types of production systems. *Source:* Storper and Harrison (1991)

Production systems based on agglomeration can be found in the two middle rows of the matrix. The horizontal axis indicates the type of governance of the system, where; *ring* means equal firms with no central power; and *core* indicates some sort of leading power. The leading power increases to the right, ending in the upper right hand corner with the totally integrated firm.

Industrial districts in the classical meaning can be placed in the first box on the third row, while much of the traditional manufacturing industry systems will fit into the third column. The figure gives a good picture of the diversity of production systems that all too often are put together into one category. Most of the automotive industry production systems will occupy the three bottom boxes in the third row, basically due to the leading powers of the assembler.

In the following we will look at some new areas of economic geography where aspects of agglomeration are in focus. The common denominator is a critique against the theoretical focus on production systems as input-output relations. It questions the basic transaction cost logic, where external economies are the driving force behind the division of labour and the "spatial glue" that makes firms stick together (Arthur 1994).

The cost of transactions is no doubt an important factor behind the decision to use outside independent firms as a part of a firm's production process, but it is far from a satisfying point of departure in order to more fully understand the geography of subcontracting relations.

It is possible to distinguish between two main lines of new research:

- Power-relations between actors in the production system are too complex to be measured by size or economic performance only. No firm or production unit is acting in isolation but rather within a *network of mutually interdependent relations.*

- The focus needs to be on the *region as a place/locality* for new types of industry, particularly within areas with a high degree of innovation and knowledge transmission. In this view, there is an advantage, and sometimes a necessity to have spatial proximity between firms in order to exchange specialised knowledge which could not be transferred over distance (see the bottom row of figure 2.1).

The network approach will be more thoroughly discussed in chapter 2.5, while the latter framework of technology and knowledge diffusion in relation to the importance of agglomerations and regions will be developed in this section.

So far, we have only discussed linkages and input-output aspects of agglomeration. One recent area of interest is the region as an environment for co-operation within industries where knowledge is the strategic factor for development and competiton. If we concentrate on clusters of related firms and industries, Malmberg, Sölvell et al. (1996) discuss this in terms of learning regions, innovative milieux and industry clusters (figure 2.1).

The basic denominator is the focus on the region as a place where firms are embedded in a specific social and institutional fabric of habits, norms and rules, often described by the term *milleux* (Malecki 1997). It is mainly within industries where innovation and knowledge-based activities are important that this view has gained interest. The argument is that certain types of information and knowledge are not possible to communicate over space, they are to a certain degree place-specific. In contrast to traditional explanations of inter-firm relations and spatial proximity are factors such as local social relations, institutions, practices and norms emphasised (Storper 1992; Asheim and Cooke 1997).

To conclude this section, we can see a large number of explanations as to why economic activity tends to agglomerate in space. The traditional analysis has been centred on quantitative input-output relations related to the economic benefits of co-operation. More recent approaches focus more on the specific spatial conditions of the region for co-operation, mainly within technology, innovation and knowledge diffusion.

This approach is rarely used in the debate on the restructuring of the automotive sector. More commonly, agglomerations such as Toyota City are explained by the economic benefits of minimised transaction costs and reliable deliveries according to just-in-time requirements. Taking the point of departure in the social and institutional conditions behind clusters of automotive-suppliers provides an interesting challenge to the established body of literature around the geography of automotive-suppliers.

2.4 Industrial linkage studies

A more empiricist approach to inter-firm relations is geographical linkage-studies (Hoare 1985). However, it should not be seen as a well-defined approach, rather a way of looking at and studying spatial aspects of industrial relations.

The common denominator for linkage studies is the interest in connections between plants or firms, and how to explain the spatial pattern of these linkages. Figure 2.3 illustrates the main area of interest in linkage studies. The arrows indicate contacts in the form of physical flows, information exchange and monetary relations. Incoming linkages are termed backward or upstream, while the output relations are called forward or downstream linkages.

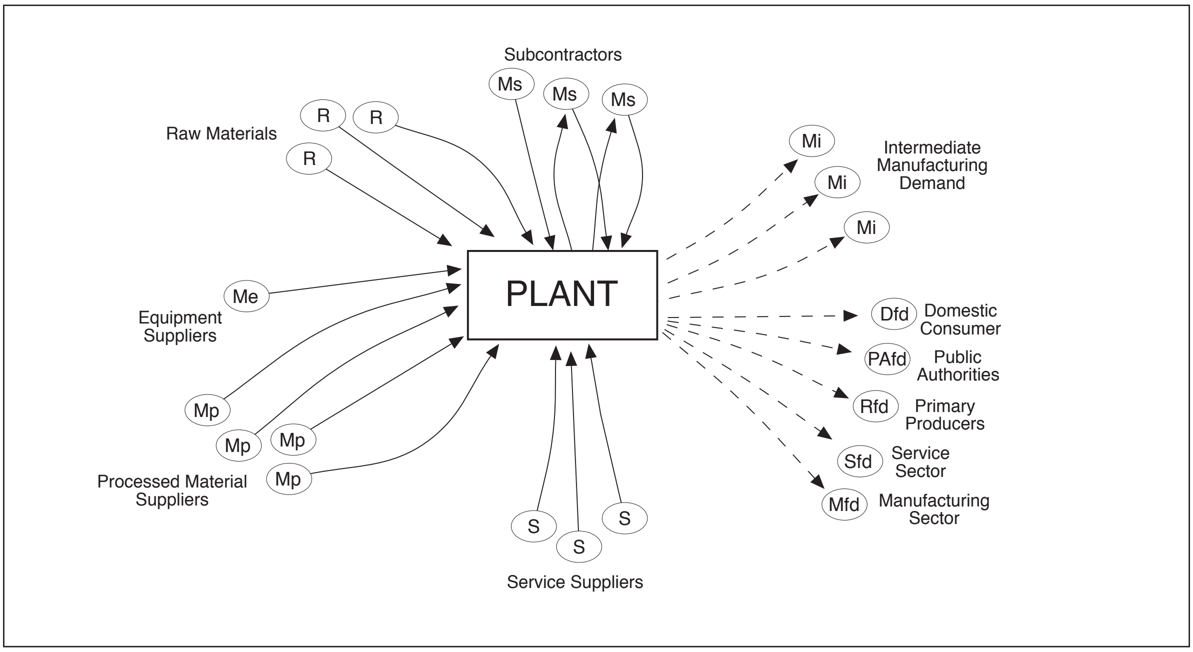


Figure 2.3: Schematic representation of linkages associated with a manufacturing plant.
Source: Hoare (1985:44)

Hoare (1985) makes a distinction between macro and micro level studies of industrial linkages, based on the geographical scale of the study and the resolution of data. Macro-level studies use aggregated data, mostly from official sources. While on the micro-level you are dependent upon extensive fieldwork to collect your own data. So, except for the mapping of whatever spatial contacts there are, a number of factors to explain the observed pattern can be discerned. Most studies can be placed into the following broad groups:

- *Macro-studies*
  - Importance of linkages to the creation or loss of employment opportunities on a national or regional scale.
  - Agglomeration of particular industrial sectors.
  - Inter-sectorial linkages and its geography. How different industrial sectors are grouped together in organisational and spatial terms.
  - Focus on industrial pair-wise relationships and what constitutes a linkage. Mainly economical variables to measure the degree and direction of flows within or between industries.
  - Focus on spatial linkages, traditionally studied through correlation between pairs of industries over any appropriate geographical area.
- *Micro-studies*
  - The geographical scale of industrial linkages. How dispersed are the linkages of certain firms or industries, especially interested in the local dependency.
  - Control-mechanisms on linkage-geography. Focus in factors that shape the pattern of local/non local relations. Factors of explanation: plant size, type of industry, organisation.
  - Temporal development of industrial linkages.
  - Locational evaluation and the importance of linkages.

Figure 2.4: A typology of linkage studies. *Source:* Hoare (1985)

A common criticism of linkage-studies is the weak theoretical framework, failing to draw conclusions from empirical observations. Without a theoretical idea about the underlying factors behind linkages, many studies end up analysing a detailed empirical material in a cursory *ad hoc* fashion, missing the basic underlying processes (Taylor 1994).

In the framework of this thesis, there are certain basic concepts that can be discussed and illustrated through the linkage-approach. Modern debate in economic geography, both in the flexible specialisation and network approaches (Yeung 1994), have linkage features. This will be more thoroughly considered in the following sections.

2.5 A network approach to industrial organisation

As pointed out by several authors there is a growing interest in the so called *industrial network approach* (Johanson and Mattsson 1988; Axelsson 1992; Hertz 1993). While traditional approaches to industrial organisation have treated firms as independent, profit-seeking actors, the network approach recognises firms as interdependent actors in a network of relations. These relations can be economic and formal, but the basic idea in the network-approach is that informal linkages have as much importance as the formal ones in forming the strategies and every day activities of a firm.

The industrial network approach developed in organisation and management studies starts with the basic assumption that the long-term development of a firm is determined by its ability to adjust to the surrounding environment, including other firms as well as social institutions and other contacts necessary for its operation. An industrial system consists of firms active in production and distribution, using both goods and services in their daily operations. This system is described as a *network of contacts* between firms. The network is characterised by a *division of labour* which makes the different firms dependent upon each other, and in the need for *coordinated activities* (Johanson and Mattsson 1988; Axelsson and Easton 1992).

The network model implies a reality where the activities of a firm is an ongoing process where contacts are created, maintained, developed and abandoned in order to create a satisfactory short-term profit as well as a long-term strategic position in the network. A basic assumption is that individual firms are dependent on resources controlled by other firms in the network. Co-operation and co-ordination, in other words, depend on a *mutual interdependence where trust becomes an important factor behind long-term network changes.*

The industrial network approach is a relatively young academic phenomenon with a large number of different directions and lacking a common general definition. In a review of the work done within industrial networks, Easton (1992) distinguishes four different areas in which most studies can be categorised:

(i) *Networks as relationships*

A distinction can be made between *relationships*, which are the long-term developments and *interactions,* which are short-term activities. Interactions are further subdivided into exchange and adoption processes. The former represents the day to day business activities and the latter describes the continuous adjustment of products and strategies. This could include problems such as; co-operation between firms, characteristics of dependence/interdependence, characteristics of bonds between firms (e.g. economic, social, technical, information), investment processes, industrial atmosphere (e.g mutuality, trust).

(ii) Networks as structures

Interdependent relationships introduce constraints into the activities of individual firms, where some firms for example, are more powerful than others. This creates a structure in the network. A basic assumption is that networks are essentially *heterogeneous* by nature and that industrial systems are a way of matching heterogeneous resources to heterogeneous markets. One way of characterising structure in a network is by the division of work between the firms involved, as for example in the question of boundaries.

(iii) Networks as position

A position in the network is the role that the organisation has for other organisations that it is directly or indirectly related to, and one term for this is strategical identity. Position can be characterised by: (i) the function in the network; (ii) the identity of the net within which the focal firm has relations and (iii) the relative importance of the firm. A major concern with these types of studies is the nature of network connections, for example how to enter or exit an established network or how to defend or change existing positions.

(iv) Networks as a process

The process of change has been a major field of study within the industrial network approach. Traditional economically-based market and hierarchy explanations do not see strong inter-organisational relationships as a normal form of governance. The network approach provides a third form of co-ordination: network processes, dominated by the distribution of power and interest structures. Competition and co-operation are seen as two complimentary processes.

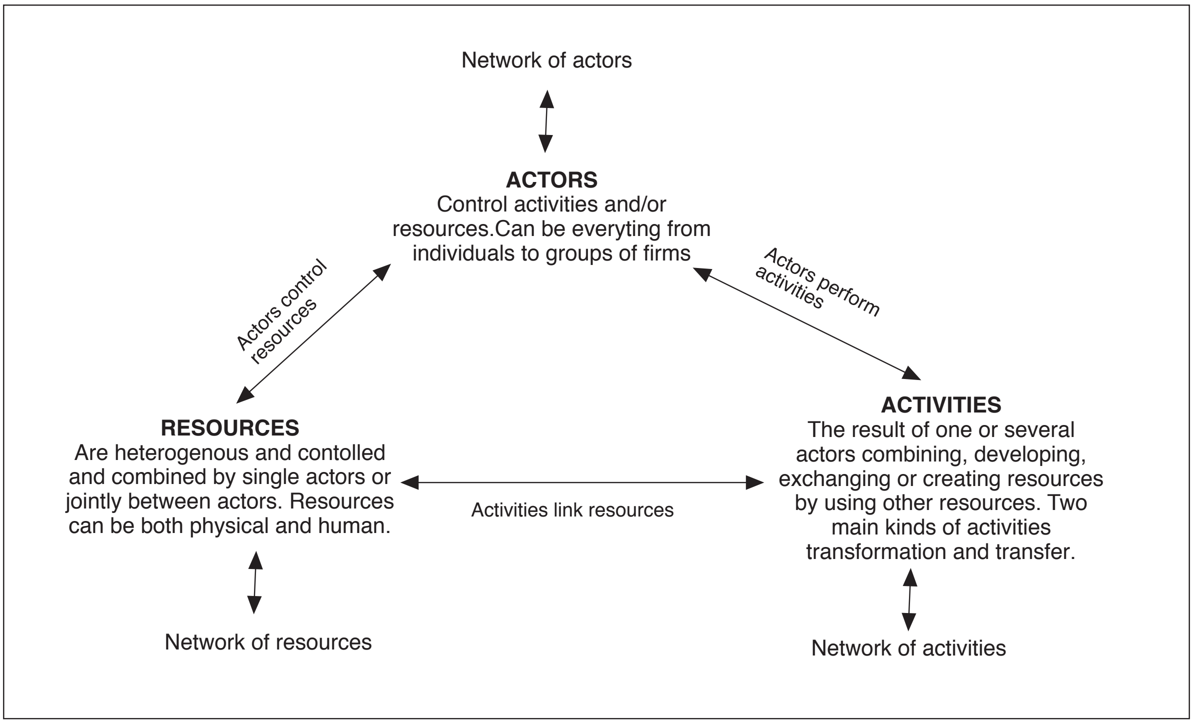


Figure 2.5: A basic network model.
Source: (Håkansson and Johanson (1992) and Dubois (1994)

The discussion above gives a good indication of the industrial network approach through a presentation of the major fields of research. But how do the different aspects fit together? Figure 2.5 presents an attempt to formalize different aspects of the network approach into a model (Håkansson and Johansson 1992). Its basic components are actors, activities and resources, which interact in a network held together by network forces. The most powerful forces are:

(i) *Functional interdependence:* actors, resources and activities are functionally related to each other, matching heterogeneous demand and resources through the network.
(ii) *Power structure:* the actor's ongoing aim to control activities and resources are to some extent dependent upon power relations.
(iii) *Knowledge structure:* activities and the use of resources are results of knowledge and experience by earlier actors and relations between them.
(iv) *Intertemporal dependence:* or the "history" of the network, includes the memory of former activities and resource transformations. In order to induce change there is a need to receive acceptance from large parts of the network. This implies only marginal changes and stability.

To summarise the discussion on industrial networks we can conclude by saying that the approach represents a different view of industrial relations. Traditional economically based explanations like the transactions-cost theory treated firms as "coordinated islands in a sea of market relations" while the current approach focuses upon the relations and interconnectedness between firms that makes up industrial systems (Johanson and Mattsson 1991).

2.6 Other theoretical approaches

Subcontracting relations have traditionally been seen as a tool for relatively large organisations to minimise costs by contracting out simple but labour-intensive work to smaller firms with lower wages or to handle peaks in demand through short-time contracts. Questions about how to efficiently organise activities within or between organisations has been studied by economists using the concept of *transaction cost economics.*

Transaction cost economics takes it starting point in two ways of organising transactions, termed *modes of governance.* In the strict definition there are only two options: *hierarchies* or *markets,* where activities are organised either internally within the organisation or between independent firms through market-transactions (Williamson 1975). The reason for doing one or the other depends on the cost involved in the transaction, which according to the transaction cost school, is dependent upon the behavioural performance of the human agents involved. The argument was primarily put forward to point at the mechanisms for moving transactions from the market and organise them internally, termed *vertical integration.* While in his later work, Williamson introduces intermediate stages, dealing with relations somewhere in between markets and hierarchies (Williamson 1986).

The adding of intermediate governance structures has interesting implications for the discussion about subcontracting relations and the development of stable relations built on mutual trust. By combining investment characteristics in terms of their specificity (non-specific, mixed or idiosyncratic) with the frequency of commercial transactions (recurrent or occasional) Williamson identified two new governance structures, *trilateral* and *bilateral* governance. The basic idea is that increasing specificity in the investment combined with more frequent transactions, makes it more economically efficient to internalise the transaction. Trilateral governance is most likely to appear if assets are specific but transaction are only occasional, exemplified by the involvement of a third party like architects in building projects. When specificity is mixed and transactions are frequent, bilateral governance is the most appropriate solution. Williamson talks of *relational contracting* as a means to overcome the problems with non-standardized transactions.

Although there are numerous references to behaviourist approaches in the world of transaction cost economics, it is still a basically economical approach. Inter-firm contractual relations and intermediate governance structures are seen as "market imperfections", and the *cost* of transactions is the one mechanism that explains why industrial relations are organised the way they are. One important shortcoming of the economic approach is the assumption that contracts are negotiated and settled in a perfect market situation. The everyday world of contracts and inter-firm relations are far from equal. Asymmetrical power relations have a fundamental impact on industrial organisation (Taylor and Thrift 1982; Taylor 1994).

Another problem is the applicability of a concept developed in a North American context where contracts and legislation are basic in order to maintain competition and uphold market-rules. Other business environments might put less importance on contractual regulation, giving the intermediate governance structure a more "normal" role. In different geographical contexts, hierarchies and markets may seem not to be so obvious modes of governance.

The transaction cost approach has been used as a point of departure for the development of the theory of industrial districts in economic geography (Scott 1988), which is discussed in more detail in chapter 2.3.

The work on competitive advantage by the business economist Michael Porter have had an impact in economic geography. With reference to the area of inquiry in this work Porter highlighted the *value chain* as an important concept (Porter 1985). This relates to the discussion on subcontracting arrangements and the new model in the automotive industry. The development towards a hierarchical organisation of suppliers builds on the idea that manufacturing is carried out through a sequential chain of suppliers, where each step performs value-adding activity. This can be contrasted to the traditional integrated automotive manufacturing model, where subcontracting was used mainly as a tool to even out peaks in demand together with the possibility to use cheap labour in certain areas of the production. A more thorough discussion on subcontracting will follow in the next chapter.

The geographical aspect of Porter's work is more pronounced in a later publication (Porter 1990), where competitive national *industrial clusters* form the basis for a number of national surveys. An industrial cluster is defined by a number of factors summarised in a "diamond-model", The model includes national characteristics in four areas: *(i)* factor conditions; *(ii)* firm strategy/structure/rivalry; *(iii)* demand conditions and *(iv)* the presence of related and supporting industries.

This thesis is not directly using the model above, but the analysis of the Swedish automotive industry cluster in Porter's work gives valuable insights into the development and competitive situation for the industry. Especially interesting is the importance of related and supporting industries which, at least to a certain degree, is equivalent to the presence of a national supplier system.

The geography of the enterprise, or corporate geography, has the firm as it's object of study. This area of economic geography was debated in the late 1980's. Mostly with the argument that the firm perspective was too concentrated on large corporations (Walker 1989). During the 1990's more aspects of inter-firm relations have been introduced (de Smidt and Wever 1990). Oinas (1998) argues for a new geography of the enterprise incorporating a more network-like view of the firm and its environment.

One academic field that is in the centre of the buyer-supplier problem complex, but very rarely has had any direct impact on economic geography is *logistics.* This lack of influence might, at least partly, be explained by relatively modest links to the world of theoretical academic work. Logistics has its origins in the practices of supplying military forces, which has later developed into a business activity with the focus on the co-ordination of the physical production process.

The close links to practitioners is further highlighted by the fact that one of the most commonly used definitions of logistics, presented below, is provided by the Council of Logistics Management, a U.S. organisation for logistics professionals, rather than from academia:

> "Logistics is the process of planning, implementing and controlling the efficient, effective flow and storage of raw materials, in-process inventory, finished goods, services, and related information from point of origin to point of consumption (including inbound, outbound, internal and external movements) for the purpose of conforming to customer requirements."
> Coyle, Bardi et al. (1992:6)

The field of logistics is, as indicated in the definition above, important in relation to the problems discussed in this work. It is furthermore used as one of the two labels on the supplier-typology matrix in figure 1.1.

The development within the automotive industry regarding suppliers has put logistics questions on the strategic agenda. Co-ordination of the supply-chain has become a competetive factor for both assembly-firms and large supplier-corporations. Christopher (1998) defines the following four main challenges for logistics in today's business environment: *(i)* the customer service explosion, *(ii)* time compression, *(iii)* the globalisation of industry and *(iv)* organisational integration. All of these challenges can be found in economic geographical studies of the automotive industry as well. However traditionally treated from a more practical management or transport technological aspect in the subject of logistics.

This situation is currently under transition as the logistics functions become more holistic by nature and therefore need to involve a broader perspective on material-flow problems. One example of a concept building on integration is *supply chain management* which has developed during the last decade and focuses on the co-ordination of processes in a supply chain. Logistics has thus become a general planning framework for the product flow strategies of an organisation or business. (Christopher 1998)

2.7 Industrial inter-firm relationships and location: a temporal-geographical conclusion

The academic field concerned with inter-firm relations is of course much wider and more complex than described in this section. Selecting certain theoretical models means excluding others, a process that is necessary in order to focus the work. This thesis is positioned within the area of economic geography and more precisely focused on subcontracting relations and their spatial dimension. The theoretical approaches presented in this chapter have their own specific aims and will be used to explain and analyse different parts of the complex problem of the spatial organisation of industrial subcontracting.

The discussion this far has only addressed geographical questions sporadically. This is especially clear in the transaction cost and network sections. This concluding section is an attempt to put together the different approaches in this chapter in the light of its treatment of the time-space organisation of industrial relations. The basic question to be explored is how the time and space dimensions have been incorporated into models of industrial organisation and location.

Early theories of industrial location can be characterised as being based on ideas of *friction of distance.* For Weber, location of industry was explained by transport cost as a function of distance and the weight of the transported materials. Time was not an important factor in the early models often based on large scale industries such as mining, forestry and steel-making (Dicken and Lloyd 1990). Most theories of industrial location had a common focus on the industry-level and with general patterns of geographical distribution, searching for optimal location solutions. One example of this is the work of Lindberg (1951) on the location pattern of the Swedish paper industry.

Although distance is taken into consideration it is important to point out that economic aspects formed the basic rationale behind industrial location theories. Least cost location was a common aim of many studies. Agglomeration and buyer-supplier relations are rarely discussed in the "Weberian" models due to their concentration on a more general scale. Weber discussed the advantages and problems of spatial clustering in terms of agglomerative and deglomerative factors, but these forces were not regarded as being strong enough to determine location on its own.

The followers of this line in location theories added complexity to the transport-based analysis, *cost minimisation* became a more important factor in order to explain location. This includes the cost of labour and land in addition to materials and transport.

The transaction-cost economics approach presented in section xx still has its roots in traditional economics, but changes the focus of study towards the single firm and how to organise production internally or externally. This has no spatial content *per se* but the basic treatment of make or buy strategies implicitly addresses geography. The use of outside firms in a production process means movement and co-ordination of goods, information and people in space. The market-hierarchy distinction has been used to explain the organisation of transnational corporations and their spatial arrangement of production and power relations.

Some of the work on flexible specialisation/new industrial districts has its roots in the TCE framework, with the hypothesis that spatial proximity will minimise transaction costs and facilitate the use of specialised subcontractors in order to enhance flexibility in the production chain. Other authors put more emphasis on small firms and *social aspects* of industrial districts. Factors such as common norms, habits and informal contacts create mutual trust and facilitate co-operation in supplier relations.

This social aspect of inter-firm relations has very much in common with the network-approach which has gained interest within the field of industrial geography. As in the case with the transaction cost framework there is no explicit geographical component in the industrial network approach. But there are similarities between geographical linkage studies and the theoretical framework of industrial networks. They both share the same basic assumption that industrial relations are linked together and dependent upon each other in a production process. What is lacking in the network approach, from a geographical point of view, is an explicit formulation of a spatial dimension in the network. Somehow resources, actors and activities are interconnected in a world without geography, neglecting the importance of spatial restrictions to both resources and activities.

Economic geographers are using the network-approach (Conti 1993), especially within work on technological development, knowledge diffusion and innovation within regions (Malmberg, Sölvell et al. 1996; Larsson 1998). The concentration on high-tech industries is questioned by Maskell (1996). It is important to define the concept of "network" because it has many connotations, especially within geography where the term network traditionally has been used to describe physical structures.

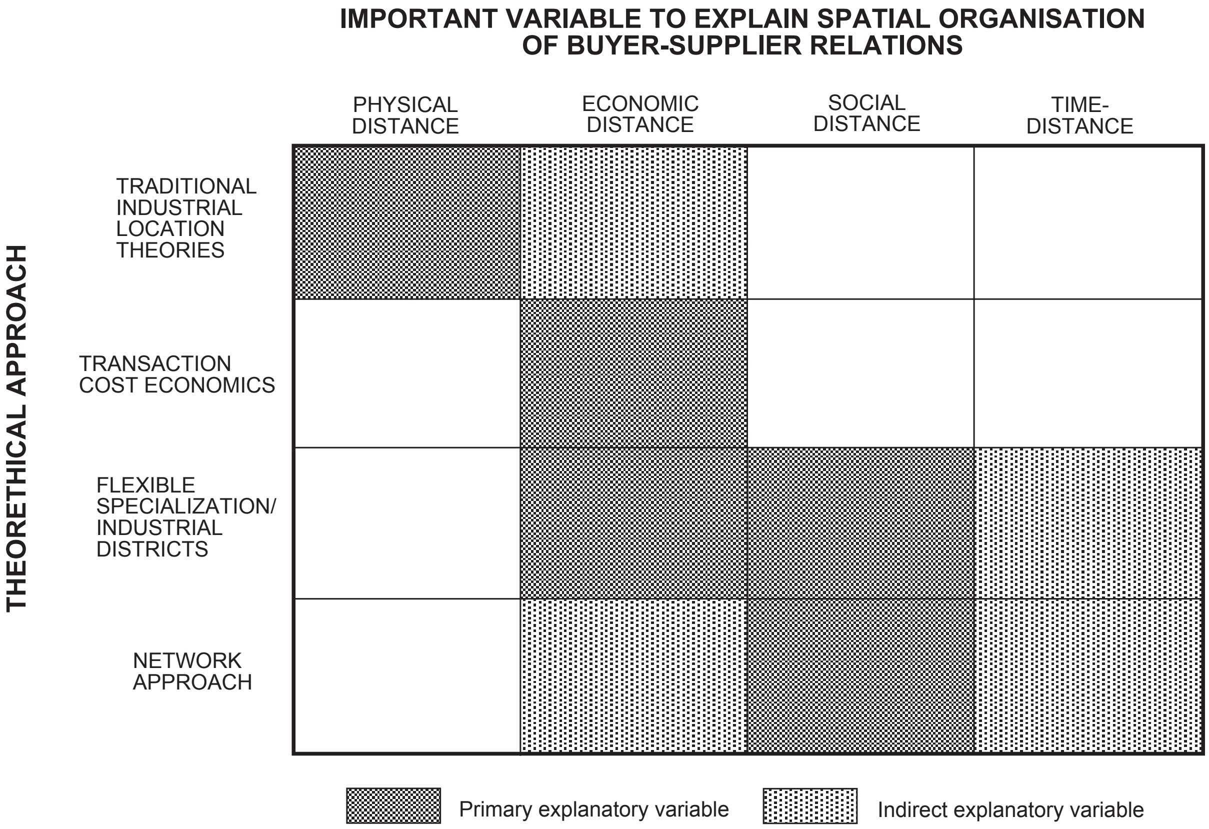


Figure 2.6: Different theoretical approaches to inter-firm relations and their explanation of spatial agglomeration. *Source:* Author.

Figure 2.6 summarises the development of explanatory variables within theories of industrial location from *physical distance* to *economic distance* and the current interest in networks and *social distance.*These are, of course, general categories to explain long-term change within industrial location theories. One missing aspect is time-distance. This means that no theory of inter-firm relations and geography explicitly discuss the *time - dimension* as an important factor behind the spatial structure of production systems. The result is that explanations of geography and time-compression strategies, such as just-in-time, tend to discuss either industrial organisation or physical distribution/logistics as separate "worlds" of reality.

One attempt to put together the organisational and physical aspects of inter-firm relations is made by Burmeister and Colletis-Wahl (1997) using the term *circulation* to point at the importance of the co-ordination of material, information and people in production systems. This framework has close connections to the network approach and is trying to add the importance of proximity. The authors analyse different aspects of location and organisation with the use of *circulatory proximity* as a point of departure. The concept involves the quality of circulatory activities, but not only on a traditional accessibility/cost level (see the distance and cost aspects in figure 2.6). It involves aspects such as flexibility, reliability and control of the process (Burmeister 1997). The link between the network approach and logistics has also been addressed within a Nordic context as a way of introducing a new, more general theoretical approach to the traditionally empirical and practical subject of transport and logistics (Füssel 1992; Gadde 1992)

2.8 Summary

This chapter has presented the major theorethical concepts which form the foundation to the rest of the work. The basic aim has been to show the growing diversity and complexity of models for geographical analysis and explanation. The majority of research in industrial geography is closely associated to empirical investigation, and hence subject to the constantly changing every-day life of business activities and decision-making. As the pace of change increases, theoretical models used as "cook-book recipies" for analysis quickly become obsolete. For a geographer, the interaction with the physical world of inter-firm relationships, quickly reminds you that general theories of society, at their best, may guide the researcher on his or her journey towards understanding.

In the following work the *network-approach* will be used as a "mental point of departure" when thinking about industrial systems and subcontracting relations. Although it acknowledges economic relations as being of importance, social interactions are given a central position in order to explain how industrial relationships are formed, maintained, changed and terminated.

One further theoretical issue is *the lack of time as an important factor of explanation* in geographical analysis of inter-firm relationships. In many industrial sectors, the growing importance of customer-ordered production and "just-in-time"– practices will need to explicitly involve time in order to understand new spatial configurations.

3. Subcontracting relationships - an overview

3.1 Introduction

A modern production process for mass-produced consumer goods, for example a passenger car or a dishwasher, contains a myriad of physical and information linkages. These linkages can be formally organised and institutionalised or they can be informal and dependent on the mutual co-operation between individuals. Companies can choose to develop, manufacture and market their products inside their own organisational domains or they may use outside sources to fill some of the requirements in the production chain. One method to organise these external relationships is to sub-contract work to independent outside firms.

This and the following chapter contain a discussion on the concept of subcontracting. The chapter starts with a discussion of concepts and definitions within the field of subcontracting relationships. This is followed by a section concentrating on the rationale for subcontracting, focusing on explanations behind the existence and development of subcontracting relationships. The discussion in this chapter is continued in chapter 4, where the current situation regarding subcontracting in the automotive industry is presented.

3.2 What is subcontracting? - Concepts and definitions

The immediate reaction to the word subcontractor is often that the company in question is a small firm with relatively simple products and unsophisticated processes combined with a high dependence on the out-contracting firm. In other words, firms do not choose to become a subcontractor, it is their last chance for survival. There might be some truth in these perceptions but subcontracting, as we shall see, is a more complex (or maybe chaotic) concept than it may appear to be in the first place.

A first basic distinction is between *industrial* and *commercial* subcontracting. The former is a situation where the products are used as input in the customer's production-process, while commercial subcontracting means production for wholesale. One example of this last category is the Swedish furniture retailer Ikea, who uses outside firms for all of it's physical manufacturing while doing marketing and sales under its own brand name (Storper and Harrison 1991). This distinction is important, especially if we want to discuss linkages on a firm level. The conditions for subcontracting may be very different if the product is intended to fit into a production process or to be sold as a final product to the end-user.

Another way of addressing subcontracting definitions is presented by (Sayer and Walker 1992) who distinguish between *relational contracting* and *subcontracting.* This is connected to organisational matters rather than the product or production process mentioned earlier. Relational contracting according to Sayer and Walker is ongoing exchange relationships and interaction between firms in order to create intra-firm connections without using market exchange. Examples are two-firm alliances, marketing agreements or licensing and research alliances. Subcontracting is seen as a different form of relational contracting where there is *involvement from one firm into another firm's process* such as product-specifications, provision of materials and machines, technical and financial assistance and quality control.

A third way of looking at the subcontracting concept is to focus on *power-relations*, an important feature in many forms of organisation and basic to the notion of (sub)-contracting. One division can be made between buyer-supplier networks with a relatively horizontal and equal construction, and the hierarchical subcontracting system with a strong vertical relationship (Sayer and Walker 1992). These are of course generalised extremes which in reality will change constantly in a dynamic interplay between the actors, both internal as well as external (Taylor 1994).

So, what is the difference between purchasing input materials in a subcontracting relationship and an open market situation? The figure below shows different aspects of inter-firm linkages and their outcome in subcontracting- and open market relationships respectively. All three aspects of the buyer-seller relation indicate that a subcontracting relationship is characterised by communication and co-operation in relation to the competitive open market situation.

	open-market relationship	**subcontracting**
product	standardised (off-the-shelf)	customer-specified
organization	competitive	relational
power	independent	(inter)dependent

Figure 3.1: Generalised linkage characteristics for open market and subcontracting relationships. *Source:* Author.

In a review of subcontracting literature Holmes (1986) suggests the following general definition of subcontracting:

> " However, it is generally agreed that formally the term 'subcontracting' refers to a situation where the firm offering the subcontract requests another independent enterprise to undertake the production or carry out the processing of a material, component, part or subassembly for it according to specifications or plans provided by the firm offering the subcontract." Holmes (1986:84)

Formally, there is nothing in the definition above that explicitly views subcontractors as being smaller or less powerful in relation to the parent firm. But if we follow Holmes' discussion and break down subcontracting into more operational terms, there are several aspects connected to power relations. But – and it is important to bear in mind – it is very rarely a simple one-way command situation. By offering a subcontract, the parent firm is always leaving a part of its own control in the hands of an outside actor.

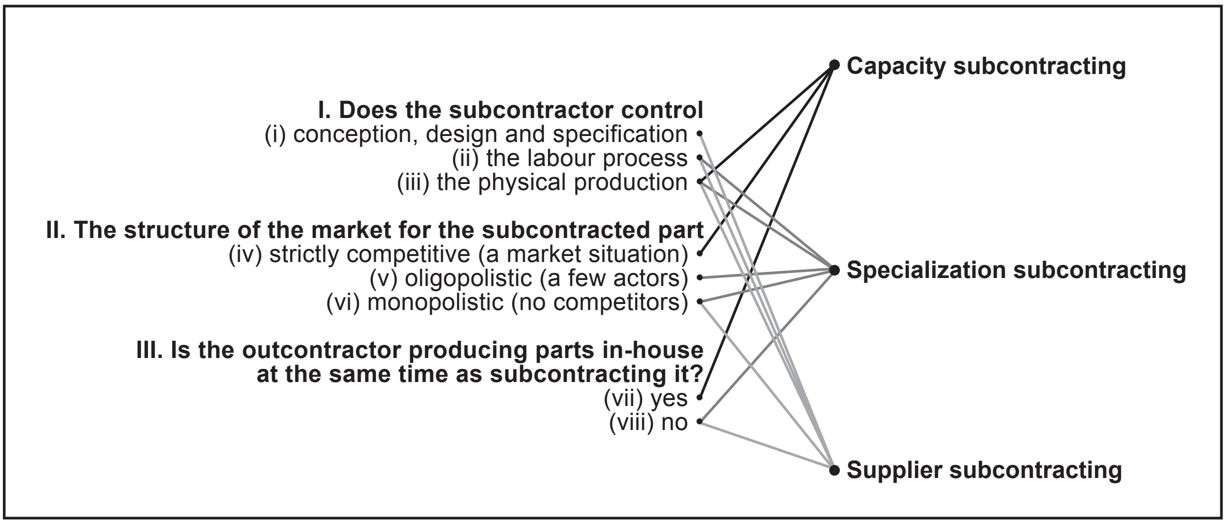


Figure 3.2: Typology of industrial subcontracting relationships.
Source: Based on Holmes (1986)

As we saw earlier in this chapter, there is a basic distinction between commercial and industrial subcontracting. The discussion here will primarily focus on industrial subcontracting, with further differentiation between different types of subcontracting arrangements. Holmes (1986) refers to the French literature for the most comprehensive discussion on the subject.[3] He presents three main criteria to use in the definition and classification of industrial subcontracting relationships, as follows:

[3] See: Chaillou (1977)

- degree of control over the production process
- the type of market for the subcontracted product
- does the parent firm manufacture the subcontracted part themselves?

Figure 3.2 shows how these criteria are combined to define three distinct types of subcontracting arrangements.

- *Capacity subcontracting*
  Is characterised by its dependence upon the parent-firm for detailed specifications, and in some cases material input. The relationship is of a short-term character based on economic considerations only. This form of subcontracting is used to "even out" peaks in demand, which would otherwise require investment in production capacity for the out-contractor.

- *Specialisation subcontracting*
  Here we have a situation where the subcontractor controls both the production and the labour process. The parent firm is not engaged in the production of the component, therefore we have a form a complementarity and interdependence which includes more long-lasting relationships.

- *Supplier subcontracting*
  According to Homes, this is category which has received least attention from authors. It describes a situation where the subcontractor is an independent firm, willing to enter into a subcontracting arrangement. This last type of relationship has been suggested as existing in the automobile industry.

One fundamental difference in terms of power relations is the one between capacity subcontracting and the other two. In the latter cases, there is a mutual interest in keeping the relationship working, because the subcontractor provides something that the parent firm cannot easily obtain. It can, for example, be a unique product or process developed together with the customer, which puts the subcontractor in a dependent position. They are dependent upon the parent firm as a market, but by the same token the parent firm is dependent on the specialized knowledge provided by the subcontractor.

To summarize the discussion so far there are two general statements about the definition of subcontractors which will serve as a platform for the rest of the work:

- *Product specified by customer* for use in his production process, which often results in specialised products not possible to sell on the open market. This means that the subcontractor needs a close and highly flexible relationship with its customer, in order to adopt new specifications without having to discard products.

- *Relational and interdependent* inter-firm linkages with a relatively high degree of communication and co-operation involved. There is, of course, a wide scale of power relations, ranging from small to total interdependence.

Note that the second point about interdependence focuses on specialisation and supplier subcontractors. This is not to say that capacity subcontracting is unimportant, but rather to underline the network-approach to inter firm relationships. Even the simplest arrangement involves two parties and should be seen as an interrelation rather than a one-way power exercise from the out-contractor.

In much of the literature on automotive production and restructuring, the term *supplier* is used in basically the same way as subcontractor, mostly without any distinction or definition. In this work the terms subcontractor and supplier will be used to describe a subcontracting-arrangement as it is defined in this chapter.

3.3 The rationale for subcontracting

As we have seen in the discussion on definitions, there is range of factors behind a subcontracting arrangement. This becomes even more apparent when trying to find any one single factor as *the* most important behind the decision to enter into a subcontracting arrangement. In order to present some form of explanation, Holmes (1986) identifies three main areas of explanation in the literature. His point of departure is that subcontracting is based on *unequal power relations* which gives the parent firm *flexibility* in relation to: (i) structural and temporal stability of markets, (ii) production technology and labour process organisation, and (iii) the structure and nature of labour supply conditions.

These three areas will be discussed in more detail below. It is important to point out that the presentation is simplified in order to establish some basic concepts of why subcontracting exists. In most cases, as we will see later, the relationship is more complex and interrelated than described here.

(i) Structural and temporal stability of markets

In this category we have explanations connected to market changes, the most basic one being the use of subcontractors due to *uncertain- or fluctuating demand.* Another incentive is the situation where there is *insufficient demand* to create economies of scale for the parent-firm. Thirdly there is a situation where a product is at the beginning or end of the *product cycle* and therefore exposed to market uncertainty. Most of these explanations for subcontracting imply a situation where the parent firm produces the item in question and use outside firms as a temporary solution. It would sort under the capacity subcontracting heading in figure 3.2.

(ii) Production technology and labour process organisation

This line of argument focuses on the fact that you can divide the production process into different stages and that there are different levels of minimum efficient scales of economy. Specialized subcontractors can, by working for several out-contractors, obtain economies of scale which the parent firm is unable to do in its own production process. Holmes concludes that this type of specialisation subcontracting is:

> ".....characteristic for those sectors where it is possible to fragment the production process without having to resort to inferior process technology or any loss in productivity." Holmes (1986:92)

It is important for the scope of this work that new technology and labour organisation allows for more industrial sectors to fragment their production process with the same or even better technology and process/product quality. One force behind this is the opportunity to segment capital in the form of investments or inventory and by doing so obtain flexibility in sectors with increasing costs for product development.

(iii) The structure and nature of labour supply conditions

Here we have a third line of argument for subcontracting arrangements, all connected to issues of labour cost and supply. Four reasons (although interrelated) for a parent firm to contract out work are presented: (i) in order to minimize and control labour costs, (ii) to retain flexibility with respect to variable capital, (iii) to maintain managerial control over the labour process, and (iv) to ensure an adequate supply of labour. These are important factors behind much of the existing subcontracting relationships, especially in regions where wage-cost and unionisation are significantly less among smaller firms.

The presentation in section 3.2 concluded with a definition of subcontracting based on customer-specification and the importance of interrelatedness. This view of the phenomenon of subcontracting may be a little too narrow if we consider the discussion in this section, where distinct notions of power and inequality have been raised.

Questions about subcontracting is also discussed within the field of business managment studies. One significant aspect, associated with sub-contracting relationships, is the concept of *core competence* and the importance of focusing on developing certain strategic fields of knowledge (Prahalad and Hamel 1990). This forms the basis for further strategies regarding what areas to concider suitable for sub-contrating arrangements. Bettis, Bradley et al. (1992) use the term *outsourcing* when arguing that inaccurate strategies regarding what to do in-house and what to out-source leads to a drainage of competence, rather than decreasing costs and increasing performance.

Finding one single factor to explain the phenomenon of subcontracting is obviously highly problematic. Flexibility for the parent firm appears to be one important driving force behind the establishment of subcontracting relationships. The development in many sectors of the industry displays how traditional subcontracting relationships are incompatible with new demands. This is best illustrated by the changing subcontracting relationships in the automotive industry, which is discussed in the next chapter.

3.4 Summary

Subcontracting is, compared to arms-length market transactions or vertically integrated production processes, characterised by a large number of different intermediate forms of governance. What unifies the concept is the fact that the out-contracting firm (or principal) is using another independent firm to undertake economic activity *based on specification from the principal.*

This is often interpreted as the production and/or processing of physical goods to be used in the production process of the principal firm. In many cases this is the situation, but the definition does not exclude R&D, services or the production of end-use products.

Entering into a subcontracting arrangement means that the subcontactor agrees to produce a unique product or service for the parent firm and are by the same token dependent upon that firm for its sales. The out-contractor in turn agrees to externalise some of its production into an independent outside firm, which in most cases includes giving away control, especially if the subcontracted goods are components in the final product of the principal. This takes us to the second part of our definition. Subcontracting will be treated as a *dynamic interrelated relationship* mostly unequal in terms of power, but never totally one-sided. The rationale for subcontracting is seen as one of achieving *flexibility* for the out-contractor in relation to:

- Changing markets for final outputs
- Production and labour process organisation
- Labour supply conditions

This can have many different organisational and geographical outcomes depending on context. Some examples of subcontracting have provided an illustration of the complexity and the importance of the issue. There is everything from hierarchically and multi-layered systems in the Japanese automobile industry to industrial districts of small flexible independent firms tied together in a production process.

Subcontracting also plays a major part in the current debate on industrial restructuring and flexibility. The flexible specialisation approach distinguishes new flexible inter-firm relationships between localised independent firms in industrial districts as a significant future path of industrial development. Another view of reality that is becoming more common in economic geography is the network approach, stressing the importance of trust and interdependence in industrial relationships. This provides us with a possibility to analyse more complex forms of interrelations in subcontracting networks.

This chapter has discussed the definitions and forces behind the establishment of subcontracting relationships in general. It seems as if there is a common agreement that subcontracting involves the production of physical products, services or information to be used as input in the production process of another firm. The other basic prerequisite for a subcontracting relationship is that the customer provides the product and/or process specification.

The next chapter will present the changing facet of subcontracting relationships in the automotive industry using the framework developed here. There will also be a discussion about the geographical aspects of this restructuring process.

4. Changes in the organisation of subcontracting relationships in the automotive industry: the importance of geographical proximity

4.1 Introduction

This chapter focuses on changes in the way subcontracting relationships are organised in the automotive industry. The discussion takes its point of departure in the organisational dimension, where a number of buyer- supplier models are presented. This is followed by an illustration of different supplier models in Japan, North America and Western Europe. Each region will be analysed both in terms of the development of the automotive industry and their suppliers, with special emphasis on geographical changes.

The common denominator which will guide the analysis in different car-producing regions is the importance of *spatial and temporal proximity* between suppliers and assemblers. This can be manifested in different formations depending on social and geographical conditions, as well as on the historical tracjectories of the respective regions and their respective automobile companies.

The chapter ends with some remarks on new forms of supplier relationships in the automotive industry. Special attention is paid to the question about the existence of a possible "new" geography of automotive suppliers, and to what extent it is possible to generalise across regions into one universal supplier model.

4.2 Organisational changes in buyer-supplier relationships - towards a new model?

A large number of authors have argued that industries with assembly-type operations are much more concerned with supplier relationships today than ever before. Imrie and Morris (1992) refers to a number of authors when he discusses the emergence of a new buyer-supplier model based on co-operation and non-market exchange, emphasising qualitative factors over price as the rationale behind subcontracting. The main reasons behind this are the growing demand for customer responsiveness; consistent high-quality production and flexible deliveries, in an environment of heightened global competition. Imrie and Morris (1992) discuss this development in terms of a traditional *adversarial* model and the new *obligational model*, where co-operation, price/quality and JIT-deliveries are three important aspects.

One other conceptual framework is developed by Helper (1991). She uses the terms *voice* and *exit* to describe different methods to resolve problems in a buyer - supplier relationship. Taking an exit strategy means terminating the relationship, while a voice-based strategy includes long-term information exchange and commitment from both parties. Her conclusion from a study of U.S. automotive supplier relationships is that voice based relations are needed if U.S. automakers wants to be able to compete globally.

The extensive MIT study on the automotive industry (Womack, Jones et al. 1990) identifies five major tendencies in the restructuring of the supply system in the automotive industry:

- Reduction in the number of suppliers to each assembly plant.
- Outsourcing - more use of outside firms as suppliers.
- Changing attitude towards quality-issues.
- More emphasis on information sharing.
- More frequent deliveries.

All of these tendencies can be analysed within the proposed development from market-transaction and price-competition towards co-operation, trust and inter-dependence in buyer-supplier relationships. This chapter will discuss changes in automotive supply relationships in general terms as well as giving examples from the major automotive producing regions of the world.

From market-based transactions to co-operation?

Compared to the traditional model of arms-length market transactions between totally independent firms, the partnership model relies on mutual trust, and of course, mutual economic benefit in the end. Figure 4.1 presents a number of stages or strategies that might be possible to choose from in the area between the two extreme options of totally market-based transactions and complete vertical integration.

The example of supply-relationships in the figure should not be interpreted as well defined categories but rather as a typology for understanding a process. In practice, there are a large number of different and overlapping arrangements. Both on a firm to firm scale as well as for an entire supply system.

Starting at the market end of the spectrum, most types of buyer-supplier relationships have a low degree of integration. It is more common that firms actually compete in the same market and subcontractors are used to adjust to variations in demand. An example of such a relationship is the supply of *standard components,* where the customer does not provide any specification and the sole selection criterion is the price. An arrangement that is very easy to terminate without any risks for the out-contractor since the actors are independent companies with their own resources for production, development, marketing, delivery etc.

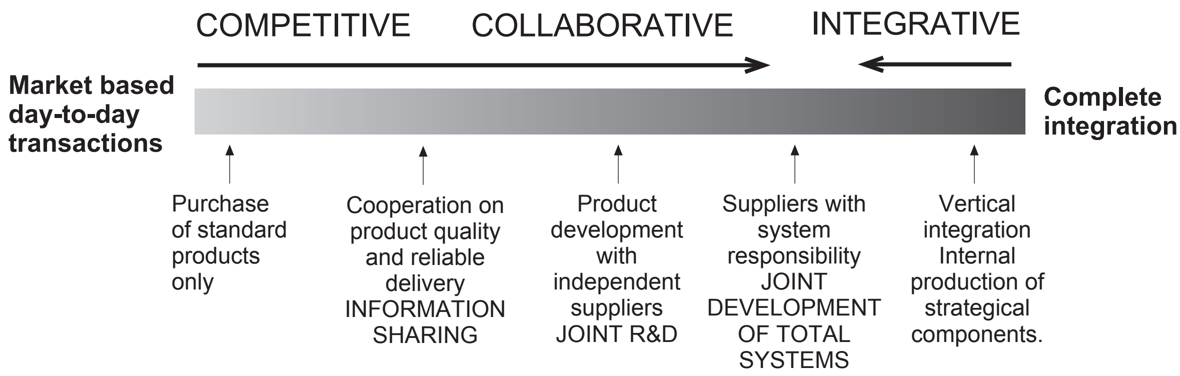


Figure 4.1: Stages of co-operation in a buyer-supplier relationship with respect to integration and commitment. *Source:* Stralkowski, Klemm et al. (1988); Alvstam (1996); European Commission (1996).

The next step on the road to integration is the "traditional" subcontracting relationship. This includes *product-specification* from the customer. Following Lamming's model we can observe that this specification has become more demanding over time. Today it is not only the product that is specified, but also to an increasing degree product-quality and delivery practices. In terms of integration, this means that the out-contractor has to transfer some of its own knowledge upstream in the production process and information needs to be exchanged between the parties.

One way to overcome problems with product quality or delivery is to organize the supply-linkages in such a way that new products and production plans are developed in co-operation rather than in isolation. In order to benefit, the buyer needs to build a collaborative relationship with the subcontractor. This includes sharing information and integrating the production process so that the new products can be put into production without delay. When started, it is more costly both in terms of loss of capital and knowledge to end the relationship, compared to the strategies above.

The establishment of *strategic alliances* is one commonly used form of formal inter-firm arrangement around a specific purpose or project (Cooke 1988; Alvstam 1996; European Commission 1996) The main area for strategic alliances in the automotive industry is in R&D where costs generally are extremely high and problematic for one company to handle.

One common method of integration is to establish relationships with suppliers with *system or sector responsibility.* This includes not only R&D but also a collaborative relationship ranging from development to the finished product. The term system supplier is used in the automotive industry to describe a supplier with responsibility for developing and coordinating the assembly of a number of components into a finished product, ready to fit into the car. Examples of this are complete seats with the correct colour and clothing or painted bumper-systems complete with spoilers and fog-lights.

Arriving at the far end of the integration spectrum leaves us with different forms of *ownership and formal control*, which of course are effective means of reducing the risk of entering into a subcontracting arrangement. This can be noted in the automotive industry where many of the strategic components (e.g engine, power-line or body) are traditionally produced within the final assembly firm, although this is changing towards more out-sourcing and alliances with other producers.

All of these stages in the integration process can be found in an automotive supply system. It is also important to point out that this process is working in both directions, often simultaneously, in the same supply system. This is indicated by the arrows in figure 4.2 which illustrates the simultaneous development towards the formation of large, often multinational automotive system suppliers. The establishment of these large suppliers is predominantly a result of the two processes indicated by the arrows in the figure:

- Restructuring of the traditional supply system through mergers and/or acquisitions of smaller firms into large automotive supply companies with major capacity both in R&D as well as in production.

- Outsourcing of the internalised stages of the production. Either through co-operative arrangements or by selling parts-production to outside firms.

The structural result of these organisational processes is an hierarchisation of the subcontracting network where a small number of top-layer firms become responsible for a system of components. In order to deliver these relatively complex products there is a need for close interaction between the buyer and the supplier. This development is more thoroughly discussed in the following section where the situation in different automotive regions of the world is analysed.

Lammings' four-phase model of changing supplier relationships

One of the most comprehensive empirical studies of the restructuring process in automotive supply systems is made by Lamming (1993) within the framework of the International Motor Vehicle Programme (IMVP)[4]. Lamming interviewed 129 companies around the world in search of factors that could describe the development in the automotive supply system since the early 1970's. The figure below shows Lammings' "four phases" of development.

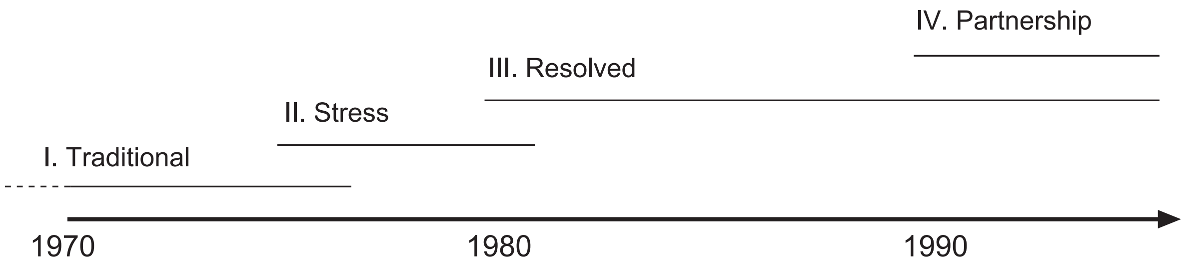


Figure 4.2: A four-phase model of customer - supplier relationships. *Source:* Lamming (1993)

The first phase is called the *traditional model* of customer - supplier relationships and is characterised by "friendly" competition on fairly stable markets. The most important sourcing criteria is price and volume, and conditions are set through negotiation. Most other indicators investigated, such as quality-issues, R&D and delivery practices, are typically organised and performed within the firm without any form of co-operation between supplier and customer.

As the oil crisis and overcapacity on world markets radically altered the nature of competition in the mid-70's, supplier relationships moved into the second phase or the *stress model.* At this point most relationships are highly competitive. Aggressiveness and conflict is becoming more noticeable in supply relationships, and co-operation in R&D is only for cost-reduction purposes. Lamming uses the term "pressure" to distinguish between the different models and the stress-model is characterised by high and unbearable stress on customer-supplier relationships.

The fierce competitive situation during the late 70's and early 80's meant that many component suppliers either left the automotive sector, went out of business or changed their scope of business to other areas. This left assemblers with a situation

[4] The International Motor Vehicle Programme was a 5-year international research project on the transformation of the automotive industry conducted between 1986-1990 at the Massachusetts Institute of Technology, USA. For a more detailed discussion see (Lamming 1993:261-262).

where supplies in some areas became scarce and incentives for co-operation began to emerg.

This is what Lamming calls the *resolved model,* which began in the early 1980's and is still apparent in many relationships. The main difference from the earlier stages is that both suppliers and assemblers began to realise that collaboration was the most logical way out of the stress-situation described above. Factors such as quality and delivery-performance gained more importance relative to price as supplier selection criteria. One major change in the resolved model is the fact that linkages between customer and suppliers started to become a management-issue. This can be seen as a first step towards co-operation and trust which is at the center of the last phase of the model.

Originating in the early 1990's and existing parallel to the resolved model is the *partnership model.* This phase of Lamming's customer-supplier relationships has many features in common with the Japanese form of supplier organisation. This means that suppliers and customers work in a co-operative form rather than competition, but still on a commercial basis where both parties are supposed to gain from a collaborative arrangement. This is clear in the way customers select suppliers where long-term issues are becoming a major factor compared to earlier when the lowest price was the sole selection factor. Partnership, long-term co-operation, trust and interrelatedness are the cornerstones in most areas of the relationship such as, information exchange, production planning, product development and product quality.

This process is also recognised by Lilliecreutz (1996) in a study of buyer-supplier relationships in the Swedish automotive industry. He concludes that the process towards co-operation in supply relationships is visible in Sweden, although there is a very limited number of examples of true "partnership"-strategies. It is only in the last few years that Volvo and SAAB have taken these ideas into practice. Lilliecreutz also points at the importance of the customer being willing to enter into a partnership with a supplier. Otherwise we will end up with the traditional one-way linkages where customers dictate orders to suppliers.

4.3 The geography of the partnership model: the spatial organisation of subcontracting relationships in some major automotive producing regions

Introduction

The automotive industry serves as a good example of how complex the rationale for subcontracting can be. Although it is a fairly homogeneous industry, with basically the same technology and product all across the globe, we can find a wide variety of subcontracting arrangements. This section will compare the situation in the three major automotive regions of the world, Japan, North America and Western Europe. The objective will be to analyse to what extent the Japanese-inspired "partnership-model" has been introduced and adapted into the different regions.

The organisation of Japanese automotive supply systems

According to Sheard (1983) we can find a distinctive pattern in the organisation of subcontractors in the Japanese automotive industry. Firms are arranged in a hierarchy with different layers of subcontractors. The upper layer consists of large subcontractors, not rarely financially controlled by the parent firm. Sheard points to the historical development of the Japanese automotive industry as one factor of explanation. During the 1950's and 60's when the industry expanded, these systems were built up from scratch with a pool of small and medium sized engineering firms that were possible to control with limited investment.

The system has since then developed into tight inter firm relationships between first-tier subcontractors and the parent firm, often resulting in formalised subcontracting associations centered around the respective out-contractor (Takeuchi 1990). Japanese first-tier subcontractors are probably best described as supplier subcontractors, with full responsibility for product development, design and production. Contracts are long-term, and when agreed upon, not subject to short time market changes (Mair 1994).

A typical structure consists of a number of layers of suppliers as shown in figure 4.3 below:

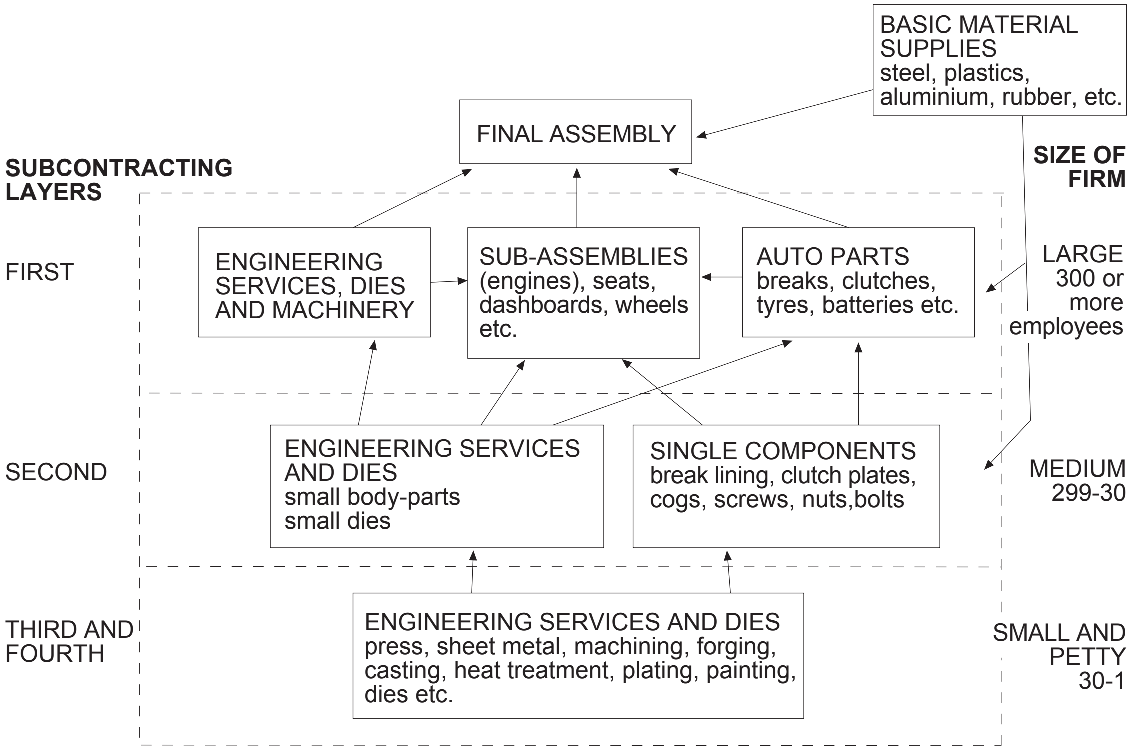


Figure 4.3: Japanese automobile production system. *Source:* Sheard (1983:55)

The demand for high quality and reliability from the leading assemblers is guaranteed through a multi-layered system of interconnected subcontractors. The division of labour is hierarchical with the first layer subcontractors involved in more complex production.

The big first-tier subcontractors are often fully or partly owned by the large assembly firm, which in return for extreme flexibility gives long-term contracts and close collaboration in product and process development. According to Sheard (1983), one typical characteristic of the Japanese system is the large number of small and medium sized firms in the lower layers. These smaller firms have no contracts with the assemblers and are usually doing less complex work offering wages much lower than top layer firms. Toyota's 220 first-tier suppliers have approximately 30.000 firms in the layers underneath (Hayter 1997), a figure that gives an indication of the complexity of the system.

Studies of the second and third tiers in the subcontracting hierarchy are few in numbers but Sheard (1983) has observed distinct hierarchies with several layers of subcontractors. These tend to be smaller the further down in the hierarchy they are positioned. It is estimated (Sheard 1983:56) that an average production system of a Japanese automobile firm comprises 171 first layer, 4700 second layer and 31600 third layer subcontractors. So we end up with a clearly segmented economy where the big auto assemblers can reduce fixed capital trough minimised inventory levels and outsourcing of product development to a small number of first-tier firms in a formalised hierarchy of subcontractors.

One explanation to the expansion of the Japanese automotive industry since the 1970's is their system of relatively cheap and closely tied subcontractors, following the quality and production needs of the parent firm. The different forms of subcontracting displayed in figure 4.3 are all existing but dominating in one layer respectively, ranging from supplier subcontracting at the top of the hierarchy to capacity subcontracting arrangements at the base.

More recent studies of Japanese automotive buyer- supplier relationships confirm this view, although there is evidence that the rigid company-centered hierarchies are starting to open up. This is caused partly by the search for new markets and new technology, and partly due to trade policy and the globalisation of supply linkages. (Fujimoto 1997; Kalsaas 1998)

It is clear from the discussion so far that the "partnership-model" has found much of its inspiration from the Japanese example. It is important to point to the fact that behind the generalised picture of the Japanese model, we can find different forms of supplier organisation not always typically "Japanese". Within the hierarchical model we can see how Toyota and Nissan show different historical trajectories and different solutions to supplier selection and management (Hayter 1997; Kalsaas 1998).

The geography of Japanese automotive suppliers

Toyota has the most extreme "just-in-time" strategy including the concentration of facilities to one location. This started in the late 1930's when the company selected Koromo, a small textile town on the southern fringe of Nagoya, as its center of production. The region's traditional silk industry was in a deep recession, which gave Toyota access to labour, cheap land and a possibility to build a "greenfield" automotive-town, which was renamed Toyota City in 1959 (Hayter 1997).

Suppliers were attracted to the area right from the beginning and the first supplier-organisation was established just after World War II. By 1980 there were eleven Toyota facilities and 220 first-tier suppliers located in Toyota City (Morales 1994). The case of Toyota City is often cited as the typical JIT-production organisation with the need for suppliers to be located in close proximity to the customers.

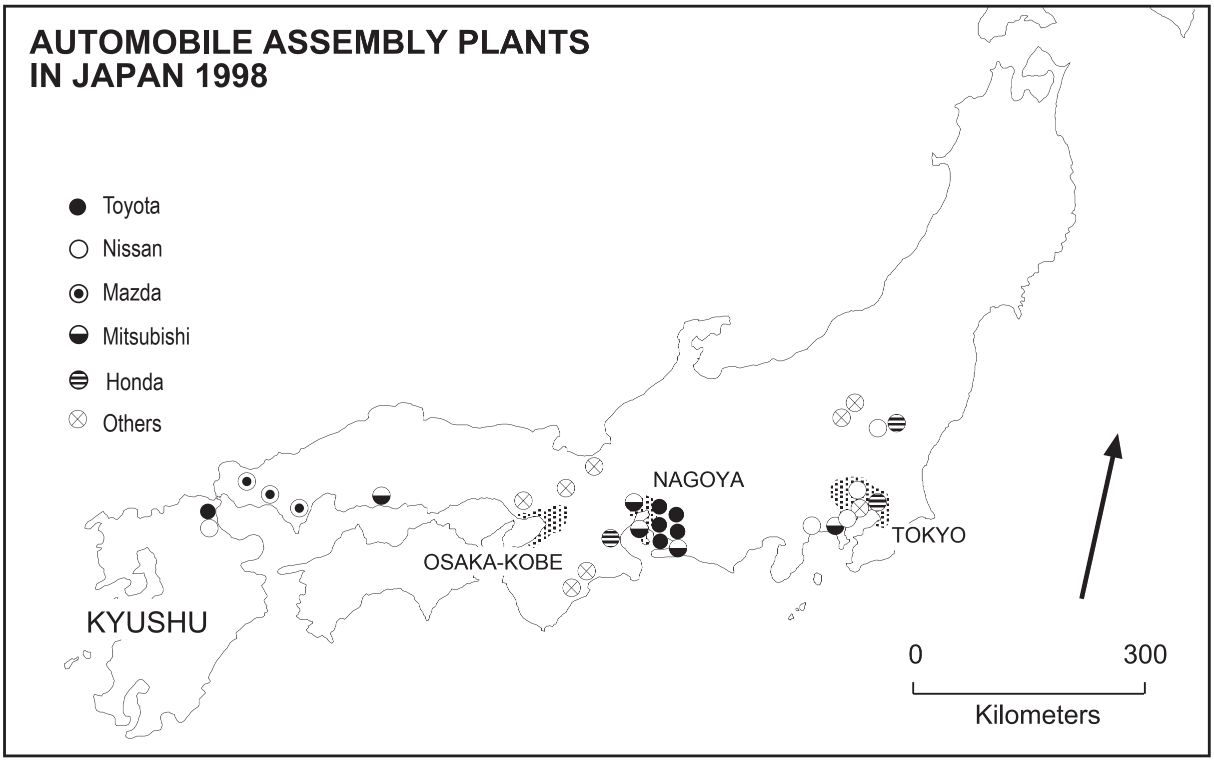


Figure 4.4: Location of passenger-car assembly plants in Japan 1998. *Source:* Japan Automobile Manufacturers' Association, in: Automotive News Europe (1999)

It is important to point out that proximity, in most cases, is associated with the use of sequential deliveries which is far from the most common form of supplier linkages in Japan (Kalsaas 1995). One example is Toyota's Kyushu-plant (see figure 4.4) which is located in a relatively remote area and is dependent on strategic suppliers in the traditional urban centers (Takeuchi 1990; Kalsaas 1995).

Nissan has chosen a different geographical strategy and had almost half of their suppliers in 1987 located in the greater Tokyo region, building on the existing urban industrial complex in the region (Takeuchi 1990). Toyota and Nissan were the first to use a full scale supplier system closely linked to the respective firm, the others had to rely on independents to a greater degree (Fujimoto 1997). This might imply that the extreme concentration to Toyota City could not be created by most other producers, due to the limited possibilities of influencing or "forcing" suppliers to deliver according to sequential JIT-demand.

One major factor to take into consideration in the discussion about location is the transport conditions in Japan in general and in the traditional automotive regions in particular. Due to the traffic situation with heavy congestion, the time-space reality for Japanese suppliers is radically different from more sparsely populated regions in North America or Scandinavia (Linge 1991; Mair 1992).

According to Kalsaas (1995; 1998), suppliers have to secure deliveries through the establishment of delivery warehouses in close proximity to the customers. This strategy might be interpreted as a sign of increasing conflict between the rather rigid JIT-delivery regime and the growing traffic problems. It is furthermore related to regional policy, where assembly plants have been located in relatively remote areas such as Kyushu and have to rely on transport from suppliers in Nagoya and Toyota. This has contributed to a situation which differs from the case of Toyota City where proximity of assemblers and important suppliers is extreme even in Japanese terms.

We can conclude that just-in-time production in Japan has a variety of spatial supplier-configurations depending on company trajectory and regional conditions. The picture of Toyota City is not the standard Japanese automotive production system, although compared to other parts of the world; it can be said that proximity and JIT-production have been closely associated.

On a regional level automotive assembly and suppliers are heavily concentrated to the major urban regions (see figure 4.4). Toyota and Nagoya have, thanks to the automotive companies, become "supplier hubs" attracting lower-tier suppliers. More than two thirds of the Nissan suppliers have their headquarters in the Tokyo region.[5] Miyakawa (1991) reports on similar findings with assembly firm clusters in the main metropolitan areas of Tokyo, Nagoya and Osaka.

The regional clustering facilitates JIT-deliveries and close contact between the actors in the supply chain, as well as members of the company-specific supplier associations.

The organisation of automotive supply systems in North America

The North American automotive subcontracting system has developed in another historical context and with different organisational outcomes. The most significant difference between Japan and the U.S. in this respect is probably the long tradition of vertical integration and market-type subcontracting relationships (Rubenstein 1988; Hill 1989). Japanese firms produce about 30% of the value of the car in-house whereas the same figure for the U.S. can be as high as 70% (Hill 1989:466). This means that the hierarchical system of subcontracting tiers is much less prevalent than in Japan.

In terms of power relations, U.S. subcontractors are more independent firms, while Japanese subcontractors are connected to a parent company to a greater degree. A study of the U.S. auto parts production Glasmeier and McCluskey (1987) shows that production for the after-market (e.g. spare parts, maintenance) as well as for non-automotive purposes is of great importance to many of the big subcontractors, a situation that further minimises the power of the parent firms.

[5] Lecture at Göteborg University by Professor Atsuhiko Takeuchi, Nippon Institute of Technology, 1994-04-28.

There seems to be a common belief among authors that the U.S. is pressured by hardening competition and rising R&D costs to follow the Japanese model (Glasmeier and McCluskey 1987; Helper 1991; Mair 1994). This would eventually lead to more out-contracting and the formation of specific firm-related subcontracting hierarchies. One example which proves that there is significant social and historical differences are the Japanese so called 'transplants' in the U.S. (Mair, Florida et al. 1988). These plants which are a transformation of Japanese production plants into the North American context have been forced to adopt a combination of Japanese, tightly controlled non-unionised systems, and U.S. more independent arrangements (Berggren, Björkman et al. 1993; Mair 1994).

The rationale for subcontracting is apparently different between the two regions. In Japan, during the build-up phase, the big automotive assemblers could take advantage of a large number of small and medium sized firms ready to enter into subcontracting arrangements. This allowed the parent firms to put pressure on the subcontractors and out-source significant parts of their operation and simultaneously being able to receive high quality and competitive prices.

The U.S., with more independent firms, did not have the same conditions for horizontal integration. The open market-approach and highly unionized firms did not produce particularly favourable conditions for building firm-centred subcontracting hierarchies. The firm-specificity of subcontracting in the Japanese auto industry can be seen as a form of social control mechanism (Hill 1989) that enables the relationship to work smoothly (seen from the view of the parent-firm) compared to the more bureaucratic and market driven U.S. approach.

North American automotive assemblers and suppliers have been influenced by the partnership model. One significant factor is the influx of Japanese firms, and the formation of supply system with a different form of organisation. One indication that the use of internal suppliers is decreasing is the restructuring of company-owned suppliers into independent companies such as Delphi (GM) and Viseton (Ford). These supplier-groupings are of course still tightly linked to their respective company, but the aim of the process is to establish competitive and more independent subcontracting companies (Financial Times 1998a).

The geography of North American automotive suppliers

Production of automobiles in North America has traditionally been associated with Michigan and especially Detroit, where the manufacturing started at the end of the 19th century. This region is still considered to be the automotive "heartland", although there has been a number of locational shifts in the last century. This process can be divided into a number of stages: (Rubenstein 1986; 1992)

- Before 1900 Automobile production starts across the north-eastern part of United States.
- 1900 - 1915 Concentration to southern Michigan.
- 1915 - 1965 Redistribution to several locations across the continent.
- 1965 - Relocation to the mid-west, first domestic firms later followed by Japanese "transplants".

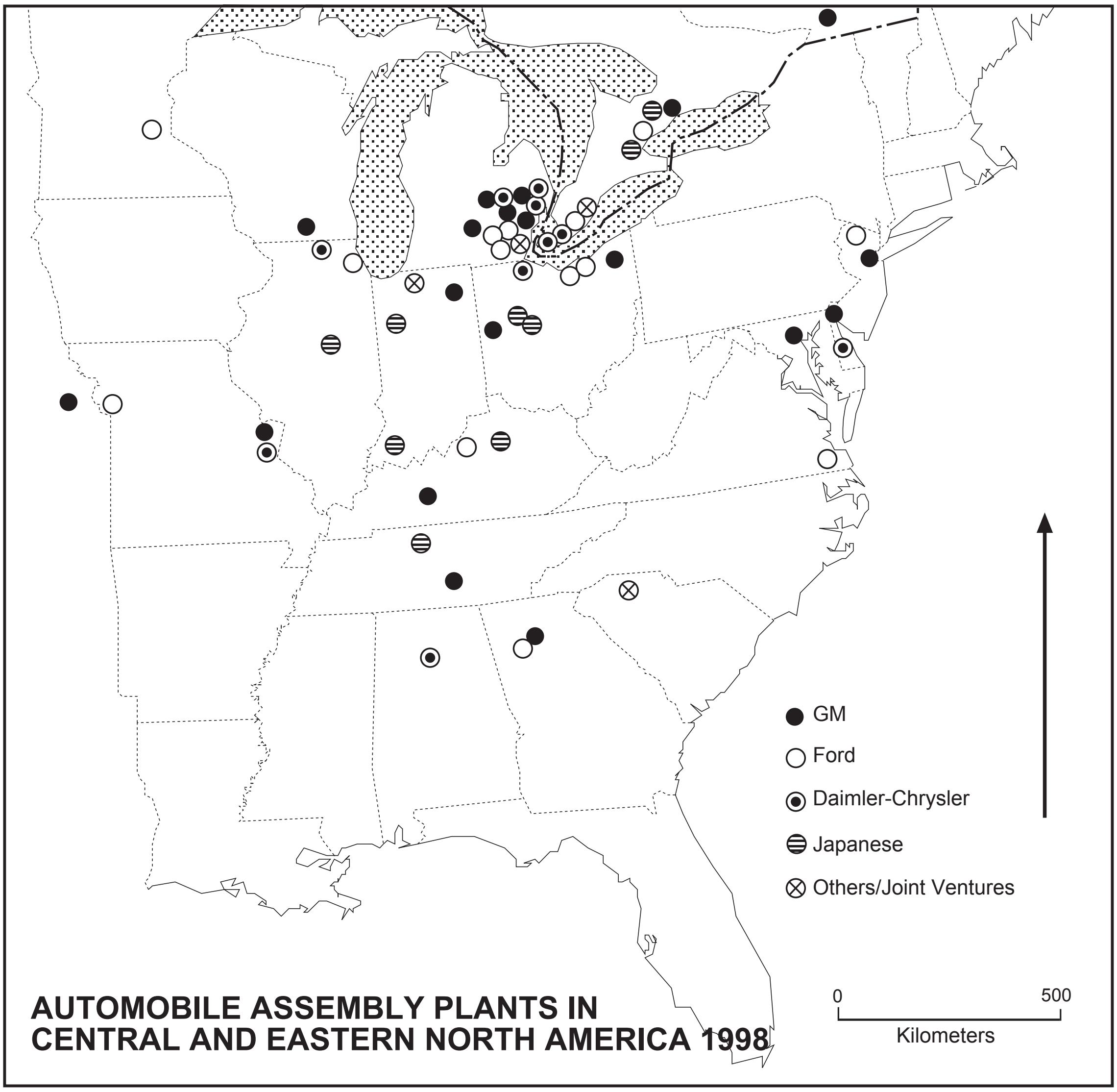
As we can see from the map in figure 4.5 below, there is a concentration of assembly plants ranging from southern Ontario in Canada, through the center in Michigan and further south into the mid-Western states. The pattern is even more pronounced for the Japanese plants. They are all located within the "transplant corridor" (Mair, Florida et al. 1988) coinciding with the above pattern, except for the avoidance of the traditional Michigan region.

This is a result of the Japanese strategy to locate in rural areas with little or no experience of industrial manufacturing. By doing so, they could create their factories and organisation without the involvement of the union or labour with experience of other forms of automotive production (Berggren, Björkman et al. 1993; Howes 1993).

Suppliers to the automotive industry display a lower degree of mobility compared to the assembly plants. There is evidence that supplier companies have remained in the mid-west to a higher degree than the assemblers (Glasmeier and McCluskey 1987). Even during the re-distribution phase, the majority of supplier-firms stayed in their original location (Rubenstein 1986). This might, at least in part, be connected to the relatively high degree of vertical integration in the U.S. auto-industry. Extensive in-house production of components is more likely to be less flexible, in terms of following the assembly-firm, compared to a system with a high level of outsourcing.

What has characterised the geography of the North-American supply system since the mid-1980's is the introduction of Japanese assembly plants and suppliers. The confrontation with Japanese "just-in-time" production philosophy changed conditions for traditional suppliers to a great degree. Newly established assembly plants in the rural mid-west had difficulties finding suppliers that could meet their delivery requirements and product quality demands. This opened the way for new suppliers, both American and Japanese, to establish production sites in relative proximity to the new assembly plants (Mair, Florida et al. 1988).

The locational pattern of these establishments has basically been determined by the Japanese assembly plants' location in the rural mid-West. Figure 4.5 shows the location of first-tier suppliers to three Japanese factories in this region. The suppliers are clustered around each factory, but at such a distance that deliveries to other plants is possible. Mair (1993b) reports from the case of Honda that Japanese transplants tend to organise their suppliers in a "just-in-time region" for each manufacturer. But there is no evidence of extreme local clustering such as in the case of Toyota City.

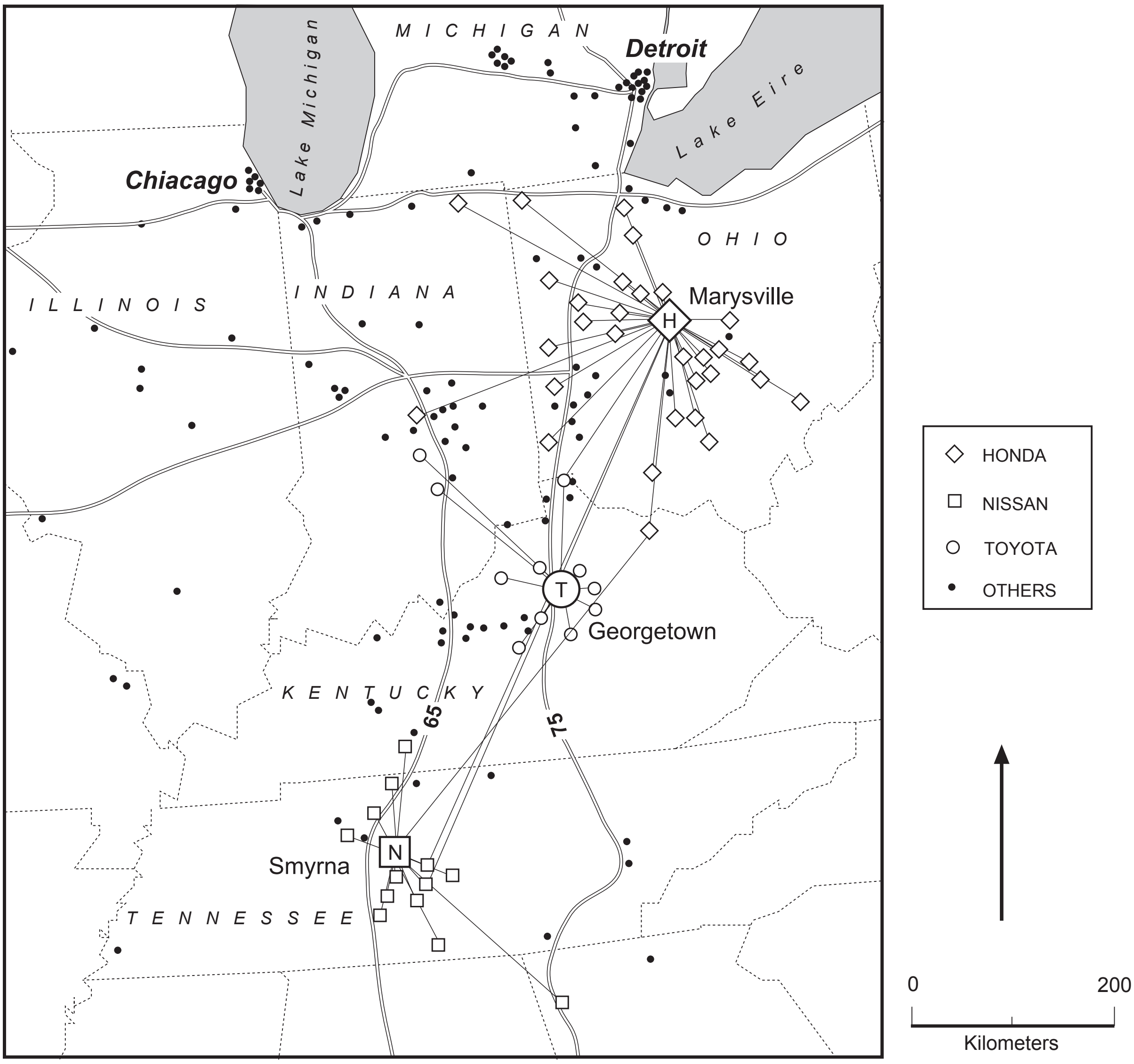


Note: Plants located outside the map: GM plants in Oklahoma City, Arlington, Texas and the NUMMI joint venture in Freemont, California.

Figure 4.5: Location of passenger-car assembly plants in eastern North America in 1998.
Source: Automotive News Data Center, in: Automotive News Europe (1999)

The regional concentration of assembly-plants allow for suppliers to combine large volumes and frequent deliveries. A study by Reid (1995) concludes that Japanese-owned manufacturers using JIT-practices purchase a significantly higher degree of their inputs from their own county compared to non-JIT users.

This clustering at the regional level is not followed by local proximity to the same extent. Several studies (Mair, Florida et al. 1988; Chapman, Elhance et al. 1995) conclude that there are no signs of supplier-complexes of the Toyota City-type found



Note: In the group others is included suppliers to other assembly-plants, both domestic as well as foreign, plus one group where customers are unknown.

Figure 4.6: Suppliers to three Japanese Automotive assembly plants in the U.S. mid-West 1988. *Source:* Mair, Florida et al. (1988)

in Japan. It is important to point out that the domestic firms have traditionally used significantly less outside suppliers. The relatively higher degree of vertical integration has produced less external supplier linkages, but the spatial proximity between automotive parts-production and point-of-assembly is probably as likely to be found inside the limits of an integrated plant.

Mair (1992) argues that time, rather than distance, is the crucial variable in JIT-deliveries. This makes comparability between locational patterns across regions and countries difficult, due to shifting traffic and infrastructure conditions. What is regarded as a remote supplier location in Japanese urban traffic conditions is considered close in U.S. mid-Western rural traffic.

What is considered as a "normal" distance to cover is of course dependent on the product and its specific delivery arrangement. One to two days for delivery is proposed by Glasmeier and McCluskey (1987), while Mair (1992) reports eight hours as a standard for the outer limit of JIT-deliveries. Honda has established a supplier region within a 100 mile radius around its Marysville Plant, although with some suppliers as far away as 600 kilometres (Mair 1993b).

One general conclusion to be drawn from the experience of Japanese investment in the U.S. is that the large domestic producers have their traditional supplier base in the Michigan - Great Lakes region, while the new "transplants" have a higher share of suppliers in the mid-Western states. This pattern can be assigned to two main factors: search for low-cost non-unionised locations in order to implement new, more flexible forms of work organisation, and the need for reliable and frequent deliveries under JIT-production regimes.

The organisation of automotive supply systems in Western Europe

The conditions under which the Western European automotive industry has developed is yet another story compared to Japan and North America. The most important difference in terms of the organisation of supply-systems is the long history of many parallel national production systems. This has produced a situation where each automotive firm has a base of suppliers in their home country with which they have developed close links.

The map in figure 4.7 demonstrates how national brands have a strong manufacturing-presence in their respective home country. France and Italy show the most homogeneous structure in terms of ownership, while U.K., Spain and Poland present a very mixed pattern. Both Spain and U.K. have had their own national automobile industries, which have been acquired by foreign companies. This is the same process that has recently put the Swedish automobile industry into foreign ownership.

From this follows that generalisations about how the partnership-model has been introduced is complicated since a variety of national contexts have to be taken into account. Due to the fact that many national systems have had their own specific conditions and regulations there has been a growth of national supply systems, linked to the domestic car producers. The degree of domestic purchasing could be as high as 85-90% in the cases of FIAT and Daimler-Benz in 1991 (Jones 1993). This can be compared to Volvo Car Corporation in Sweden before Ford's acquisition, with only 30% purchasing from domestic suppliers.

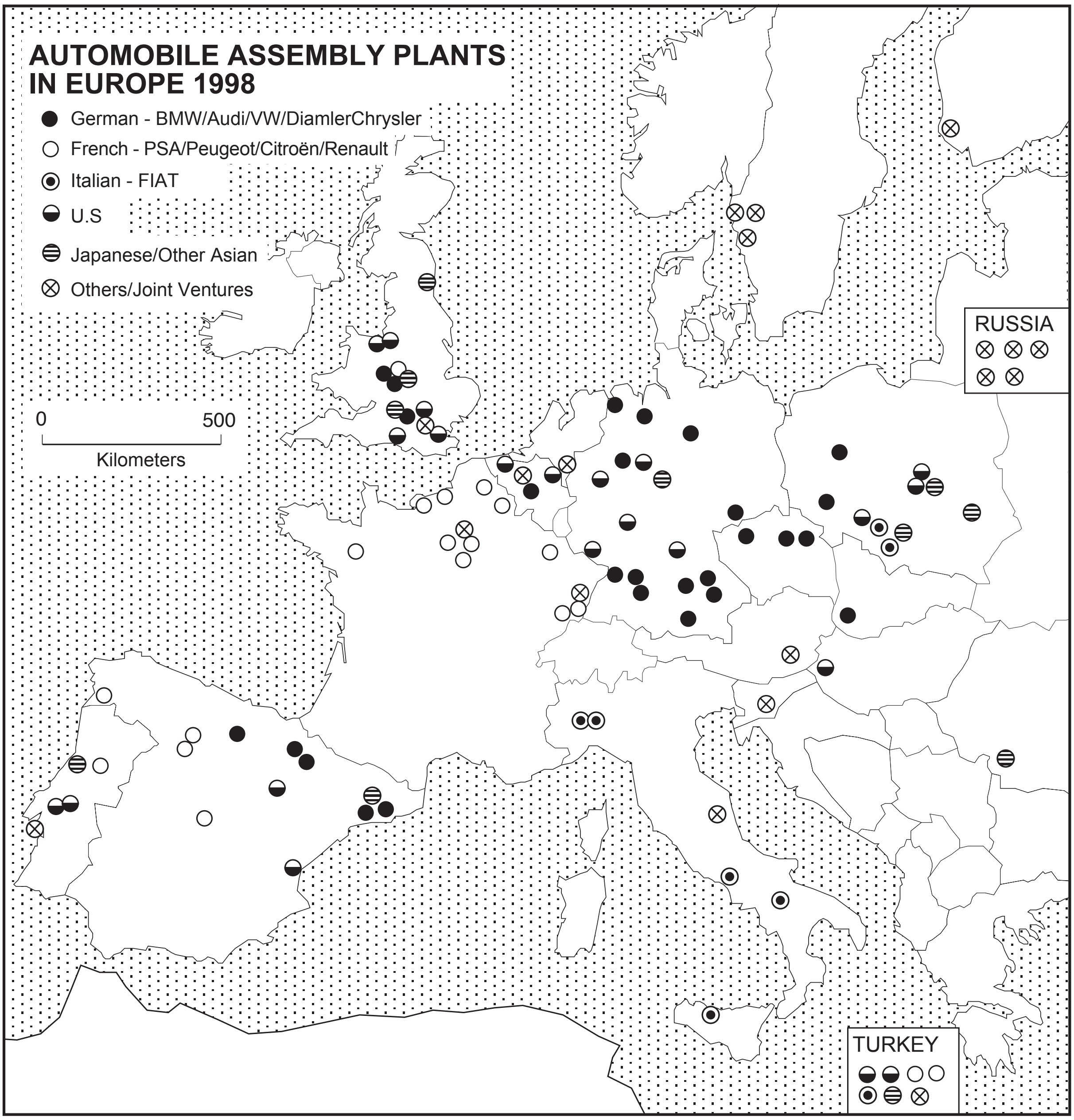


Figure 4.7: Location of passenger-car assembly plants in Europe 1998. *Source:* European Automobile Manufacturers' Association in: Automotive News Europe (1999); Hudson and Schamp (1995:239-240)

But in the face of increasing global competition and the creation of the single European market, the conditions have changed dramatically, and we can observe a restructuring process towards an *europeanisation* of the supply-system (Hudson and

Schamp 1995; Sadler 1997). This has changed conditions for suppliers and opens up for a restructuring and concentration phase in the business. This can be observed through the intense ownership changes in the automotive components sector globally which has affected Western Europe, especially in the last 5 years (Financial Times 1996a; 1996b;1996c).

While Japanese automotive firms have tried to import their tight subcontracting relationships into the U.S. via Japanese subcontractors, there is another picture in Western Europe. One major difference is the magnitude of Japanese investment which has been considerably less comprehensive compared to in the U.S. Together with European Union regulations on local content (Munday, Morris et al. 1995) and a segmented automotive market, we have a situation where transplants are smaller and the scope for Japanese subcontractors to follow their parent firms is less obvious (Morris 1989; Jones and North 1991).

The transplants (Japanese fully owned plants) in Europe are almost exclusively located to the U.K. Unlike the U.S. situation, there are only a few Japanese subcontracting transplants in the same region. Jones and North (1991) present two explanations for this. Firstly that only subcontractors of bulky items, due to logistical coordination and transport cost, have located plants in the U.K., and secondly that many Japanese firms have chosen a joint-venture strategy to enter into the existing British subcontracting industry.

The German automotive supply-sector has not experienced any major Japanese investments so far, but the development of subcontracting relationships is gradually being influenced by new practices, among them Japanese production concepts such as "just-in-time"' (Schamp 1991). According to Schamp (1995) the German supply sector is characterised by a long tradition of independence in relation to the big assembly-firm. This might be an important factor that works against the "partnership-model" in the sense that suppliers need to give up a certain amount of their power and independence.

Lagendijk (1997) notes that the partnership model has spread among European suppliers, but started relatively late compared to suppliers associated with Japanese carmakers. He points furthermore to the fact that similar ways of organising supplier relationships might have been in use locally as a traditional form of inter-firm relationships. This last observation is important to have in mind, since the debate often defines Japanese-style supplier relationships as a totally new invention, which is far from the truth in all companies across Europe.

The geography of European automotive suppliers

As discussed above, the European automotive supply industry has developed in a framework of national automobile industries. This structure has been challenged in the last decade by two main factors, the influx of Japanese investments and the introduction of the common European market.

This can be observed in the case of the U.K. automotive industry, where the traditional assemblers in the Midlands have been associated with a large regional domestic supplier industry . When the domestic car-producers were out-competed during the 70's and 80's, many of the Midlands-suppliers went the same way. In 1977, 43 of the 60 biggest component firms were U.K.-owned, a figure that fell to 28 in 1988 (Sadler and Amin 1995).

The most important factor for the "rebirth" of the U.K. auto-industry was the Japanese investments in the late 1980's and early 90's. Japanese supplier practices, including "just-in-time"-delivery and single-sourcing changed the conditions for suppliers. Many observers expected the new demands to be manifested in spatial proximity between supplier and assembler. This has come true only to a very limited extent. In the case of Nissan's greenfield location in Sunderland (Morris 1991; Garrahan and Stewart 1992) only a few suppliers located themselves in direct proximity. In 1993, only 25 out of a total 180 were located in the north east of England, with more suppliers in the Midlands (Charles 1996).

The conclusion from the U.K. automotive industry is that no supplier-complexes such as Toyota City have developed around new Japanese factories. One has to bear in mind the relative size of the British Isles in comparison to the U.S. Any U.K. location would fit into the U.S. mid-west region and form a regional cluster in that context, while it will appear to be remote in a British setting.

The locational restructuring pattern in the U.K., with a relatively stable supplier-base seems to be present on the Western European scale as well. The location of auto supplier clusters coincides well with the traditional patterns of assembly plants in regions such as, the West Midlands, Greater Paris, north-east Italy and Baden-Württemberg/Bayern (Jones 1993). A study of suppliers to Ford Wells and Rawlinson (1992) in the early 1990's seemed to confirm this thesis. Mapping Ford's supplier sites in the major automotive regions in Western Europe reveal spatial clusters, not related to Ford production units, but to traditional industrial regions.

The traditional continental auto-clusters have not attracted Japanese investment, as the case along the automotive corridor in mid-western North America. Instead we can observe a concentration to the U.K., and in some cases to the European "margin"; Spain, Portugal, Poland and Hungary (Jones and North 1991).

One major difference between the North American and the European context is the long tradition of national protection of the automobile assembly industry. These formerly regulated markets have now, in the face of the E.U. common market, developed into one large internal market. But the protective policies are still very important, resulting in the demand for a minimum of 80% local content (local meaning the European Union) in foreign investment projects. This is undoubtedly one of the most important factors behind the relatively modest Japanese investments both in the assembly as well as the supplier sectors (Jones and North 1991; Sadler 1995).

One important aspect of new purchasing models in the European automotive industry is the increasing use of sequential JIT deliveries. This has lead to a growing use of dedicated logistics warehouses or final assembly points in close proximity to the customer. Munday, Morris et al. (1995) report on low levels of local purchasing from Japanese investments in Wales. When local suppliers were utilised it was mainly for logistics reasons, and involving bulky products with a low technological level.

This is discussed by Pallares-Barbera (1998) as an important aspect of the restructuring of the Spanish automotive supply system. The Spanish automobile industry has adopted flexible production methods including JIT-production, a process which has been triggered by foreign investment in new assembly plants during the late 1980's and early 1990's. These new establishments have, to a significant degree, taken place outside the traditional automotive-producing regions in Madrid and Barcelona. The decentralisation-process can not be identified to the same extent among suppliers. This is explained by the widespread use of local warehouses for the coordination of deliveries from distant suppliers. Similar solutions to transport and delivery requirements are used by Renault. Savary (1995) reports on the formation of "synchronous suppliers" of high volume and low value parts located in close proximity to assembly plants.

Besides the importance of Japanese investments and the E.U. regulatory framework for the geographical restructuring of the European supply industry, the transportation- and infrastructure conditions are one important factor for just-in-time production and locational strategies on the local and regional scale. Mair (1993a) discusses how local authorities have tried to utilise JIT-strategies to foster local development. He uses the term "growth pole" around which so called "magnet companies", predominantly Japanese automobile assemblers, are supposed to attract suppliers geographically through the need for JIT-deliveries. Transportation infrastructure is vital to attract the magnet company, but can also work as a negative factor for supplier attraction. Good transport conditions allow for longer transport distances, and will consequently widen the area of location from which it is possible to guarantee reliability in deliveries.

Another solution to problems with reliability in logistics and transport is the use of supplier-hubs or supplier parks. This has been practised in a number of cases such as

Ford in Saarlouis and Valencia and SEAT in Barcelona (Wright, Hunston et al. 1998). The concept of supplier parks will be discussed in further detail in chapter 12, in relation to the development of the Volvo supplier-park in close proximity to the Torslanda assembly plant in Göteborg, Sweden.

One conclusion that can be drawn from evidence in different Western European countries (Conti and Enrietti 1995; Hudson and Schamp 1995; Laigle 1997) is that buyer-supplier relationships based on the partnership features discussed by Lamming are known to have predominantly positive features. The implementation process however appears to be highly correlated with the introduction of new models or new greenfield investments where working practices and supplier relationships can be reconstructed with fewer problems compared to existing facilities. Examples of this is the FIAT plant in Melfi (Pulignano 1997), Volkswagen's plant in Mosel/Zwickau (Chew 1999), Opel/GM in Rüsselheim (Kurylko 1999) and the rebuilt VW-owned Skoda facility in Mlada Boleslav (Ny Teknik 1998).

4.4 Towards a new geography of supply relationships in the automotive industry? – concluding remarks

If we try to draw some general conclusions out of the examination of automotive subcontractors, and at the same time return to the theoretical discussion earlier in this chapter, there are some points to be made:

- The **Japanese** system is characterised by a *multi-layered hierarchy centred on the big manufacturers.* Subcontracting is a common strategy to ensure cheap labour and organisational flexibility. Power relations are unequal and dominated by the big assembly firms. Firms are often engaged in *tight relationships* with little or no market-like features. The further down in the hierarchy the smaller the firm and the more capacity subcontracting.

- In **North America** there is less use of subcontracting, although lately Japanese 'transplants' have imported their own subcontractors. Traditionally, there have been more market-like relationships between independent firms, producing a less hierarchical and more competitive subcontracting system.

- **Western Europe** shows a much more complex picture. Fragmented national markets and European Union rules on local content prevent large-scale plants and the Japanese influence has been considerably less important. The multi-layered system is not yet a typical feature of the European automotive industry, although the degree of subcontracting is higher than in the U.S.

The automotive industry and its supply sector is a highly diverse and context dependent phenomenon. Organisational changes away from price-competition towards co-operation and "partnership" arrangements have spread from the big Japanese companies and are today a common feature in the reality of suppliers in both North America and Western Europe.

It is important to point out that Japan, North America or Western Europe are far from homogeneous regions in terms of supplier-strategies. It is probably more correct to talk about firm-specific strategies, although firms within the respective region have many features in common regarding supplier strategies.

The geographical outcomes of the restructuring process are consequently shifting between regional and national contexts and conditions. Japanese automobile production has traditionally been associated with tightly connected suppliers and JIT-deliveries. A high degree of agglomeration to metropolitan areas is currently being challenged by new establishments outside the traditional "company-towns", both due to regional policy and extremely problematic traffic conditions.

Japanese investment in North America has changed the traditional locational pattern of the automotive industry and its suppliers. Not so much on the national level, where the traditional auto-region in the mid-west is still the main target of investment. The major changes have been on the regional scale where the Japanese automotive producers have created company-centered supply regions around their new greenfield locations in predominantly rural settings

On the local scale, though, there is no evidence of the local clustering of suppliers as in the case of Toyota City. This is most likely explained by the relatively favourable traffic and infrastructure conditions in the regions selected by the Japanese firms. Deliveries can be carried out over much longer distances with preserved high levels of reliability in relation to the traditional urban locations in Japan.

If North America displays a relatively straightforward picture in terms of locational patterns, the European situation is very much the opposite. With four major, and a handful of smaller, automotive producing countries the pattern is very fragmented. The tradition of politically supported home markets has created large national producers and supply systems. These have been challenged by the opening up of the European market and the influx of foreign investment, both in assembly as well as in the concentration process in the supply industry.

Geographically, Western Europe is still characterised by a number of parallel national automotive supply systems. Each of the major national brands in Germany, Italy and France purchase a majority of their inputs from domestic suppliers. The U.K. is a special case since all of the major national producers have disappeared. This has partly been replaced by Japanese companies using U.K. suppliers, although not by the same historical rationale as most continental producers.

Since the Japanese investment is considerably less extensive in Europe compared to the U.S., the influx of Japanese suppliers and the JIT-based company regions are less pronounced. One example is the Nissan-plant in Sunderland, where a handful of large Japanese suppliers have followed Nissan to locate adjacent to the assembly-plant.

New foreign greenfield plants is an efficient tool to introduce new supplier practices into an already existing system. Due to the limited number of such investments outside Britain, new supplier practices in other parts of Europe are associated with model-shifts, or the establishment of new production units.

In order to manage JIT-production and sequential deliveries in the traditional system, the use of delivery centres or logistics hubs has become popular (Wright, Hunston et al. 1998). These centres act as intermediate points of delivery, between the traditional production site and the customer's assembly plant. In order to facilitate reliable and frequent deliveries these hubs are located close to each production plant.

To summarise the geography of the partnership model discussed in this chapter, we can distinguish a number of spatial strategies for automotive suppliers. The most common situation is that automotive-suppliers are located within traditional industrial clusters. In the case of Japan, the main metropolitan areas are centers for the majority of suppliers in the lower tiers, while North America and Europe display a concentration to traditional industrial districts.

At the other end of the locational spectrum lies the extreme dedication to a specific company or even assembly plant. This can be found in Japan, specifically in the case of Toyota City. In other regions, examples of major local concentration of suppliers are scarce. One observation from several studies is that most JIT-arrangements with a need for frequent and highly reliable deliveries use different logistics planning solutions to avoid having to move operations. What we see then is a number of new small operations opening up in the direct vicinity of assembly plants. Their main aim is to arrange incoming parts from the traditional production locations, so that they can be delivered according to the JIT-demand from the customer. The function and structure of such operations can be either in the form of single companies or as a warehouse facility run by a logistics company.

This leaves us with a third strategic solution, the creation of a regional JIT-production sphere with the establishment of new complete production plants of suppliers as a result of new demand from the assembly firms. Such a development has not been observed when the partnership model has been taken on board by the traditional U.S. or European car manufacturers. But it can be distinguished in the formation of new greenfield establishments in the U.S. rural mid-west. It involved a substantial influx of Japanese suppliers to fill the need for high performance companies in a setting that previously had little experience with engineering-industry.

It looks as if the partnership model is of great importance when analysing the changing conditions for automotive suppliers today. The link between tighter inter-firm relationships and proximity in supplier location seems to be less obvious in most cases. It can be observed on different levels in different contexts, but to draw the general conclusion that new supplier practices based on the partnership model always include a component of spatial clustering of suppliers would be wrong.

5. Time-compression and subcontracting

5.1 Introduction

The proceeding chapter discussed the changing nature of buyer–supplier relationships, both in terms of organisation as well as geography. New forms of organisation and power structures, such as hierarchical supply systems, are one outcome of the current restructuring process. But there is also, a sometimes neglected, physical side to this problem.

This chapter will concentrate on the significance of time in the production process. The main objective is to discuss how the ongoing restructuring process in the automotive industry is linked to time-rationalisation in the production chain. A development which has profound implications for the temporal organisation of material flows and its spatial outcomes.

The rationale behind time-rationalisation strategies in industry can be traced back to the more general tendency towards flexibility (Schoenberger 1988). This is especially evident in consumer-goods sectors such as automobiles where models and colours changes with shorter intervals all the time. To be able to deliver a personalised vehicle within a specific time-limit has become an important strategic competitive factor, especially in high-end segments where Swedish manufacturers operate.

This chapter starts with a discussion of time-rationalisation using the concept of *time-compression*. It is followed by a more detailed presentation of how this can be used on different levels of a supply system. Furthermore, the idea of "just-in-time"–production is discussed and related to developments in the automotive industry.

Thereafter, transport- and supply-chain issues are the main concern. The discussion focuses on time-related strategies and refers to geographical aspects only to a limited extent. These topics can also be discussed from a regional angle, where local assets such as skilled labour, local learning capabilities and industrial tradition can act as forces behind spatial proximity. It is not possible to define exactly whether the forces behind spatial restructuring of subcontracting relationships are related to company strategies or local conditions. It is most likely a combination of both, with different weights of the factors depending on specific circumstances.

5.2 The concept of time-compression

Many were the trips that company executives took to Japan in the 1980's, everyone expected an answer to the unparalleled development of Japanese industry. They were obviously producing consumer goods such as cars and home-electronics cheaper, better and in a wider variety of versions than Western firms. We heard of things such as *flexible manufacturing*, *just-in-time*, *lean production* and *kanban* (Womack, Jones et al. 1990). Some of the Japan-travellers came back and told us that this was the model to copy, while others concluded that it was place-specific and not possible to completely transfer between geographical settings.

Here we will concentrate on one common feature of these strategies: *the reduction of time-usage in the manufaturing process,* with special focus on assembler-subcontractor relationships. Time, as it will be argued, is one of the basic factors behind the success of what is usually lumped together under the name "Japanese production philosophies"[6]. Let us start with a personal experience:

> *A couple of years ago I went into a Swedish news agency to buy today's newspaper. At the same time I had a quick look in the latest number of a U.S. computer magazine. To my surprise they actually had a review of a Mapmaking/GIS-software, great! I decided to wait until Monday to buy, which, regrettably was the first day of the next month. The magazine was gone! I didn't get too upset because it is always possible to get a back-copy somewhere I thought... But the magazine was nowhere to be found! The answers I got was in the line of – we don't store anything anymore or – it's too expensive to have old magazines in store... and this was one day after the last day of the January-issue!*

Even though this is only one single occurrence, it made me aware of how important time has become in the practical business world. Someone makes the effort to import a monthly U.S. magazine to Sweden and then it is impossible to find it in the shops one day over time. It highlights the importance of time as a source of competitive advantage, and the compression of turnaround time as a means of gaining efficiency in the physical circulation of goods. This is discussed by Stalk Jr. and Hout (1990) when they talk about time-based competition:

> " Today's innovation is time-based competition. Demanding executives at aggressive companies are altering their measures of performance from competitive costs and quality to competitive costs, quality and responsiveness." Stalk Jr. and Hout (1990:1)

We are not dealing with a new revolution that will sweep away everything else and place time as the only important factor in business. But the combination of cost, quality *and* time will give some firms a competitive advantage, such as the Japanese automobile manufacturers in North America or Europe (Mair 1994).

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[6] The term "Japanese production philosophies" is used as a general term comprising physical production, organisation as well as the underlying cultural context.

Companies changing their attitude toward time is only one side of the story. There has to be a market as well, buyers who are willing to pay for the responsiveness. In other words, for whom time is an important factor. Harvey (1989) sees this as a general tendency in society, a development towards shorter turnover time, finding the most striking examples in the circulation of international capital thanks to the use of modern information technology.

Harvey uses the concept "time-space compression" to describe how the speed of information and transportation is changing the experience of time and space. Economic transactions can be made around the globe just by clicking on the mouse, and people and goods can be moved between continents by air-transport in just a couple of hours. If we look at it in a long perspective, space and therefore time has become less and less of a restriction. The concrete outcomes like the telephone, fax, e-mail or fresh fruit every day at the supermarket also means that the perception of time changes, as Harvey (1989) concludes:

> "The conclusion we shall draw is simply that neither time nor space can be assigned objective meanings independently of material processes, and it is only through investigations of the latter that we can properly ground our concepts of the former" Harvey (1989:204)

The term *time-compression* is derived from Harvey's discussion about time-space compression in order to focus attention on the time-factor in the production process. It is used in this work as a general term for strategies aiming at reducing the amount of time used in the production process, from the individual machine to the entire production chain, where "just-in-time" - production is one of several examples

If we limit our discussion to how customers' perceptions of time have changed industrial production and organisation, there is a useful distinction between Fordism and post-Fordism. The former consisting of mass-production of standardised consumer goods for large homogeneous markets. An extreme example is the Ford T-model, which in its peak year 1923 was produced in 1.9 million units (Womack, Jones et al. 1990), and the customer could have "any colour he or she liked, as long as it was black".

The situation in the post-Fordist economy is different, especially in the practices of the production - consumption process. In figure 5.1 Swyngedouw (1986) contrasts the Fordist mode of production and post-Fordist flexible production. He shows that production is shifting from being a resource-driven process of mass-produced standardised goods, to a demand-driven flexible production process capable of producing a wide variety of products (Pine II 1993).

The growing importance of customer ordered products, combined with the increasing use of shorter lead-times in the supply chain, produce a situation where the "old geography" can not respond to new demand. This process is currently under way, and this thesis will, based on the case of Volvo, discuss the charateristics of a possible "new geography" of suppliers in the automotive industry.

Time is obviously in focus, at least according to Harvey and Swyngedouw. But it is important to point out that this is a long process with different spatial expressions in different social and industrial contexts. The automobile industry is one often-cited example of flexible production using JIT-production methods. Other areas like the petrochemical industry (Bathelt 1998) have their set of specific conditions which, although acting in a post-Fordist world, produces different spatial and temporal outcomes.

Fordist production (based on economies of scale)	***Just-in-time production (based on economies of scope)***
mass production of homogeneous goods	small batch production
uniformity and standardisation	flexible and small batch production of a variety of product types
large buffer stocks and inventory	no stocks
testing quality ex-post (rejects and errors detected late)	quality control part of process (immediate detection of errors)
rejects are concealed in buffer stocks	immediate reject of defective parts
loss of production time because of long set-up times, defective parts, inventory bottlenecks, etc.	reduction of lost time, diminishing "the porosity of the working day"
resource driven	demand driven
vertical and (in some cases) horisontal integration	(quasi-) vertical integration subcontracting
cost reductions through wage control	learning-by-doing integrated in long-term planning

Figure 5.1: Comparison between Fordist and post-Fordist production processes, exemplified by "just-in-time" production. *Source:* Harvey (1989:177), after Swyngedouw (1986).

Time and thus space are becoming increasingly important in the everyday activities of people and business organisations. As society changes, there is a continuing change in the perception of time. Tourism has in only thirty years grown into an enormous mass-industry where there is a real possibility for a large part of the population to buy a holiday-trip in Sweden one day and to be in Florida the next. It might be an extreme example, but it proves the point, the perception of time and space in everyday life is changing. This is what the next section is about, how new technology - organisation strategies have grown in close interaction with changing customer preferences, both material and temporal.

5.3 Time-compression in the production process

Introduction

The more general discussion in the previous section concluded that changes in technology - organisation, linked with a changing perception of time and space, are reshaping customer expectations and has placed time on the list of strategic factors in business activities. The production process have to be flexible in order to supply intermediate products, finished goods or services (depending on where you are in the production process) to a segmented market with a growing concern of time.

In the literature on industrial restructuring, many authors use flexible production and Japanese production as similar concepts. In the following, flexible production will comprise a more general meaning which includes "Japanese production techniques and organisation" among other flexible business strategies. Vertical disintegration and the use of subcontractors can be one way to ensure flexibility, but it is not necessarily Japanese. As we will see in the empirical study, Volvo has been building passenger cars in Sweden since 1927 with a large base of independent subcontractors and spatial division of labour. There are quite a few examples of firms that have been subcontractors to Volvo for more than 30 years without any formal integration.

The general tendencies in society, discussed earlier in this chapter, have implications on the need for time-compression strategies in a production process on different levels, from the general long-term political-economical development in society down to the individual machine on the factory floor. Figure 5.2 shows three "levels" of analysis which will be covered in the discussion.

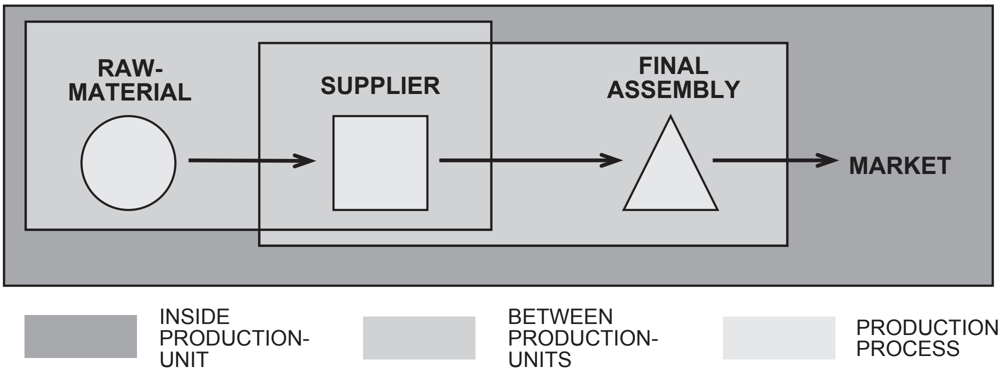


Figure 5.2: Three different levels in the analysis of time-compression strategies in a physical production process. *Source:* Author

This distinction between different levels of the production process is made primarily in order to highlight the fact that there are substantial differences in time-compression strategies depending on where you look. Different firms within the same production system might have contrasting conditions and incentives for the introduction of time-compression strategies. This affects the relationship between the production units and forms different spatial and organisational patterns within the system. The largest scale is the system-scale which needs to be taken into consideration both for its own dynamics as well as giving the prerequisites for the actors within the system.

Inside the production-unit

In order to discuss time-compression strategies in the physical production inside the factory, we will highlight four different aspects; *(i)* manufacturing technology; *(ii)* labour utilisation; *(iii)* material flow including inventory and buffers, and *(iv)* product and process quality.

• *Manufacturing technology*
One of the key factors of time-compression production is the use of flexible machines and production techniques. The main objective is to escape the trap of "economies of scale" and instead be able cut down the overall turnaround-time in the production process (Schoenberger 1988). With the introduction of numerically controlled machines and CAD/CAM- production techniques it is possible to change quickly between different products. Automation, though has no value in itself. It is important to recognise that technological change is very much dependent on the social context in which it is implemented, as shown by (Gertler 1995; 1988) in his studies on the introduction of German technology into Canadian firms. Automation

• *Labour*
With flexible manufacturing techniques and frequent changes in the production process there is an increasing need for flexible labour. This is an area where "Japanese production philosophies" have been highly noticed and debated (Gammelgaard 1994; Mair 1994; Hayter 1997). In terms of time-compression there are some major implications. Decentralised decision-making and shop-floor organisation means that many day-to-day technical problems can be solved continuously as they appear, without the need to stop the production process.

• *Inventory and buffers*
One of the most widespread contents of the "Japanese production philosophy" is the "just-in-time" (JIT) concept (O'Grady 1988; Kalsaas 1995). The overall aim of the JIT-philosophy is to reduce all unnecessary material that is not active in the production process. This directly addresses the use of input-materials, finished product- and work-in-progress inventory. All of these represent an economic asset tied up in components or finished products. Reduction of inventory levels has a twofold aim. Firstly, it is a method to release capital tied up in the inventory of inputs as well as finished products. Secondly, it eliminates buffers, which in the traditional system had the function of hiding problems in the production process.

• *Quality*
The discussion above presents some quite problematic features of flexible production techniques and time-compression inside the factory. Flexible small-batch production with short lead-times and minimum inventory levels would be an almost impossible situation, due to its vulnerability. This is why the production process is dependent on high quality, both in the product and the process. High quality is not only a prerequisite for flexible production, with high quality in the entire process there is less need to spend time on quality-control because the process becomes more or less "self-tuning".

Between production units

The discussion above related to a situation inside one particular production unit. But since modern, large scale industrial production is characterised by division of labour, there will be a whole set of problems (or opportunities) when you combine two or more production-units into a production chain. One basic source of problems are different strategies of time-compression and different quality levels. The fact that the production units are most likely located in different places adds a spatial dimension to the problem. "Working closely together" may not only be seen as a metaphore for close social contacts, but actually be a competitive advantage in a time-compressed environment. Specific questions regarding the relations between component suppliers and assembly firms will be covered in the next section, this section will treat the question on a more general level.

If we start with an ideal situation where two firms are linked together in a production chain and both have a highly flexible and time-compressed production as well as high quality. This would probably work quite smoothly, but only if the firms are willing to cooperate and share information, because flexible customer-ordered production and minimised inventory levels give very little time to correct mistakes.

This is probably where the "just-in-time" concept has one of its major problems. It assumes that firms are as flexible and time-compressed as the leading firm, which is rarely the caser if we are dealing with independent firms. Japanese firms and their subcontracting networks are usually built in a strict hierarchical order, with a leading firm and several tiers of firms underneath (Sheard 1983; Mair 1994). With this arrangement can the leading firm secure their need for flexibility and quality, especially since many large subcontractors have links with the leading firm.

One way to ensure reliable deliveries is to integrate the sub-contracted production into the production-process of the parent company. Although this may be the case with certain high-value and strategically important components, there are no major signs of development in this direction (Imrie and Morris 1992). In the eyes of the leading firm, the use of subcontractors is a flexible strategy, both in terms of investments and labour. For producers of complex, high-value products like automobiles, there are probably incentives for more out-sourcing because of the cost involved in keeping an increasingly complex production in-house.

The entire production process

Now that we have seen what time-compression means in and between firms, what does it mean for the entire production process? If we try to summarise what the two more detailed levels of analysis have brought forward, we can see four main aspects of flexible and time-compressed production.

- *Demand-driven.* This means that the entire process is ultimately guided by what the customer demands. In theory the system will be able to respond to customer orders in such a flexible manner that nothing has to be produced before it is actually ordered.

- *Information-driven.* The more time-compressed and flexible your production system is, the more need for quick and reliable information. Otherwise, it will be impossible to produce to customer orders and use a time-compression strategy at the same time.

- *Quality-based.* Excellent quality in both products and processes through the entire chain is a basic condition for time-compressed and flexible production. Quality problems will jeopardise the production, basically because it is designed to run smoothly without security or backup buffers/inventory.

- *Logistics-dependent.* Coordination of the production chain will become a strategically important part of the overall operations. It is not just a matter of moving goods from A to B anymore, it has to be the right things, to the right location (still B though) and at the right time. This calls for the use of logistics as a strategic instrument included in the firms total operations, rather than just focus on a logistical strategy. This will be discussed more extensively in the following chapter.

All of the points above point in the direction of increasing demand for co-ordination and communication. In mature industries, with a large supply network such as automobiles, this creates new forms of time-efficient subcontracting relationships. The interesting aspect for a geographer is that this has not been directly connected to the need for new spatial conditions. When new "lean" organisations meet the "old" and often static geography of suppliers, the question of proximity will be placed high on the agenda.

5.4 Time compression and inter-firm relationships: the case of subcontracting linkages

One of the areas that has got most attention among geographers in relation to flexibility is buyer - supplier relationships. There has been an ongoing discussion during the last ten years about how industrial production in the post-Fordist economy will take new spatial forms as flexible specialisation among firms forces them to cluster more tightly together (Scott 1986; Storper and Christopherson 1987; Schoenberger 1988). Other authors have been more critical to the ideas of a major break in the way industrial production - organisation and the capitalist economy is performed (Gertler 1988; Lovering 1990).

Independently of the argument, there has been an interest in how flexibility in production affects how firms organise their interactions in time and space. The case of subcontracting is very interesting in this sense, because it has all the ingredients that will be deeply affected in a flexible, time-compressed environment.

As discussed in chapter three a subcontracting relationship is characterised by the fact that the out-contracting firm, to a certain extent, *specifies* the product. To emphasise specification is important in this context, because it points to a situation of interdependence. Even though the customer firm in most cases is the dominant part, there is always a question of linking the production process of an outside firm into the one of the out-contractor.

The physical production process will be seriously affected by time-compression strategies. When the parent-firm introduces new flexible production, reduces inventory levels and applies customer-ordered production, the subcontractor needs to make a strategic choice. Either by following the parent-firm and restructuring the entire production-chain, or by establishing a large inventory in order to cope with short-time changes in demand.

One basic difference between the production systems of the large Japanese firms and the corresponding "Western" ones is the role of the leading firm. It is essential that subcontractors adopt the same quality and flexibility standards as its customers in order to make the entire system work smoothly. This is much more likely to work in a Japanese-type environment where the big customer leads the entire hierarchy of firms in one direction.

In the "Western" model there is a long history of arm's-length market transactions between independent firms, not used to be deeply involved and committed to a big leading company. This might make flexible and time-compressed buyer-supplier relationships more difficult to implement and coordinate. (Gammelgaard 1994) discusses this in terms of the willingness of suppliers and other actors to work within a context of more control from the main principal firm. Increased control is necessary to achieve the reliability which is the backbone of just-in-time production.

This of course is neither black nor white. Japanese firms have to trade off time-compression against inventory when the traffic conditions and location possibilities force them to do so (Takeuchi 1990; Mair 1992), as well as Western firms do not entirely rely upon market relationships to secure their production.

5.5 Just-in-time manufacturing and automotive suppliers

Questions involving new temporal conditions in buyer-supplier relationships in many cases are referred to as being closely related to the "just-in-time" production philosophy. This is not incorrect or especially surprising, especielly considering the success of Japanese firms such as the large automobile manufacturers (Womack, Jones et al. 1990). As concluded earlier just-in-time is regarded as one of several, although probably the single most important, strategies to achieve time-compression. This section will put time-compression into context through a discussion about JIT and the automobile industry.

Many authors trace the origins of the just-in-time production system back to the 1950's and the Japanese automobile producer Toyota (Sayer 1986). It has gradually developed into a philosophy rather than a toolbox of production methods. The basic objective of JIT is to eliminate waste in every part of the production process, where waste is considered to be everything over the absolute minimum amount of equipment, materials, parts and labour necessary for the production (Frazier, Spekman et al. 1988). Put in a more popular form it is about doing the right things at the right time in the required amount. Delivering too many components ahead of the scheduled time is regarded as being as inadequate as late and incomplete deliveries.

The implementation of these general objectives have profound implications on the production system in the following areas: (Manoochehri 1984)

- Rationalisation of inventory and buffers, both for components, work in progress and finished goods.
- A major decrease in lead-times (the time from idea to final product).
- Increasing quality and productivity.
- Increasing flexibility and susceptibility to changes.

Sayer (1986) characterised the traditional Fordist production system as a *just-in-case* system compared to the Japanese *just-in-time* system. The traditional method relies on production planning, things are produced just in case they are needed and the material is *pushed* through the process based on forecasts of sales. Just-in-time on the other hand, has the objective of reducing unnecessary items in the production process. Things are therefore produced when needed and *pulled* through the system based on customer orders.

Just-in-time in Japanese automobile firms is not primarily focused on production technology, although flexible and computer controlled machines are used. The basic idea behind JIT is not reached through sophisticated high-tech solutions but rather by the use of simple and reliable processes (Womack, Jones et al. 1990). Reliability is a basic prerequisite for time-compression under JIT (O'Grady 1988). Because of the overall aim of reducing unnecessary components there is no inventory to act as buffers between unreliable machines or parts of the production chain.

Subcontracting relationships under the JIT-model in the Japanese automobile industry can be characterised by a strong hierarchical organisation, both in terms of physical linkages as well as financial and ownership networks (Sheard 1983; Takeuchi 1990). In order to respond to the time-compression demands without buffers or inventory, there are very frequent deliveries of small quantities. In the most extreme case of Toyota City, the first layer subcontractors are located within a 30 kilometre radius and deliver several times per day (Mair 1992).

Averages for each region 1989/1990	Japanese Japan	Japanese America	American America	All Europe
Supplier Performance: (1)				
Die change times (minutes)	7,9	21,4	114,3	123,7
Lead time for new dies (weeks)	11,1	19,3	34,5	40,0
Inventory levels (days)	1,5	4,0	8,1	16,3
No. of daily JIT deliveries	7,9	1,6	1,6	0,7
Supplier/Assembler Relations: (2)				
Number of suppliers per assembly plant	170	238	509	442
Inventory levels (days, for 8 parts)	0,2	1,6	2,9	2,0
Proportion of parts delivered just-in-time (%)	45,0	35,4	14,8	7,9
Proportion of parts single-sourced (%)	12,1	98,0	69,3	32,9

(1) From a matched sample of fifty-four supplier plants in Japan (eighteen), America (ten American-owned and eight Japanese-owned) and Europe (eighteen). T Nishiguchi, *Strategic Dualism: An Alternative in Industrial Societies,* Ph.D. Thesis, Nuffield College, Oxford, 1989, pp 313-347.
(2) From the IMVP *World Assembly Plant Survey,* 1990.

Table 5.1: Cross-Regional Comparison of Suppliers. *Source:* Womack, Jones et al. (1990:157)

Table 5.1 gives a clear indication of the difference in time-use strategies in subcontracting relationships between Japanese and Western automobile firms. It is important to see that the geographical origin of the firm is not the only factor in explaining JIT-behaviour. Many of the factors show a significant difference between Japanese firms located in Japan and North America respectively.

It is also important to stress that the use of JIT in the Japanese auto industry differs between firms. A comparison shows that the use of subcontractors and the time-space limitations in the production system is unique for each firm (Linge 1991; Mair 1992), although with some general features in common:

- A hierarchical organisation of subcontractors, with the top layer firms being the most important.
- Close technical, financial and ownership links between first-tier subcontractors and the assembly firm. Subcontractors often dedicated to the automobile sector.
- A general trend towards the use of JIT.

This situation can be contrasted with the development of Japanese automobile production in North America and in Europe, preferably in the U.K., where we can observe different strategies to just-in-time in the respective region. The different historical and social conditions made it difficult to introduce a strict JIT-philosophy without adjustments. The basic strategy was the same in the U.K and in North America, including: green-field location, the avoidance of traditional unionised automobile regions and the use of strict recruitment policies (Dicken 1998). Despite the similarities in location strategy, very different geographical patterns of Japanese automobile establishments is seen in North America and Western Europe.

This means that time-compression in the form of orthodox "just-in-time" à la Toyota City is difficult to introduce in the traditional North American or European automotive supply system, basically because the subcontractors are not used to being controlled and arranged in a strict hierarchy dominated by one big leading firm.

The current concentration of ownership in the automotive components sector might be a sign that suppliers tend to concetrate to certain products and/or customers. A few large supplier-multinationals dominate the market within a number of important segments. Their strategies include closer cooperation with the assemblers using JIT-deliveries and the growth of a more hierarchical supply system. This development can be seen in the case of Volvo Automobile where the new S80-model is produced using sequential JIT deliveries from a handful of system-integrators located in close proximity to the Göteborg plant. For a more comprehensive discussion see chapters 12 - 14.

5.6 Summary

This chapter has discussed time-compression, both as a concept and its spatial implications for subcontracting linkages. Time-compression is used in this work as a general term for strategies aiming at reducing the amount of time used in the production process, from the individual machine to the entire production chain.

This is followed by a presentation of how time compression can be introduced inton different levels of the production process. The point of departure is taken inside the single unit, where production technology, labour relations and quality issues become central components. On the next level coordination is put into focus. Regarding the highest general level, the system is seen as driven by demand and information which puts quality in the focus as a basic prerequisite and logistics become a strategic factor in order to gain reliability. It is furthermore concluded that when new flexible time-based strategies meet the traditional often stable geography of subcontraction systems, spatial questions will arise on the corporate agenda.

The changes within technology and industrial organisation are discussed in relation to a general tendency in society towards customisation and the creation of a more segmented and time-compressed market, an evident condition for the restructuring process within production.

Time-compression is then discussed within the area of subcontracting where the coordination of activities between separate units is of basic importance. A comparison is made between the "Japanese" automotive industry and Western firms, where the former seems to have been in the forefront of time-related supplier strategies. It is also concluded that depending on the social context, there are different versions of time-compression activities within industry.

In the next chapter this general discussion about concepts will be put into a practical environment focusing on the physical circulation of material in automotive supply systems under just-in-time requirements.

6. Physical supply linkages in a time-compressed environment: the significance of transport and information

6.1 Introduction

Much of the debate and discussion concerning new buyer - supplier relationships has been concentrated on the issue of organisation. The main line of argument is often that the automotive industry is meeting new market conditions by becoming more internationalized and at the same time focusing on time-compression and close co-operation with suppliers. This analysis often neglects one important aspect of the buyer-supplier relationship, namely *the co-ordination of the physical circulation of goods in the system.*

This chapter will focus on the organisation of physical linkages between suppliers and buyers in a time-compressed environment in the automotive industry. The co-ordination of physical flows will be analyzed from two points of departure:

- Organisation of transportation
- The use of information in connection with the circulation of material

Both aspects are seen as mutually important but are discussed separately in order to point out their respective features and importance in a time-compressed environment.

6.2 Transportation and time-compression

Introduction

The adoption of time-compression as a strategy for the production of automobiles has profound implications on transportation. Shorter lead-times, minimum inventory and high-quality significantly changes the role of transport in the supply-chain. The traditional role as mover of goods to the lowest possible price will shift, as the co-ordination of component-flows between suppliers and assemblers becomes one of the most critical and strategic stages in the entire process.

These new conditions have changed the process of physical transport and information towards a situation with more frequent deliveries of smaller shipments, consequently there are also less opportunities for the assembler to act if a delivery is late or faulty. The basic transport quality parameter in a time-compressed environment under the conditions discussed in the previous chapter could be generalised into the concept of *reliability*. This will be used to describe the ability to deliver a requested product to the specified location, "just-in-time" to enter into the production process. The next section will discuss reliability and how changes in the demand for transport in automotive supply systems produces different models of transport organisation.

Time-compression and reliability

Stjernman and Lumsden (1993) present a set of quality variables from different Swedish studies which gives a picture of how authors have approached quality in freight transportation from different starting points. The determinants from these four studies reveal that *reliability* is the single most important quality component, followed by frequency and flexibility. These findings are of a general nature and not specific for the automotive industry.

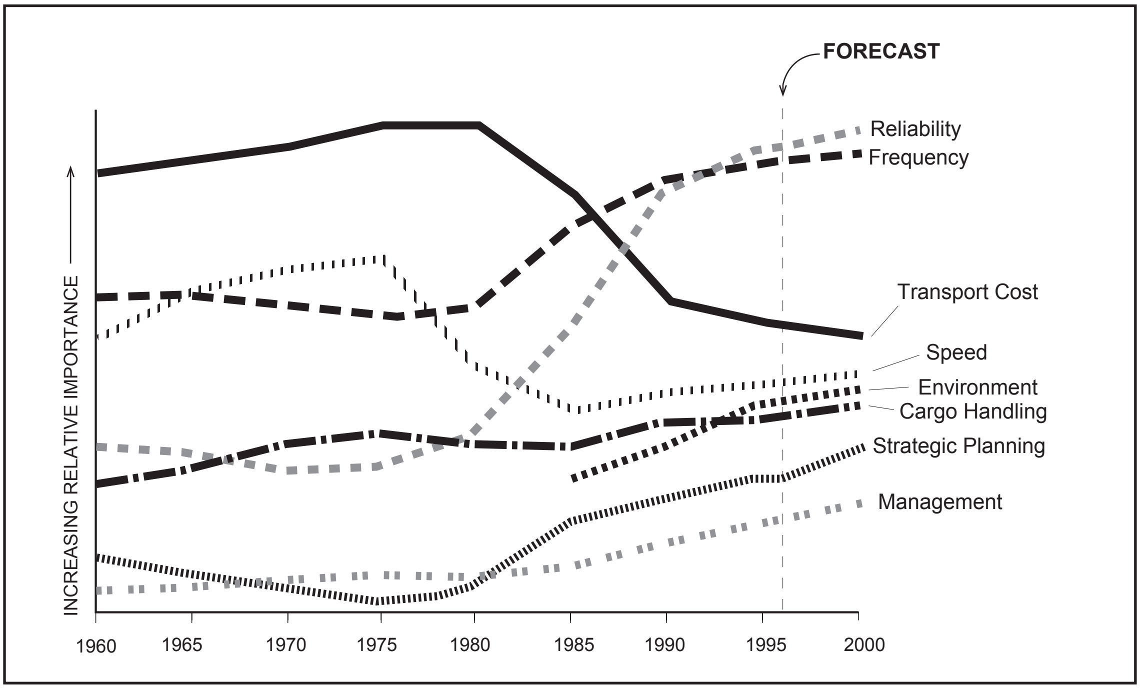


Figure 6.1: The Volvo Transportation Corporation's view of the relative development of components of interest in the evaluation of transport systems. *Source:* Volvo Transport Corporation.

The importance of reliability is confirmed by Volvo Transport Corporation and their view of the relative importance of different components in a transport system as presented in figure 6.1. The rise of reliability in the figure is matched by the relative decline of the cost and speed, which to a great extent, can be explained by new demands from the customers.

Reliability and frequency are the two factors in transportation which can be seen as basic prerequisites in a modern automotive production systems. This has been more important since time-compression strategies have led to smaller and more frequent deliveries from subcontractors, in order to cut inventory levels and ensure flexibility (Estall 1985; Harper and Goodner 1990; Larsson 1994). The relative fall in the importance of costs illustrates an ongoing trend towards integration and logistics planning with the basic goal of reducing total costs, not just the individual parts treated in isolation (Williamson, Spitzer et al. 1990; Fabbe-Costes and Colin 1993).

If a production-system is organized according to JIT-requirements it becomes dependent upon regular and frequent deliveries because the concentration on time-rationalization has reduced safety-margins in the supply chain to minimal levels. So if both flexibility and time-compression is required in subcontracting relationships, reliability in deliveries will become a strategic factor to ensure the stability needed to coordinate and guarantee a smoothly running production process. (Manoochehri 1984; Kalsaas 1995).

For the continued discussion we will conclude that *reliability* is a central factor for the co-ordination of physical linkages in time-compressed supply-systems. The next section will discuss changes in transport organisation related to the need for reliability.

The geographical aspect of the need for reliability is to substitute transport with relocation. In order to overcome the uncertainties of long transport, one option is to move the point of delivery closer to the customer. If the transport-time is only a couple of minutes, then reliability in deliveries due to transport-problems can be neglected. The proximity may also facilitate better day-to-day communication between the parties involved.

Models of transport organisation under JIT-production

The changing demand in a production system under time-compression has had an impact on how transportation of components from suppliers is organised. From the discussion of different phases of supply-system restructuring in chapter four, Lamming (1993) presents three different models of transport organisation.

1. *Apparent just-in-time deliveries*: The supplier holds a stock of finished products produced in batch-orders and delivers to the customer who has no inventory. This arrangement gives the reliability needed, but the cost for inventory is only transferred from the assembler to the supplier and there are no real improvement in the supply chain.

2. *In-line warehouses:* Suppliers establish a warehouse in close proximity to the assembly plant where they keep stocks of components for further assembly according to the customers short-term orders. It is the same principle as the apparent JIT, with large buffer stocks but with some assembly operations in order to become flexible towards customers.

3. *The milkround system:* This arrangement works with pick-up rounds where the assembly firm is responsible for collecting components according to a specified time-table. The actual transportation is often done by an external logistics firm. This type of arrangement is especially favourable when new delivery requirements is introduced into an already existing supplier structure, since traditional suppliers had problems with the increasing transport volumes of true JIT-deliveries.

All of these models of transport organisation existed during Lamming's stress-phase where suppliers and assemblers were looking for new ways of dealing with a changing and unstable situation. They were coming from a traditional transport system where automotive components were treated as any other goods by the transport-firm.

This can be exemplified by the development in Sweden during the first half of the 1980's. Many of the major companies with a lot of assembly-type of production established their own transport subsidiaries (e.g Volvo formed Volvo Transport and Electrolux established Distrilux,) because the traditional logistics-firms were unable to provide the logistical solutions needed to fill the reliability requirements (Ljungström 1988).

Volvo Transport developed a model based on the milk-round system explained above. This was implemented both in Sweden as well as the rest of Europe, and gave Volvo the reliability they needed to coordinate their production operations. As Volvo now are proceeding into an even more time-compressed production strategy there are some adjustments necessary to ensure reliability in deliveries.

As we shall see in the empirical study, Volvo has actively worked to substitute transport with location in the new supplier-park in Arendal. It is designed for the suppliers with highest delivery frequency, and serves as a dedicated factory for the Volvo Torslanda plant. This will be thoroughly investigated in chapter 12. Other large volume suppliers located further away will deliver full truckloads directly to Volvo. It leaves the smaller and not critically important suppliers in the milk-round system. But as shall be seen later, even these firms have experienced a significant rise in delivery frequency during the last 5-10 years.

All three of Lamming's transport models are characterized by the inclusion of both production- and delivery aspects. True JIT has to encompass *both production and delivery* between supplier and customer. One study of Scottish suppliers (Waters-Fuller 1996) concludes that JIT-production is a perquisite for JIT-delivery under conditions of minimized inventory. All of the firms in the study which did not manufacture according to JIT-requirements had experienced increased inventory levels in some form.

JIT production in traditional facilities or new greenfield location?

One of the points made by Lamming is that different problems of JIT-supply depend on the environment where it is implemented. As previously discussed in chapter four, several authors have reported on how the Japanese automotive assemblers have created just-in-time regions around new assembly facilities in the U.S. mid-west (Rubenstein 1988; Mair 1992; 1993b). The same pattern of location is also reported from within Japan, especially in the case of Toyota City (Sheard 1983; Takeuchi 1990).

All these examples have one common feature, suppliers and assemblers have built a production system dedicated to JIT-production and delivery. In the U.S., as discussed in chapter 4, it was a major inflow of Japanese suppliers during the last half of the 1980's. The majority located in the rural areas of the mid-west. This facilitated the introduction of JIT-production and deliveries from the start without having to adjust to suppliers with a tradition of doing things in a more traditional manner. High frequency and reliability in deliveries was also made easier by the fact that the traditional rural areas had low traffic volumes and high road standards.

This is not the case in the traditional Japanese automotive production regions where traffic volumes often make deliveries from within a relatively small radius unreliable, especially since the automotive production has traditionally been located within the metropolitan areas of Tokyo and Nagoya (Sheard 1983; Hayter 1997). The most striking example of a "greenfield" location is Toyota City with twelve assembly plants and the majority of the suppliers within a 30 kilometre radius. This spatial configuration allows for true JIT production including frequent and reliable deliveries several times per day (Mair 1992). The transport arrangements are less complicated when JIT-deliveries are built in from the beginning. Production facilities and loading/unloading space can be planned, road- and traffic conditions are known beforehand and because suppliers are locating their operations in a new environment it is possible to coordinate deliveries already in the planning phase.

This situation can be contrasted by the process of implementing JIT deliveries into an already existing supply network, such as the European automotive industry. There are at least two major areas of difficulty:

i) *Organisation of production.* Instead of building a new plant with the possibility to plan and organise for just-in-time from the start, there has to be major restructuring measures within an existing organisation. Traditional ways of organising production, trade-unions, wage-structures etc, will influence the process of JIT-implementation. This is exemplified by the different paths of development in North America and Western Europe, where the later has seen a much slower pace and extent in the build-up of Japanese JIT-supply networks (Jones 1993; Rawlinson and Wells 1993; Hudson and Schamp 1995).

ii) *Organisation of transport.* Interlinked with the argument above is the problem of incorporating new demands on transport (e.g frequency and reliability) into an existing transport framework. Unlike the situation in the U.S, Japanese automotive firms built their new operations in or adjacent to traditional automotive supply regions. This made the introduction of JIT supply a more complex task. Schamp (1995) reports from the German automotive industry that JIT-deliveries have produced many different spatial and organisational outcomes depending on geography-specific conditions. Within certain segments (high-volume, high-value, many and shifting variants), designated supplier-plants have been set up close to the respective assembler, while in other cases JIT-deliveries are made within the traditional supply system.

To conclude, one important aspect in the geographical analysis of JIT-supply systems is whether JIT is built in from the start or is introduced into an already functioning system. The later situation calls for more diversified solutions within the same supply-system in order to change the old structure gradually, rather than remodel the entire system for JIT-production in one step.

Synchronised sequential JIT-deliveries

One important aspect of just-in-time deliveries, especially in the automotive industry, is the use of synchronised sequential production. This arrangement sets extremely tight boundaries regarding delivery reliability since the entire production process is dependent upon the timely delivery of components.

The need for extreme reliability comes from the fact that sequential JIT production requires suppliers to deliver unique components in the same sequence and synchronised with the assembly process of the customer. This means that once a component is ordered from the supplier it is destined for one particular car on the assembly line. Any errors in delivery or product quality can not be solved by taking another component since it is specified for another car.

This type of arrangement is what a true JIT-system would look like. But due to high costs, reliability problems and the structure of existing supply systems, we can see a differentiation in JIT-deliveries. Some components, (mainly high-volume and colour/ model specific) such as seats, interior trim, bumpers are supplied in sequence. Thanks to the growing complexity and number of variants no modern automotive assembly plant will have the space to store these components. Neither will the assembler want to tie up fixed capital into increasingly more costly and complex components (Shimokawa, Jürgens et al. 1997).

Parallel to the sequential deliveries are more traditional suppliers producing and delivering according to JIT-standards. This means shorter lead-times, increased frequency and higher quality standards but with more "relaxed" delivery requirements compared to the sequential deliveries.

The distinction between sequential and non-sequential JIT deliveries is very important for the discussion about geographical implications. *Production and delivery according to sequential JIT arrangements puts reliability in focus in such a way that temporal and spatial proximity between supplier and customer becomes of strategic importance.* An example of the relationship between location and sequential JIT-deliveries is presented in the case studies of Hydro-Raufoss and the Volvo Arendal supplier-park, in chapters 12 and 13.

6.3 The importance of information and information technology

Introduction

Many observers in the field of buyer-supply relationships stress the connection between just-in-time production/delivery and the use of information technology. The argument is that the co-ordination of several hundred suppliers working under tight time-restrictions and delivering, at least daily, would be impossible without fast and reliable information. This has been facilitated by the rapid technological development in areas connected to the information-sharing between suppliers and customers (Daugherty and Ellinger 1995; Charles 1996).

We will start with a brief discussion on the terms and concepts used within the information technology sphere. This is followed by a presentation of the technological development, with special emphasis on supplier-related issues. Information technology as a tool for communication will be the focus in the next section.

Information, IT or ICT, some notes on concepts

Concepts within the field of information technology (IT) are often used without very much elaboration on the definition of what the research question in focus is. It is important to note the distinction between:

- *Information* which is the actual message/content to be distributed between two or more actors. For example the colour and variant of bumpers to be supplied to the assembly line. This information could be given to the supplier in a number of ways, both manually as well as via telephone/fax or through computer communication.

- *Technology* describes the form in which the information can be transmitted, stored and displayed. The development within the field of technology has produced new methods of handling and distributing information. Mainly via computers and networks which give new opportunities for coordinating a supply system. In the bumper example above the assembler is sending information directly to the supplier, via a computer network. The result is an automatically printed label with all the relevant delivery information.

From this example it is obvious that information technology needs to encompass both the information and the technological components, although its significance is mostly due to the rapid technological development.

Both Hepworth (1989) and Kellerman (1993) refer to IT as the integration between computers and telecommunications. Kellerman makes a distinction between computers as information *processors* and telecommunication as information *transmission.* Hepworth describes IT as a generic term for the products and services derived from the *"convergence"* in computer and telecommunications innovations.

In order to study the communicative aspects of information technology, the term *information and communication technology*–ICT is used. Examples are Lorentzon (1995) in a series of studies of large Swedish firms and their use of information technology. Furthermore Li and Williams (1998) have studied the global aspect of ICT in inter-firm communication.

Information technology and automotive suppliers

One aspect of changing supply conditions is the use of modern information technology in order to enable communication and consequently the ability to coordinate JIT-supply relationships. The automotive industry is one of the pioneers in the process of using new technology for the co-ordination of suppliers.

The use of information in the process of co-ordinating physical flows of components from suppliers has traditionally been pioneered by the large automotive firms. As early as the 1980's, many automotive assemblers required computerized communication as a basic criteria for being considered as a supplier at all. (Lamming 1993; Larsson 1994)

In the following will two types of information in automotive supplier relationships be discussed: (Larsson 1997)

- *Standardized and structured information*
  Information of this kind is often found in connection with the day-to-day co-ordination of physical flows of components. This involves production-plans, delivery-orders, delivery-confirmation and invoicing. All these information steps have been the subject of significant technological development, mainly within the area of EDI (electronic data interchange). EDI refers to a technology used to electronically exchange information and data across organisations (Germain and Dröge 1995; Mackay and Rosier 1996). The objective is to increase flexibility and speed in the handling of information between suppliers and assemblers through computer communication and the linking of computer systems.

- *Specific and unstructured information*
  This type of information is mostly connected to different stages of product development where suppliers and assemblers need to exchange information when a problem occurs, rather than according to a time-plan. Unlike the structured information type above, we have a situation where information is specific for each contact and standardised solutions are of limited use. Individual tools such as e-mail and file-transfer are probably of greater use in these situations. In extreme cases strategic information may be restricted from systems with access to public networks such as the Internet.

The main IT-development in supplier relationships has mainly taken place in relation to the first type of information. Mostly because day-to-day information is more suitable for the standardisation needed for electronic exchange between organisations. The implementation of EDI into the supply network has also been a tool for integrating the production systems of suppliers and assemblers, creating more cooperative relations. Mackay and Rosier (1996) indicate from a study of the Australian automotive industry that the success of EDI is linked to the degree of integration of suppliers and the assembly firm.

Following the argument from the earlier chapters about increasing organisational integration in automotive supply chains, EDI must be seen as a strategic tool for this integration. The JIT ↔ EDI relation is reported to be the most important aspect of EDI in a study of over 200 U.S. manufacturing firms (Germain and Dröge 1995), while structural and organisational aspects were of less importance. This result emphasizes the relationship between JIT-strategies and the use of EDI-solutions as especially important.

The automotive industry proves an example where computer communication with suppliers has been a standard since the early 1990's. An industry-wide standard has been developed under the name ODETTE for structured and automated EDI communication between suppliers and assemblers. Any major supplier to Volvo is required to use EDI for standardized communication, and it is not regarded as a technological advantage, but rather as a prerequisite for being on the supplier list.

The development in the field of specialized unstructured information is not easy to overview, but in general suppliers and assemblers use IT to communicate in development projects although in a fragmented and unstandardised fashion compared to the day-to-day transactions discussed above. Charles (1996) makes a distinction between inter- and intra-firm communication. The inter firm communication in the automotive industry is of the standardized type, while more complex projects such as coordinating a development project is often performed within the organisation.

To summarize the discussion we can notice two different types of information in automotive supply chains; structured and standardized day-to-day information and unstructured specialized information. The first type is to mostly handled through EDI-solutions in order to save costs and increase flexibility. The second category can be related to R&D functions and the use of IT to coordinate an international or global pool of knowledge in order to develop new products. Having this competence might not give short term returns but rather giving an advantage compared to competitors with less developed IT-strategies.

6.4 Organisational aspects of JIT-deliveries

This chapter has previously discussed JIT deliveries in terms of transport quality and the need for reliability as well as the importance of information and information technology for deliveries and supplier relationships. To complete the picture we need to discuss how the physical deliveries and the information systems are organised in a JIT-environment.

The organisational development within the transport aspect of supplier relationships in general, and the automotive industry in particular has clear connections to the restructuring of the supply systems themselves. In order to respond to the demand from the automotive industry regarding reliability and cost of deliveries, transport providers have to *integrate* their operations with both suppliers and assemblers. An arrangement frequently termed *third-party logistics* within the logistics and transportation literature (Coyle, Bardi et al.1992:495-97).

Following the same rationale as automotive suppliers (competition, quality, customer demand) there is a clear tendency among transport providers to work in the direction of increasing co-operation and integration with customers (Wright, Hunston et al. 1998). If we take our start in an automotive buyer-supplier relationship under JIT-conditions there are a number of aspects that relate to the management of the flow of components.

One direction of development is the creation of *strategic alliances* between transporters and their customers in order to use joint efforts to coordinate the entire supply-chain (Gentry 1993). This means, in the case of automotive suppliers, that the transport provider is involved together with the supplier and the assembly-firm to plan and coordinate the flow of material. This involvement can range from very sporadic and limited to long-term strategic arrangements.

One example of the later is the supply network of Nissan in Great Britain (Charles 1996) where an independent logistics firm owns and runs a consolidation facility for JIT-deliveries of components from the Midlands to Nissan in Sunderland. The components from approximately 35 suppliers are picked up and transported to the consolidation center (termed "cross-dock") where a mixture of components are loaded on larger trucks for the main transport to the Nissan plant. Nissan provides both the logistics firm and the suppliers with daily information on production plans via EDI. The logistics firm is responsible for the matching of components in relation to the production requirments of Nissan. The main result of this three-party logistics solution is better control and reliability in supplies, increased frequency and substantial savings in transport mileage.

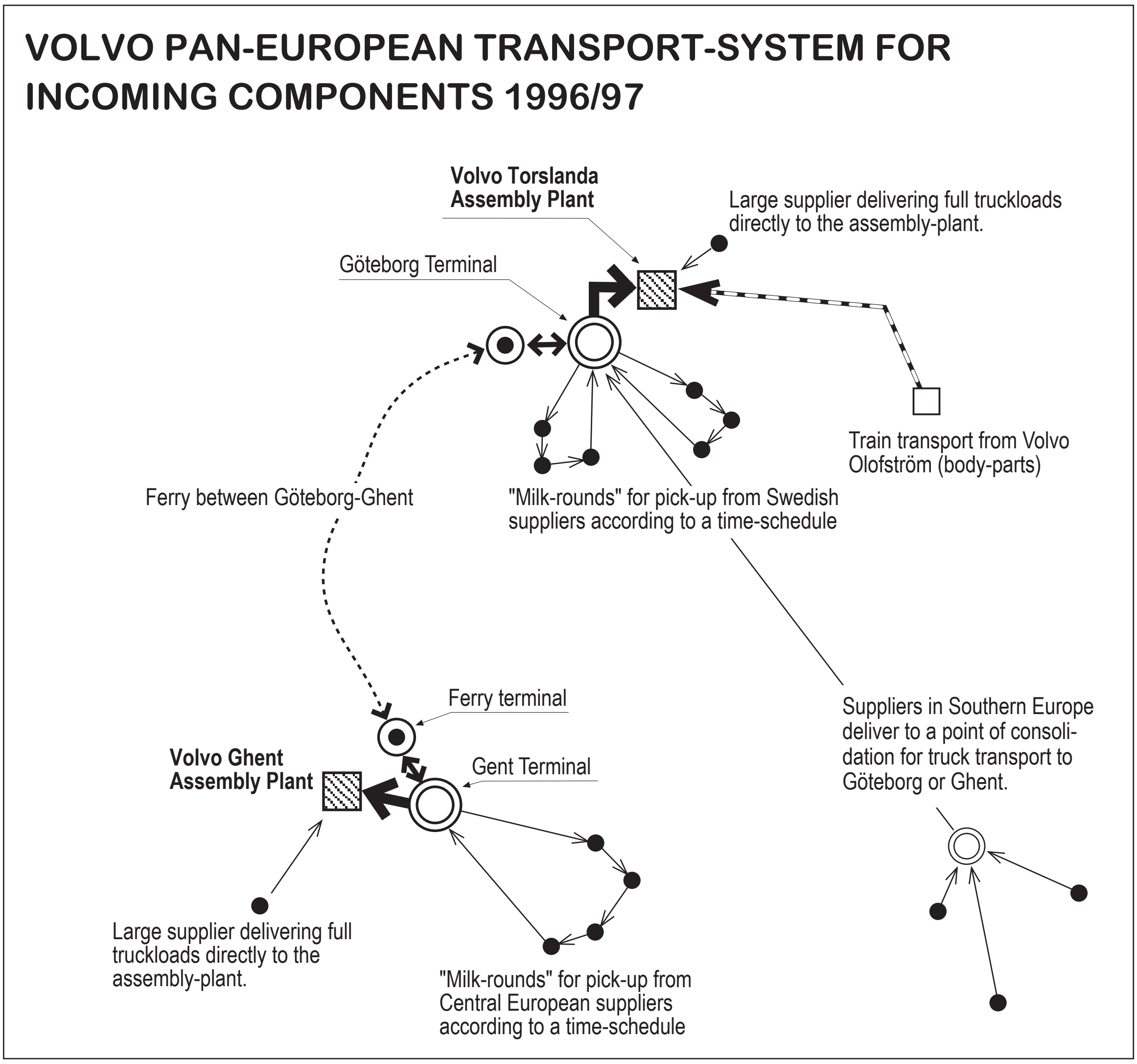


Figure 6.2: Generalised plan of the Volvo pan-European transport-system for incoming components to automobile, truck and bus production in 1996/97.
Source: Interviews with Leif Segerberg, Volvo Transport Corporation

Volvo has taken a different route and developed its own competence in logistics planning through the Volvo Transport Corporation. They provide the entire logistics solution for the Volvo-group and contract out the physical transportation only. This has grown out of the specific situation with equally important assembly operations in Sweden (Göteborg) and Belgium (Ghent) which are dependent upon a reliable circulation of material within the organisation.

Figure 6.2 presents the Volvo pan-European logistics system with the two main hubs in Göteborg and Ghent. These are connected with a daily ferry-line which constitutes the backbone of the system. The production in the respective assembly plants can utilise "non-sequential" JIT-production and delivery on an European scale based on the current system. The ferry-trip takes 12 hours one-way and needs to be very reliable since the buffer of components at the terminal is only a few days.

There are a few large domestically located suppliers delivering full truck-loads directly to Volvo, while the majority of the smaller firms are included in the "milk-round" system of time-table controlled pick-up loops. The suppliers involved in sequential deliveries are not part of this system, their transport frequency and volume provide the basis for direct deliveries. Southern-Europe constitutes a special case in the system. Due to the relatively long transport from the supplier before reaching the terminal in Ghent, it is more efficient to let the respective supplier deliver to a local transporter who takes it directly to Sweden by truck instead.

As we have seen, both road- and sea transport are important components in the logistics system that allows Volvo to have JIT-production in such a relatively remote location as Sweden. Railway is the mode of transport which is the least utilised, although it is an important part of the flow of components from the Volvo body-parts plant in Olofström in southern Sweden and for the distribution of spare-parts across Europe.

Volvo has made a clear strategic choice to have direct control over its logistics chain across Europe. This involves forming an "internal" third-party situation including Volvo Car Corporation, Volvo Transport and an outside firm for the physical transport. This can be contrasted with the case of SAAB Automobile who utilise an outside logistics firm for the storage, assembly, sequentiation and transport of components from approximately 20 major European suppliers.[7]

As can be concluded from interviews and questionnaires from Volvo-suppliers, there is a neglect of the importance of physical deliveries. Much emphasis has been put on organisation, product quality and information systems leaving transport behind as a practical and rather uninteresting part of the production process. This is an area where more resources have to be channeled in the future, especially since time-compression seems to spread in the entire system and more parts of the car will be delivered in sequence in future models. Examples of this are plans for joint transport-arrangements for suppliers located in the Arendal supplier park (see chapter 12), and the current plans for a high-speed ferry between Göteborg and the European continent.

7 Based on an interview with Mr. Per Persson, Se-De International AB, Trollhättan in May 1998.

6.5 Summary

This chapter has discussed the importance of physical transportation and associated information flows in time compressed buyer - supplier relationships. *Reliability* is put forward as a basic prerequisite for transportation in order to respond to the JIT-production requirements from customers in the automotive industry in particular.

Different types of logistics solutions have been discussed. One important distinction is made between "relaxed" just-in-time and *sequential JIT*, where the later requires extremely frequent and reliable deliveries.

The most efficient way to introduce these regimes is probably to build a new plant and include all the necessary aspects of sequential deliveries, such as good communication, minimum inventories and a high degree of reliability in the buyer-supplier relationship. In most cases this is not possible, and you have to introduce JIT and sequential deliveries into a traditional production system instead.

One major aspect of this development is the use of *information technology* (IT) for communication purposes. Without computerised inventory, production planning and ordering together with supplier communication JIT and sequential production would be extremely difficult. A distinction between structured and unstructured information is put forward.

The outcome of this is shown in the case of Volvo where a number of parallel pan-European transport arrangements are needed to provide the flexibility, quality and reliability expected on the assembly line.

7. Subcontracting in Swedish industry: an overview with focus on the automotive sector

7.1 Introduction

This chapter addresses the importance of subcontracting in Swedish industry in general and in the automotive industry in particular. Following the discussion in chapter three, it is not surprising that subcontracting as a phenomenon in industrial activities is difficult to define and analyse. Problems arise from the limited number of studies and official statistical sources that directly address subcontractors, either as independent firms or as a functional part of a production chain. In addition to this, the definition of subcontracting varies between studies, making comparisons problematic.

Unless stated otherwise, the definition of subcontracting follows the discussion and conclusion in chapter three. Subcontractors are distinguished by the fact that they produce *non-standard* items for customers according to *specification.* The term "suppliers" is used in a more general manner, to describe the entire base of firms linked to the production process, including suppliers of standard materials as well as services.

7.2 The significance of subcontracting in Swedish industry

Although problematic, there have been attempts to analyse the importance of subcontracting in the Swedish industry using surveys as well as interviews and case studies. The Swedish Industry Board conducted a study in the early 1970's (SIND 1975) which estimated that 20-30% of the value of the production in the engineering industry could be defined as input material to other production processes. This included both subcontracting in the narrow sense as well as suppliers of more standardised goods.

Indications of increasing imports in the share of input materials in the Swedish engineering industry was the main aim of a later study on the international competition facing subcontractors (SIND 1982). A number of traditionally intermediate segments within the engineering industry such as: casting, forging, metal sheets, industrial rubber, plastics, electronics, hydraulic and pneumatic components and metal-processing machinery were studied. One of the main conclusions was that imports of intermediate products occurred due to the lack of domestic supply, forcing the buyers of intermediate products to look outside Sweden for components to match their requirements. It must be regarded as logical for a country with a history of free-trade, a small industry and market (compared to Germany or the U.K), to lack certain segments of the supply industry, and accordingly have to rely on imports to a large degree.

The study suggested that increased specialisation, product development and co-operation with customers was one preferred route towards a strengthening of the domestic suppliers. Exports were seen as another tool for increased production volumes and the scale necessary for product development and marketing. This is emphasised by the fact that the strong segments of the subcontracting industry are either closely connected to major Swedish companies or internationally competitive firms in their own right.

The Swedish Industry Board made another study of the subcontracting sector in the mid-1980's in order to produce a base for its future policy in the field (SIND 1985). A survey was conducted through a random sample of 250 (out of a total of 3558) manufacturing firms with 20-200 employees. This reflects the general understanding that subcontractors are mainly to be found among small and medium sized firms within the manufacturing sector.

The results showed that 30% of the firms produced more than half of their output as input into the production process of another firm and were therefore characterised as subcontractors. This corresponds to approximately 1.000 firms and 73.000 employees. A majority of these firms (57%) were active within the engineering sector.

Table 7.1 below shows the significance of the automotive industry and its suppliers on the basis of official statistics classification codes (SNI). This includes all firms within the automotive sector and the figures representing the number of production establishments can be misleading. Almost 90% of the employees in automotive and engine assembly in 1996 could be found in four locations, Göteborg (Volvo Automobile), Trollhättan (SAAB Automobile), Södertälje (Scania Trucks) and Skövde (Volvo Components Engines). The geographical pattern is discussed more thoroughly in section 7.3.

The structure regarding automotive suppliers shows the same concentration in the classification code 342 which includes chassis and trailers where two production locations account for two-thirds of the employment. This pattern is not present within the SNI 343 category which includes firms producing components and accessories to motor vehicles. This industry is more evenly distributed both in terms of firm size as well as geographical concentration.

SNI	Sector	1989 prod-sites*	1989 empl.	1996 prod-sites*	1996 empl.	Change 89-96 employment abs	Change 89-96 employment %
341	Automotive and engine assembly	39	47 105	43	38 400	-8 705	-18,5
342	Chassis and trailers	132	13 930	123	8 569	-5 361	-38,5
343	Components and access. to motor vehicles	231	22 176	264	23 412	1 236	5,6
34	**TOTAL Automotive industry**	**402**	**83 211**	**430**	**70 381**	**-12 830**	**-15,4**

* Local administrative units (LAU's)[8] with one production site are excluded from the data due to regulations by the Swedish Bureau of Statistics concerning data secrecy . An estimate made by the author would add to the total number approximately 50 LAU's with only one production unit.

Table 7.1: Number of production sites and employees in the automotive industry in 1989 and 1996. *Source:* Adaptation of Swedish Bureau of Statistics, Employment Database.

Firms characterised as suppliers/subcontractors are generally small or medium sized companies. Figure 7.1 shows the size distribution of Swedish automotive suppliers, based on the SIND 1989 study of 250 firms. According to SIND (1990) automotive suppliers are bigger than the average supplier in the manufacturing industry. This structure is regarded as a major problem for Swedish subcontractors in the light of the ongoing restructuring process in the supply sector. There is a lack of companies large enough to meet the demand for product complexity and R&D capacity put forward by the major assembly firms, lead by the automotive industry. This will be more thoroughly discussed in the empirical study of the largest domestic Volvo subcontractors.

[8] Sweden is divided into 289 local administrative units "kommuner", which are commonly used as a common denominator for regional statistics. The term local administrative unit (LAU) will be used in the following.

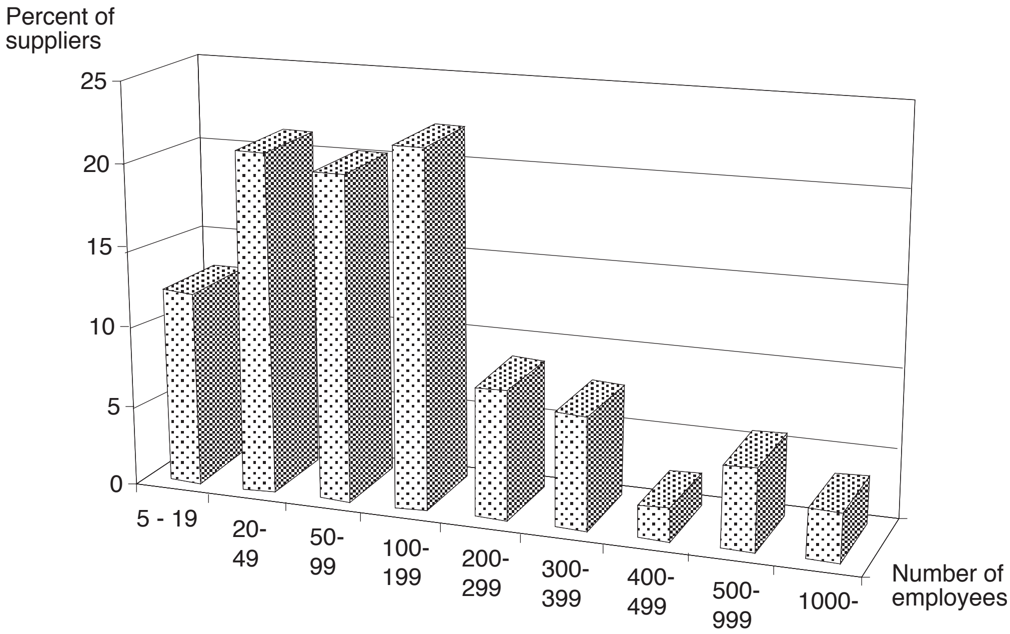


Figure 7.1: Swedish automotive suppliers by number of employees 1989.
Source: SIND (1990)

One important observation in most studies is the strong links to the large Swedish manufacturing firms as customers, with the automotive industry as the leading sector. The single most important problem facing the subcontractors, according to their Swedish customers, is the lack of product development capacity, a situation that leaves no alternative but to search for suppliers on the international market in order to secure long-term product development.

One general conclusion to be drawn from the studies above is that the relatively limited industrial base in Sweden is not large enough to contain a complete subcontracting industry, This means that customers must look outside the national industry in order to find subcontractors. By the same token only a limited number of subcontractors (if any) can continue to act solely on the domestic scene, and at the same time, reach the scale of production that allows them to invest in product development and keep their status as first-tier suppliers.

All of the studies cited above, including a more recent subcontracting study (Brandes, Lilliecreutz et al. 1991), stress the importance of the automotive industry as a major customer for Swedish subcontractors. The table below indicates that the automotive sector represents 15 % of the cost of raw-material purchases in the Swedish manufacturing industry and one-third of the engineering industry in 1996.

INDUSTRIAL SECTOR	TOTAL OPERATING EXPENSES 1996* in million SEK	RAW MATERIAL EXPENSES MSEK	% of total expenses	% of total manufacturing industry
MANUFACTURING INDUSTRY	988 058	453 141	45.9	100.0
Engineering industry	479 937	218 007	45.4	48.6
Metalware excl. machinery & appl.	50 374	19 483	38.7	5.1
Machine industry & appliances	109 236	47 395	43.4	11.1
Office machines & computers	3 594	1 639	45.6	0.4
Electronics, other	25 057	11 326	45.2	2.5
Telecommunication equipm.	85 882	46 256	53.9	8.7
Precision instruments	25 336	9 084	46,7	2.6
Motor vehicles	154 821	72 240	46,7	15.7
Vehicles, other	25 636	10 583	41,3	2.6

* Note: Expenses for raw materials excluding: packaging, electric energy, fuels and trade goods.

Table 7.2: Raw-material expenses for the Swedish manufacturing industry, engineering industry and selected sub-categories, 1996. *Source:* SCB (1998)

The importance of the traditional Swedish engineering sectors such as machines, appliances, telecommunications and motor vehicles as buyers of input material is evident. Motor vehicles and machines together account for more than half of the raw-material expenses of the engineering industry. Most of the automotive suppliers have a long tradition of delivering input materials to other firms in the engineering industry, with the automotive companies as major customers. There is some evidence (Larsson 1993) that automotive suppliers are more dedicated to their customers than suppliers in general, but very few are totally dedicated to one single customer.

One conclusion is that the domestic engineering sector in general has been crucial for the development of a supply base in Sweden, but new purchasing regimes mainly in the automotive industry are changing the situation. Growing demand for co-operation in product development might force suppliers to become dedicated to the automotive industry and increase their market within that industry by exporting or foreign investment. The rest of this chapter will focus on the automotive sector, the single most important industry in terms of being customers of sub-contracted work. First, we will look at the importance of subcontracting and its spatial characteristics in Sweden, followed by a comparison with the European and international situation.

7.3 The automotive supply industry

The structure and importance of subcontracting

The Swedish Industry Board has conducted two major studies of the automotive industry and its suppliers/subcontractors (SIND 1980; 1990) which provide relatively detailed figures.

The first study shows the situation in 1976 and is based on a postal survey to 220 automotive suppliers (SIND 1980). It includes all firms with deliveries for 1 MSEK or more per year comprising 82% of the total value of input materials produced in Sweden during the year of the study. Outside this core of automotive subcontractors were approximately 1500 firms with only marginal deliveries to the automotive sector. The total number of employees within the automotive supply sector is estimated to 2% of the total number of employees in the manufacturing industry. If we add the automotive firms, the total is 7,3% which shows the importance of the automotive industry.

The study from 1989 included 212 firms with almost 30.000 employees, delivering to the automotive industry (Volvo and SAAB), and was estimated to cover 60% of a total of 350 Swedish automotive suppliers (SIND 1990). This figure appears to be reasonable compared to the study from 1980, although the figures are not fully comparable due to differences in definitions. A more detailed estimate i given by Brandes, Lilliecreutz et al. (1991) who divides 350 automotive suppliers into 300 specialists, 40-50 function suppliers and only 4-5 system suppliers.

A more recent publication by the Invest in Sweden Agency (ISA 1997)[9] estimates the total number of automotive suppliers in 1996 to be 180 with total sales of SEK 29 Miljarder. The concentration within the industry is shown by

INDUSTRIAL SECTOR	PERCENT OF SUPPLIERS
Engineering	73
Plastics and rubber	15
Iron-, steel- and metalworks	9
Textile	3
TOTAL	100

Table 7.3: Share of Swedish automotive suppliers by sector. *Source:* SIND (1990)

[9] The ISA report is written by Automotive News Europe journalist Edmund Chew based on a feasibility study by the consultancy firm Arthur D. Little.

the fact that the ten largest firms account for 42% of the total sales. Having in mind the difficulties and differences in definitions and survey methodology, we can conclude that the Swedish automotive supply industry has undergone a restructuring process which is characterised by a decreasing number of suppliers combined with a concentration of activities into a small number of large international operators.

The standardised categories for industrial statistics in Sweden provide only limited guidance to the functional division of labour in the automotive industry. A more appropriate categorisation has to take its point of departure in the production process of the automotive sector. SIND presents the following distribution between different sectors in their 1990 study, as indicated in table 7.3. Engineering industry with 73% of the suppliers is a very general category, which needs to be broken down for further analysis. All of the cited studies in this section have different criteria for the categorisation of suppliers into industrial sectors and are therefore difficult to use for a comparison. What can be said is that the engineering sector accounts for the majority of firms in all of the studies, but it is not possible to follow the technical development of components and the growing importance of electronics and plastics in modern cars. Most of these companies are most likely lumped together within the engineering industry category.

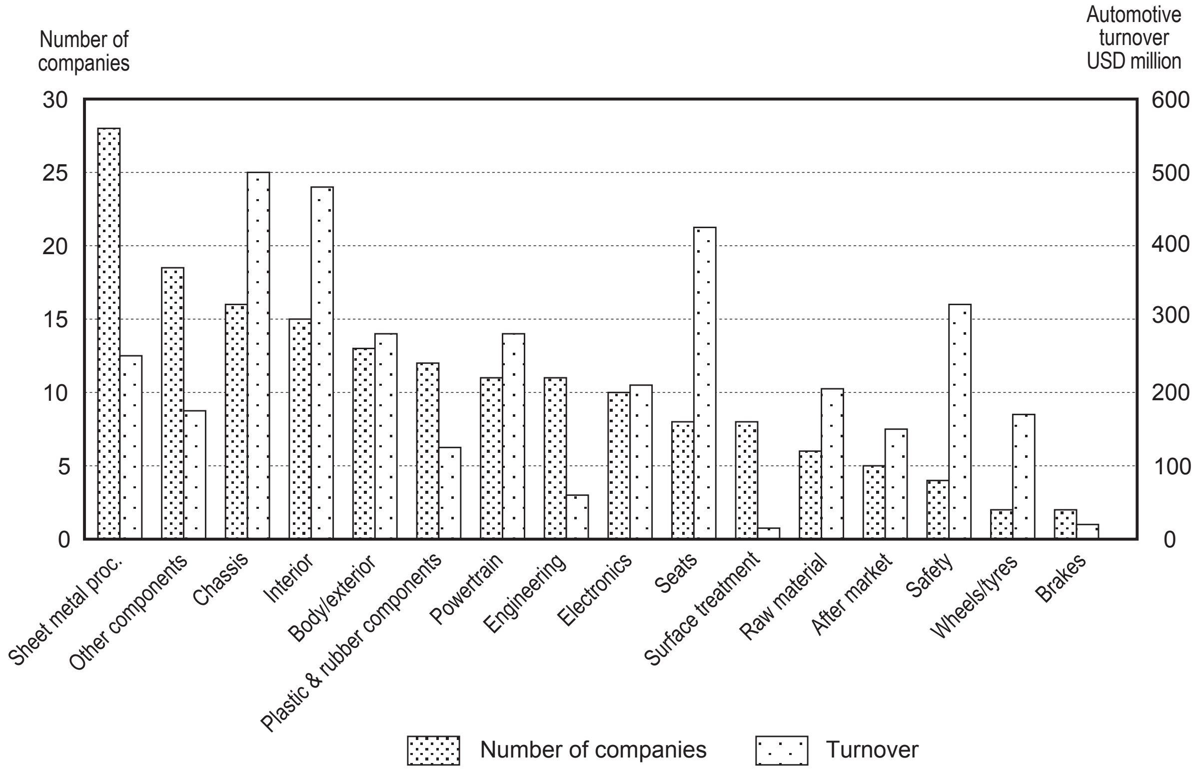


Figure 7.2: Number of companies and turnover in theSwedish automotive industry by segment, 1996. *Source:* ISA (1997)

In the publication by the Invest in Sweden Agency (ISA 1997), figures on automotive suppliers are divided into relatively detailed segments is presented. Figure 7.2 indicates that the majority of Swedish automotive suppliers are active within sheet metal processing, chassis, interior, body/exterior and plastics/rubber. This confirms the general picture from earlier studies where the traditional domestic suppliers are within relatively mature segments such as metals, rubber and plastics. It is also possible to discern the two major system-suppliers, Lear Corporation and Autoliv, within sectors with a high turnover and few companies.

The historical structure of the Swedish automotive supply industry will be discussed in more detail in the empirical study of Volvo's domestic suppliers. One aspect of the figure is that the division of segments can be seen a reflection of the situation regarding restructuring in 1996. Very general groups such as sheet metal processing and engineering are mixed with categories which represent a product or system such as seats, wheels or interiors. This reflects the structure where systems- or module-suppliers are active within interiors, seats, safety and wheels. During the period 1996-98, there have been major changes in the supplier structure towards a few big companies supplying entire modules. One recent example is the development of the Arendal supplier park, which is discussed later in this work.

Spatial characteristics of automotive subcontracting

The assembly plants of Volvo Car and Trucks (Göteborg) and SAAB Automobile (Trollhättan) are located in the south-west of Sweden while Scania Trucks are made in Södertälje south of Stockholm as can be seen in figure 7.3. Shown on the map is also Skövde, the location of the Volvo Engine Plant.

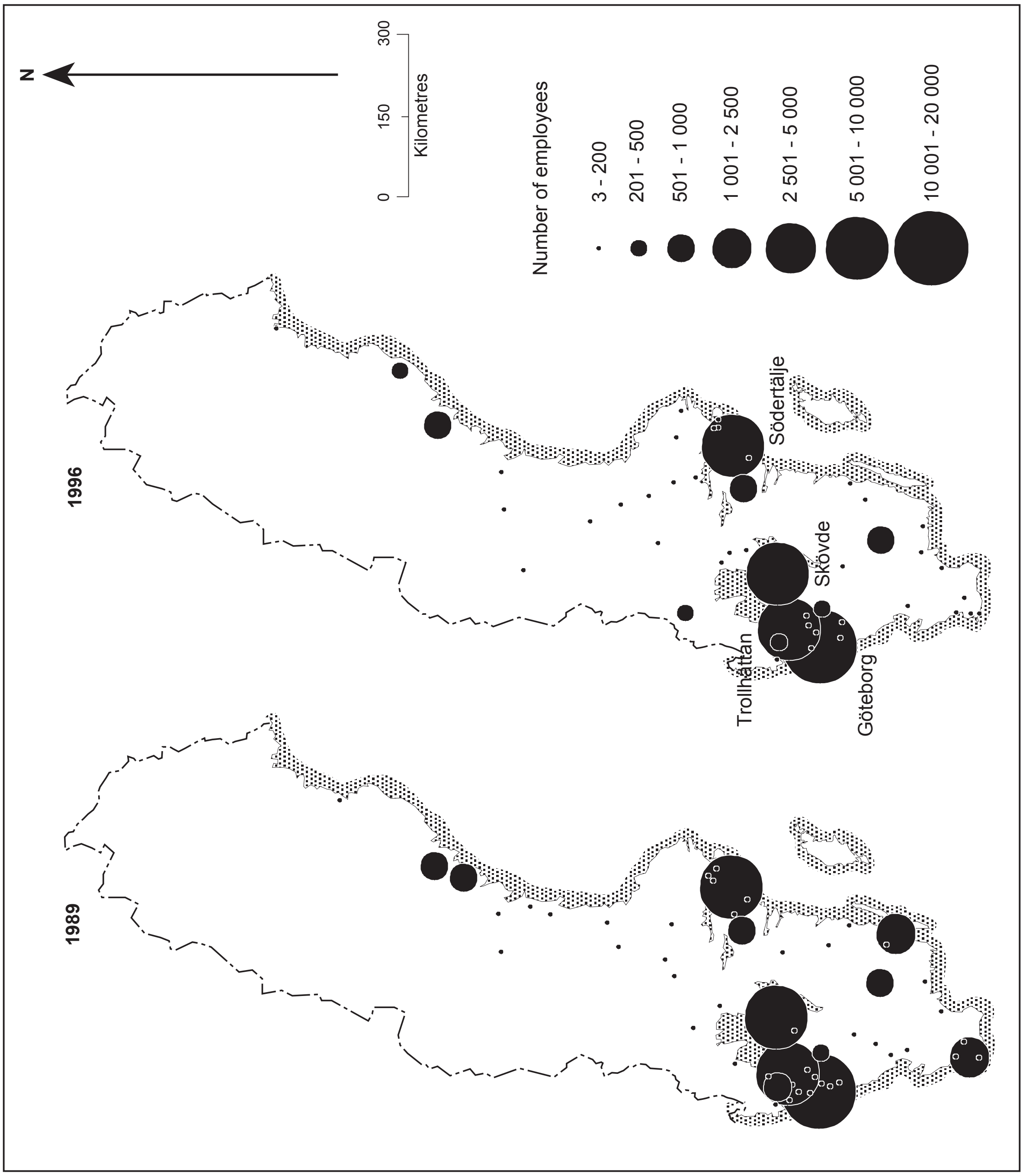


Figure 7.3: Number of employees in the assembly of motor vehicles and engines (SNI 341) 1989 and 1996 by local administrative unit. *Source:* Adaption of Swedish Bureau of Statistics, Employment Database.

These four major locations accounted for over 90% of the 38 400 persons employed in vehicle and engine assembly in 1996. The figures include all employees, not only the shop-floor workers in firms classified as vehicle assemblers.

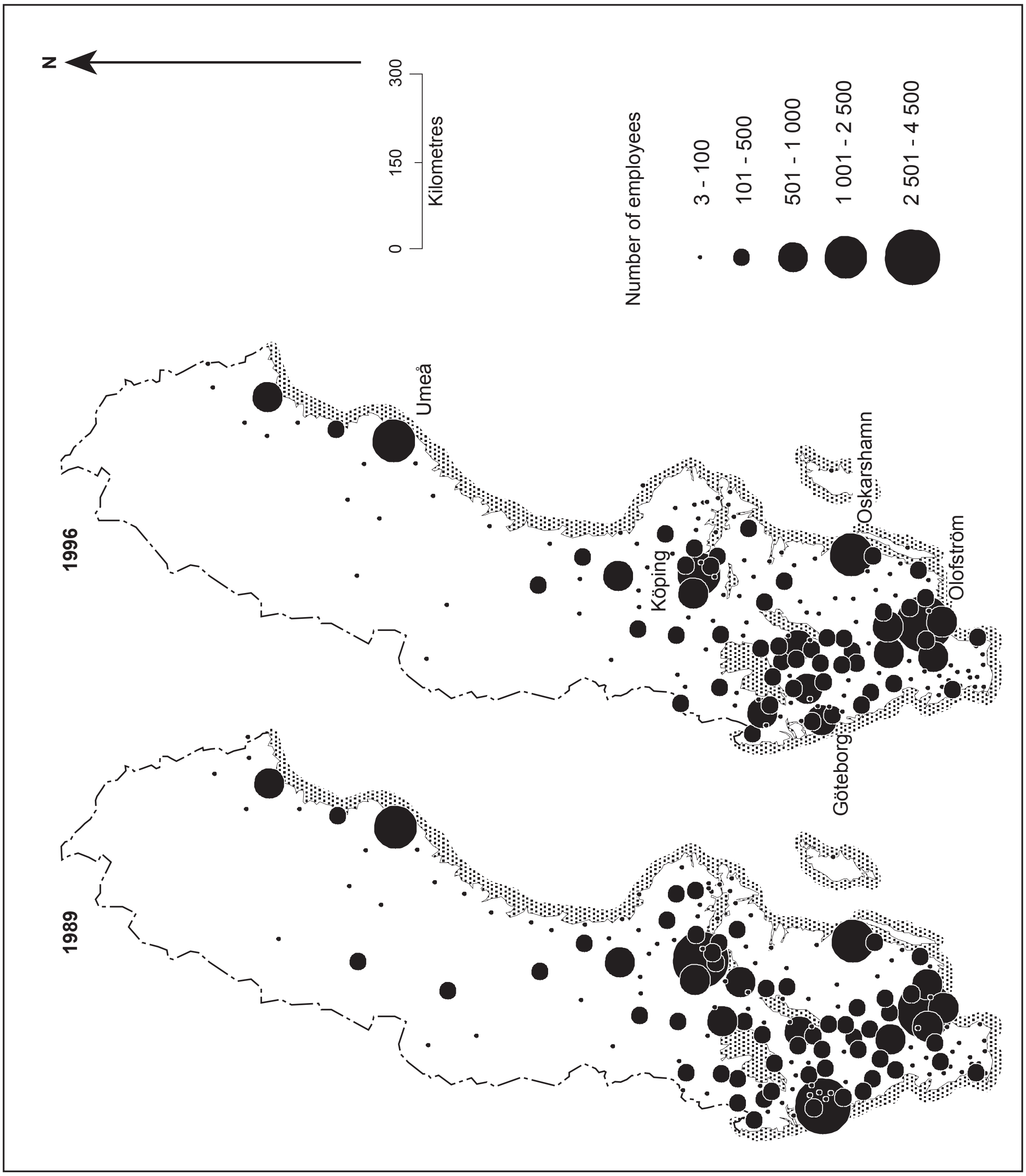


Figure 7.4: Number of employees in firms producing chassis, trailers and components to motor vehicles (SNI 342 and 343) 1989 and 1996 by local administrative unit.
Source: Adaption of Swedish Bureau of Statistics, Employment Database.

This concentration is reflected in the location of suppliers to the motor-vehicle industry as shown in figure 7.4. On a national level, there is a distinct concentration of suppliers to the south-west. There are a number of regional patterns which can be derived from the map. Firstly, there is a clear agglomeration of suppliers to the south-west, which is considered to be the traditional automotive region in Sweden. The map displays the number of employees, but other studies indicate that the majority of purchases in terms of value are made in this region (SIND 1990).

Within this traditional automotive region there are a number of geographical clusters. In the central south is the Volvo Components Plant in Olofström in the centre of a region with several local administrative units with a large number of employees within automotive supplies. Another cluster is located in the central south, from south-west of Göteborg and north towards the Volvo Skövde Engine Plant. The Southern edge of this region is in the traditional small-scale industrial district *"Gnosjö"* (Asheim 1993). This area has had a long tradition as a supplier to the automotive industry but is not especially marked on the map. This is most likely due to its diminishing importance and the fact that most of the firms are active within a variety of sectors and will therefore be defined within another industry. The third major geographical cluster is the region west of *Lake Mälaren* including several Volvo-owned plants such as Köping (power-line) and Lindesberg (truck components).

One explanation related to the importance of the west and south is the increasing demand on delivery. In the case of Volvo Automobile, there is a clear link between time-related demand and the fact that all of their suppliers are located south of Stockholm. Volvo requires all their suppliers to be able to deliver within 24 hours after the final order. It shall be noted that there is a basic difference between "just-in-time" deliveries as a general strategy and the use of *sequential* JIT-production and delivery. This is discussed in more detail in chapters five and six, but the point to be made is that deliveries in sequence between supplier and customer do imply a very pronounced tempo-spatial element where proximity is often used in order to create reliability in deliveries. One particular case is the Volvo Arendal supplier park which is discussed in chapter 12.

If we look at the number of production units per LAU, we can see a relatively even spread of locations with only one or two firms, which is a feature that can be seen as typical for the automotive supply sector. Volvo has a long tradition of purchasing components from independent firms (Malmberg 1995) which has produced a pattern with a substantial number of small and medium size firms, many of them in relatively small towns.

Another explanation to this might be that the traditional centres for automotive assembly has the same labour market as most of their suppliers. The competition for labour produces a shortage of qualified labour as well as relatively high wage levels. As indicated in figure 7.4, only a limited number of suppliers are located within commuting distance of the assembly plants of Volvo and SAAB.

The change between 1989 and 1996 is not dramatic in terms of spatial restructuring, although Göteborg has lost some 1500 employees within chassi production. This is not connected to any major change during these years. One possible explanation is that the statistical classification has changed during this period and that the figures are attributed to vehicle assembly in 1996.

In general, the maps reveal an agglomeration to a number of core areas, with the major difference between the sub-categories chassis/trailers and automotive components. The former has decreased almost 40% to 8.500 employees during the period while the components industry has gained 5% and comprised 23.000 employees in 1996 (see table 7.1).

One recent trend, which contradicts the weakening of the Göteborg region is the build-up of a supplier park in direct proximity to Volvo. The project has attracted eight new establishments during 1997/98, and is projected to hold more new subcontractors when the next car model is introduced. This would add another 600 employees to Göteborg, data which is currently not represented on the maps.

The Swedish automotive-components industry in relation to Western Europe

Many observers have concluded that the Swedish automotive supply sector is facing a period of major restructuring where only a small number of large firms will survive as primary suppliers. The main reason for this is the need for large scale operations in order to meet the rising demands from the international automotive corporations. It includes more R&D functions, global sourcing and a trend towards more complex products where only large companies or supply-groups have the financial and technological capability to compete.

Changes within the automotive components industry can be studied on different geographical levels. Some authors focus on the "globalisation" of the sector (Wells and Rawlinsson 1994; Dicken 1998), while others discuss in terms of "europeanisation" (Hudson and Schamp 1995). Independent of the scale of the investigation of restructuring, there is evidence that the automotive supply sector is in a state of transformation from many separate national markets to a few international ones.

The small scale of the Swedish components industry becomes evident when looking at the European situation. Within the manufacturing industry in the European Union in 1994, automotive assembly occupied the second position in terms of employees as displayed in table 7.4. Automotive subcontractors might be put into the category "production of motor vehicle parts" which held close to half a million employees in the EU-12 countries in 1994. Motor vehicle assembly and parts production also accounted for ten percent of the total production in the manufacturing industry.

A comparison with official Swedish statistics shows that Sweden had approximately two percent of the EU employees in automotive assembly and 6.5 percent in components industries in 1996 (based on EU-12 figures from 1994). Even though employment in automotive components is higher than for assembly firm,s it gives a clear indication that Sweden has a marginal automotive assembly- as well as components industry in a Western-European perspective.

Industrial sector	Number of employees	Employment growth 1987-94 (%)	Share of total manufacturing production value
Food, drink, tobacco	1 778 885	-4.1	17.2
Assembly of motor vehicles	1 026 234	-15.4	10.3 *
Footwear and clothing	949 365	-18.5	2.3
Telecom equipment	769 424	-15.7	3.2
Processing of plastics	759 541	14.6	4.0
Footwear and clothing	949 365	-18.5	2.3
Tools & finished metal goods	719 025	-3.6	–
Basic ind. chemicals & petrochem	530 453	-19.0	4.3
Parts of motor vehicles	475 481	-6.0	–
Wooden furniture	455 294	0.2	2.8
Pharmaceutical products	398 576	5.9	2.8

* = Including parts of motor vehicles

Table 7.4: Largest sectors of employment in EU 1994 by number of employees, change and relative importance. *Source:* European Commission (1995/96)

Table 7.5 indicates that only one of the 80 leading European component firms in the beginning of the 90's had their main manufacturing location in Sweden, that is SKF a supplier of ball bearings and wheel modules[10]. This puts the domestic supply industry in a problematic situation in the ongoing restructuring process. Large multinational corporations acquire smaller firms or form groups around certain specialities such as seating, brake-systems and interior-design (Financial Times 1996b; 1996c).

Germany stands out as the most important location for automotive suppliers. According to a study by The Boston Consulting Group (cited in: Wells and Rawlinson 1994) almost 330.000 people were employed in this sector in Germany in 1991. This can be compared to Sweden where the Department of Industry estimated the corresponding figure to be around 40.000 (SIND 1990) and official employment statistics in 1996 say 30.000. These figures are of course very general but might serve as a rough guidance in order to place Sweden in the European context.

[10] Product development and production of automotive components within SKF is located outside Sweden, mainly in Germany. This fact underlines even more the absence of large supplier companies in Sweden.

COUNTRY	PARENT LOCATION	MAIN MANUFACTURING LOCATION
Germany	36	43
France	8	15
UK	8	9
Italy	7	8
Belgium	0	1
Spain	1	2
Sweden	1	1
Japan	2	–
USA	16	–
TOTAL	80	80

Table 7.5: Ownership and principal production location for the leading European automobile components firms 1991. *Source:* Wells and Rawlinsson (1994:72)

The global scene is witnessing a fierce restructuring and concentration process. The new large automotive suppliers are becoming global corporations with customers world-wide. Among the worlds top 40 automotive suppliers in 1998, 17 were European, 17 from North America and 6 from Japan (Automotive News Europe 1999). The distribution was almost the same in 1996 (Financial Times 1996a), although behind the relatively stable figures is a turbulent concentration process where the major supplier groups have acquired smaller companies.

The influx of large international automotive suppliers to Sweden was relatively limited up until the mid-1990's, with only a handful of operators. This picture has changed rapidly during the last years of the 90's. The development of the new Volvo S80-model has involved a major restructuring towards the formation of systems- or module suppliers. These are predominantly foreign-owned and have acquired a substantial number of domestic suppliers within their respective sectors. This is analysed in more detail in the empirical chapters ten, eleven and twelve.

What we can expect from this process from a Swedish perspective is a structure with a few large multinational components companies or groupings dominating the top layer in the supply pyramid. The traditional domestic suppliers to Volvo and SAAB will be either large systems suppliers themselves or acting as second-tier suppliers, exemplified by the falling number of suppliers to Volvo. Each new model has seen a reduction in suppliers to the assembly plant in Göteborg, the 700-series had 375 suppliers while the 850-series had approximately 275 and the new S80-model in 1998 will have around 175 direct suppliers.[11]

[11] Company interview with Lars Bolminger, Volvo Car Corporation, June 1996.

Within this general trend towards concentration and internationalisation of the automotive components industry, there is a wide variety of different technological and organisational paths of development. They may be influenced by firm specific factors, changing markets or different institutional contexts.

The following cases of Volvo and their suppliers have to be analysed with this in mind. One especially important aspect is the geographical location of Sweden in the periphery of the European market. This puts a special emphasis on time-compression and supply over relatively long distances which give concepts such as just-in-time different conditions compared to more centrally located production facilities.

7.4 Summary

The enterprise to analyse the extent and importance of subcontracting in Swedish industry is very much limited by the fact that subcontracting is a functional activity and therefore cuts across several official statistical categories. This has forced surveys and estimations of the subcontracting sector to adopt definitions which differ between studies, thus making comparison difficult.

Taking this into account there seems to be a general conclusion that industrial subcontracting is mainly confined to the engineering sector. The subcontractor is generally within the small and medium-size segment and accounts for approximately one third of the firms in the manufacturing industry.

Having in mind the relatively small market and industry in Sweden, it is not surprising that the "supply" of subcontractors only fill certain segments of the market. This has forced the major manufacturing companies to rely heavily on foreign inputs and subcontractors. The internationalisation process has, on the other hand, worked as a "springboard" for Swedish suppliers in their work to broaden their markets.

The most analysed industrial segment by far is automotive production where Sweden holds a relative strong position with two different companies and a corresponding supply-base. The domestic automotive suppliers of importance are estimated to be around 200 in 1996 and mostly active within mature segments such as metalworks, rubber and plastics.

The geographical structure of the supply industry is characterised by a concentration to the south-western part of the country, with a number of clusters often related to component plants linked to the large producers.

During the last 2-3 years, the international trend towards concentration and globalisation in the automotive supply industry has started to make an impact in Sweden. A handful of global actors have acquired many of the former domestic suppliers within certain segments such as interiors and seating. This has put the industry into a continuous process of restructuring, which so far seems to go in the direction of a hierarchical supply system with a small number of global corporations in the top tier. The traditional domestic suppliers are, if they stay in the automotive business, to be found in the second or third layers.

8 Introduction to Volvo and the context of the case studies

8.1 Introduction

The purpose of this chapter is to provide a general introduction to Volvo with special emphasis on questions regarding subcontractors. It will begin with a presentation of the empirical investigation, with focus on methodological issues. This is followed by a summary of the company's historical development and a presentation of the current organisation and structure of the Volvo Group. From this general platform the discussion will focus on supplier organisation and strategies within the passenger-car segment. A number of different stages will be identified followed by a presentation of the current situation.

8.2 Discussion of the empirical investigations

Introduction

In this work, the methodological discussion has been divided into two parts. The first section, placed in the introdutory chapter, focuses on general methodological questions and forms the starting point for the study of the Volvo suppliers. This part constitutes the second section on methodology. The aim is to describe, in more detail, the empirical data collected from the suppliers to Volvo Torslanda. Both the data collection process as well as reliability, validity and the degree of generalisation is discussed.

The empirical data in this thesis is divided into three different segments. Firstly, a study of the 40 most important independent suppliers of components to the final assembly at Volvo Torslanda located in Sweden, secondly a case study of a newly established supplier-park initiated by Volvo and finally an in-depth case-study of one single Volvo supplier.

Data collection and reliability

The data in the supplier-study was collected through a survey conducted during 1996 and 1997. From the Volvo supplier list for 1996, the 40 largest domestic suppliers in terms of purchase value were selected. These were contacted via telephone and asked to participate in a telephone interview. The next step was to find the most appropriate person to answer questions regarding relationships with Volvo Torslanda assembly plant. After this person had been identified, and a time and date was set for telephone interview, the questionnaire (see appendix 1) was sent to the respondent. Sending the questions in advance gave the respondents the possibility to gather information and to minimise the time of the actual telephone interview. In some cases the questionnaire was filled out and returned by fax, without a telephone interview. These answers were analysed and the respondent was contacted via telephone if there were any uncertainties in the information reported.

Most suppliers had a positive attitude towards participation in the study, though many of the smaller companies found it difficult to allocate the approximately 20 minutes needed for the telephone interview. The main reason behind this was that these companies had only one or two people with an overview of the total situation regarding production, transportation, purchasing and marketing. In larger firms the same problem occured, due to the fact that Volvo-contacts were handled separately by one, often very busy, key-person. This resulted in a lengthy data- collection process.

The bulk of the interviews were made between october 1996 and november 1997, with a few in the beginning of 1998. Although the time-span is relatively long, there has been no major restructuring in the supplier-base or in the manufacturing process during the period. One source of problem has been the fact that the development phase of the Volvo S80-model, launched in April 1998, coincided with the period of investigation. The respondents were instructed to avoid S80-related activities in their answers. This is of course very difficult to control or validate, especially regarding questions where the respondent is asked to estimate the importance of different factors. This has to be taken into account in the analysis of the questionnaire data.

Validity of the data

As mentioned above, the suppliers in the study were taken from the 1996 Volvo supplier list. It was not possible to acquire the sales figure for the entire supplier population for the same year, so the validity of the data has to be compared to figures for 1997.

Volvo had in total 375 external suppliers linked to the final assembly at Torslanda. Of these, 154 were located in Sweden. The exclusion of Volvo-owned suppliers in the study is mainly due to the fact that these companies are not subject to the same market- forces as independent firms. One further aspect is that the internal suppliers such as Volvo Components in Skövde and Olofström are ten times larger than the average supplier in the sample which makes comparison even more problematic. A limitation is also made to the supplier of components to the final assembly. The reason for this is that purchases for the body-shop and paint-shop is handled by a separate department. They have not been possible to approach in the same way as the final assembly purchasing department.

The total value of purchases for the final assembly in 1997 was 6.8 Billion SEK, half of which originated from suppliers located in Sweden. The sample in this study contained the 40 largest suppliers in Sweden, who accounted for 85% of the value of domestic purchases. This means that, apart from marginal changes, we can assume that the suppliers in the study represent the great majority of domestic purchases. It is furthermore likely that changes in buyer-supplier relationships, to a greater degree, can be found among larger firms with more capital and resources to follow the demand from the automotive assemblers.

Out of the original 40 suppliers, 34 left a completed questionnaire and 29 participated in the telephone-interview. An analysis of the six non-respondents showed no systematic bias in terms of firm-size, product category or other significant variables. Among these firm was one large system-supplier, as well as firms in more traditional sectors.

Since a significant part of the restructuring process is controlled directly or indirectly by foreign actors, the limitation to domestic subcontractors can be a methodological problem. But with the experience from the study of the suppliers in Sweden, a widening of the investigation to include Western Europe would pose some major problems. The method selected in this work requires a combination of interview and questionnaire, something that would be extremely time-consuming in a foreign environment. Experience from other studies (Lorentzon 1994) shows that detailed studies at firm-level in other business cultures require a high level of local connection. This was not considered possible within the limits of this work.

The case-studies

In order to achieve a more accurate picture of the current restructuring process two case studies were conducted. The first is presented in chapter 12 and covers the newly established supplier-park in close proximity to the Volvo Torslanda assembly plant. There are eight suppliers located in the park, of which all but one are newly established module suppliers.

Information regarding the supplier-park project was collected via interviews with the Volvo Purchasing Department. The suppliers in the park were approached by telephone using a list provided by Volvo. Due to the timing of the study to the start-up phase of production, the eight firms only agreed to participate in a short interview . The start of the new supplier-park has drawn a considerable amount of interest both from media and academia, resulting in a certain reluctance to – *"answering more* *questions to students and other university people"* – as one respondent expressed himself. In problematic cases the contact with Volvo Purchasing Department worked as a key to get the attention needed to explain my study, and thereafter all of the firms agreed to answer a short questionnaire (see appendix 2).

The second case-study is concerned with the supplier-irm Hydro-Raufoss Automotive Plastics, and is based on company interviews and visits to persons responsible for logistics and suppliers at the plants in Belgium, Norway and Sweden. Interviews have been updated through a telephone interview in the case of Belgium and via plant visits in Norway and Sweden.

Hydro-Raufoss was selected as a case on the basis of its work with restructuring and product development according to the requirements from Volvo. This made it possible to exemplify and discuss the theoretical models presented earlier in the work. The aim was consequently not to develop general theoretical results from this case, but rather to illustrate and discuss the geographical aspects of the restructuring process in a "front-end" supplier organisation.

It is important to have in mind that the supplier structure has undergone fundamental changes during the last three years. In connection with the new S80-model, Volvo took a major step towards dedicated systems/module suppliers located in close proximity to the Torslanda Plant A development that radically changed the conditions for the traditional Swedish supplier base.

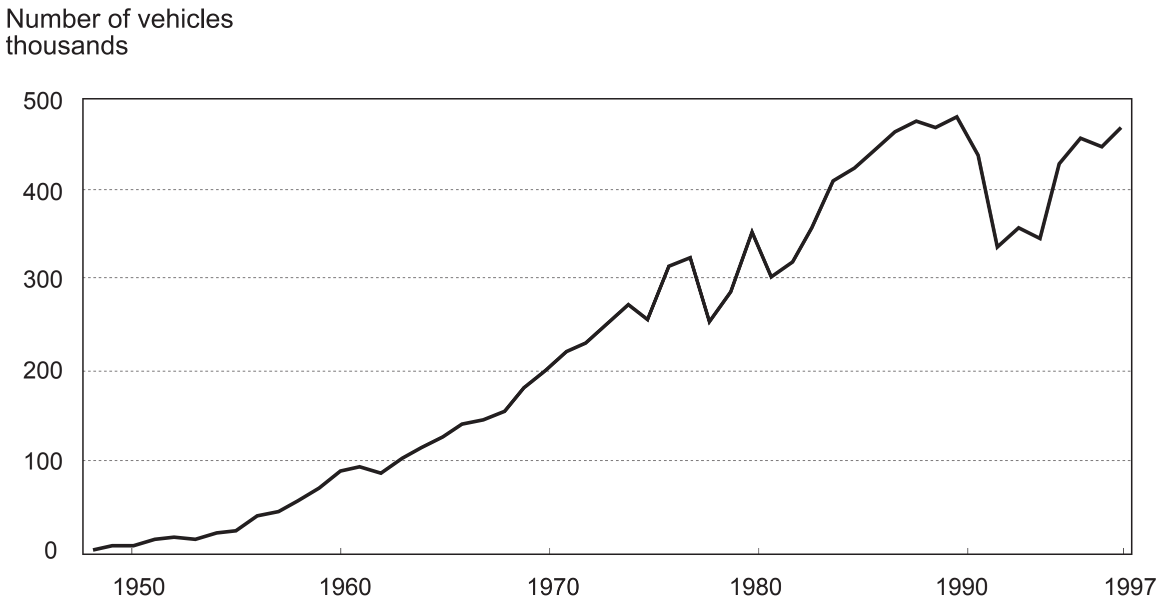
As discussed in section 1.5, the restructuring process in the automotive industry is a source of methodological problems in this type of study. How to accurately describe and analyse a continuing process while it is happening is a basic problem which has no definitive answer. The strategy in this work has been to use the 1996/97 supplier-data to analyse the situation prior to the S80-model, when the system still had distinct features of the traditional Volvo supply strategies. This is then contrasted with the more recent development in the case studies of the supplier-park and the subcontractor Hydro-Raufoss.

8.3 The development of Volvo

Historical background

The early days of Volvo are very much connected with its founder Assar Gabrielsson and his vision of a Swedish car made for specific local conditions. His first prototype was presented in 1924 but it took another two years until enough capital was raised to start production (Kinch 1993). Both capital and the brand name came from the ball-bearing company SKF. Production started in 1926 in a small factory in Göteborg, the hometown of Gabrielsson, the chief engineer Gustaf Larsson as well as their former employer SKF. Volvo was a subsidiary to SKF until 1935 when the company was introduced on the stock-market and since then has been an independent company (Elsässer 1995).

The development of Volvo from the late 1940's and onwards can be described in a number of stages (Ellegård 1983; Elsässer 1995; Volvo 1998a). The period from the early 1930's and until the end of the second World War, can be characterised as a *growth phase* where Volvo relied heavily on trucks and buses for their profits. It was not until 1962 that passenger cars became the single most profitable business. The vision of a passenger car was still alive and the main breakthrough came with the PV444 model launched in 1947 (see figure 8.1).



Note: Figures include production abroad.

Figure 8.1: Number of vehicles produced in the Volvo Group 1947-1997. *Source:* Data 1947-82: Ellegård (1983:185), 1983-86: Bilindustriföreningen (1998:34), 1987-97: Volvo (1998b)

The 1950' and 60's can be characterised as a period of very *rapid expansion* for the automobile production. Figure 8.1 shows the increase in production from the late 1950's until the first oil-crisis in 1973. Volvo opened up its assembly plant in Göteborg in 1964 and one year later in Ghent, Belgium. Exports became the main market during this period. In 1957, Volvo exported 42% of their total production; almost half of this was the export of passenger-cars to the newly penetrated U.S. market. This was the start of a constantly growing export-share for both Volvo and SAAB. The share in

1996 was 86% (Bilindustriföreningen 1997), a figure which gives an indication of the dependence on exports in general, and the North American markets in particular (see also figure 8.3).

The change of CEO in 1971 marked the start of a new era where the oil-crisis had put the entire business under uncertainty. Volvo chose a *diversification strategy* and entered into a number of sectors such as energy and food (Ellegård 1983). On two different occasions Volvo had plans for close co-operation with outside actors (SAAB in 1977 and the Norwegian State one year later), which did not come to realisation.

The period since the mid-1980's has seen a *return to original areas of business* in motor vehicles. Co-operation started with Renault and later with Mitsubishi and the Dutch State. In 1993, Volvo and Renault proposed a plan for a merger, something that created a turmoil at Volvo and was later rejected by the shareholders.

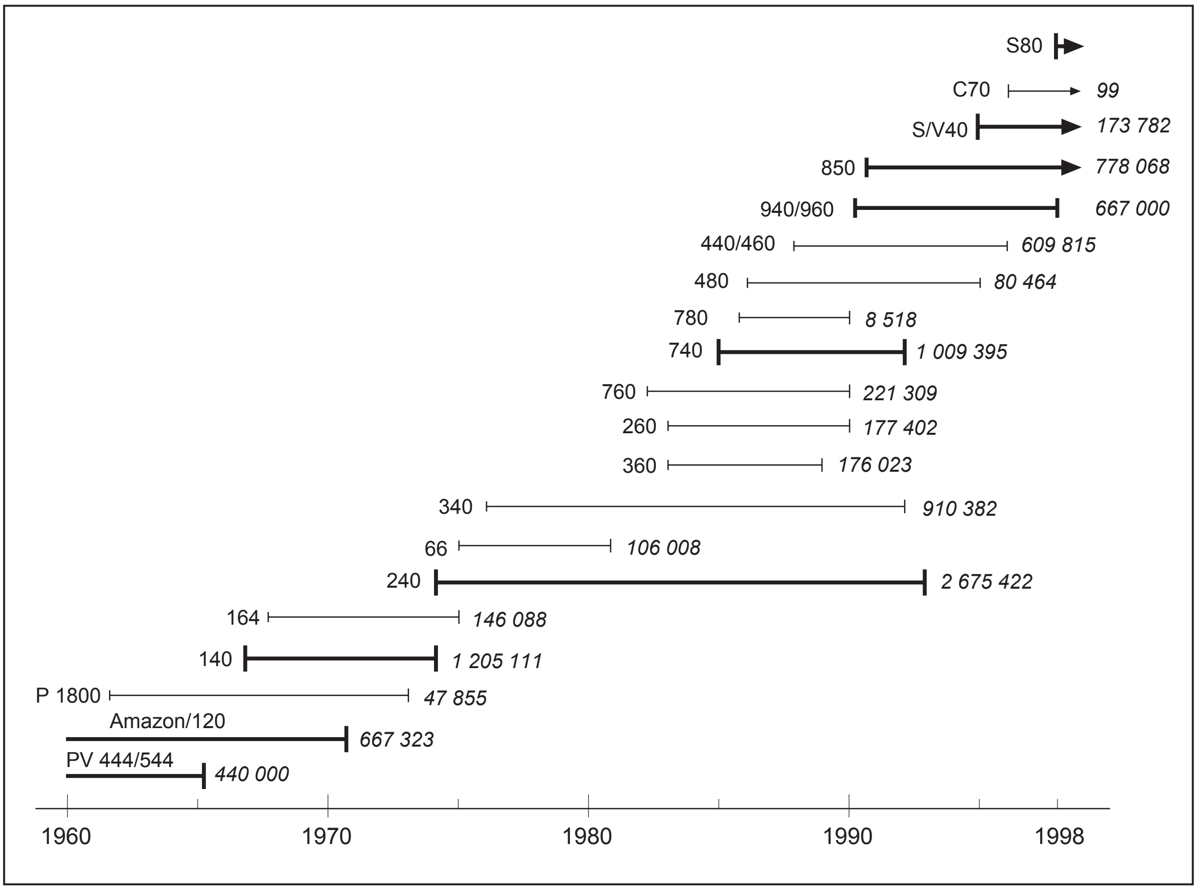
Products

One important aspect of automotive production and sourcing strategies is the introduction of different models. Figure 8.2 shows the Volvo passenger-car models from 1960 until 1997 including the number of units produced. The major models are displayed with wider lines. The figure show how the 100-, 200- and 700- series have been the most important model-families during the period up to 1990, while in recent periods there has been a more even distribution between the 400-, 900, and 850-series.

One observation is that the life span of models has become shorter. This can most likely be seen as an indication of frequent model change as a means of competition. The stagnation and insecurity in the 70's is reflected in the relative long period without any major new models.

Since the end of production of the 940/960- models Volvo has restructured its models into three segments; medium-sized (S/V40); large-sized (S/V/C70 in 1996) and luxury (S80). These will be the starting point or platforms for continuous upgrading and new types of vehicles. One example is the 4-wheel drive cross-country version V70XC.

One important aspect that will be discussed later is the function of model-changes as opportunities for the restructuring of purchases and the subcontracting structure. This has been pronounced during the 1990's where each new model has involved a substantial reduction in the number of direct subcontractors.



Note: Figures for models still in production represent the situation at the end of 1997.
The 850 model changed name to S/V70 in 1996.

Figure 8.2: Chronological order and total number of units produced for Volvo passenger-car models 1926-1997. Bold lines represent "main-models".
Source: Elsässer (1995:104); Volvo (1998a)

Production and markets

The organisation of production and markets has been influenced largely by the fact that Volvo is a small producer in a high-value segment, located relatively far from the major markets for motor vehicles.

Today, production is centered to a few locations in Sweden and Europe. This has forced Volvo to rely on exports in order to increase sales. The figure 8.3 below presents the relative distribution of sales by region for Volvo passenger-cars. One important change is the relative decline of the domestic market and the growth of the European markets. It is also interesting to notice that North America accounted for 22% of the exports aas early as 1960.

The geographical change in sales is not matched by the same in production. As can be concluded from table 8.1, production has been focused to Sweden and Europe during the last ten years. North America presents the biggest discrepancy between sales and production, having one quarter of the sales and only marginal production. Europe outside Sweden shows the opposite pattern with more production than sales, while Sweden is the most extreme with 13% of the market and almost one third of the production.

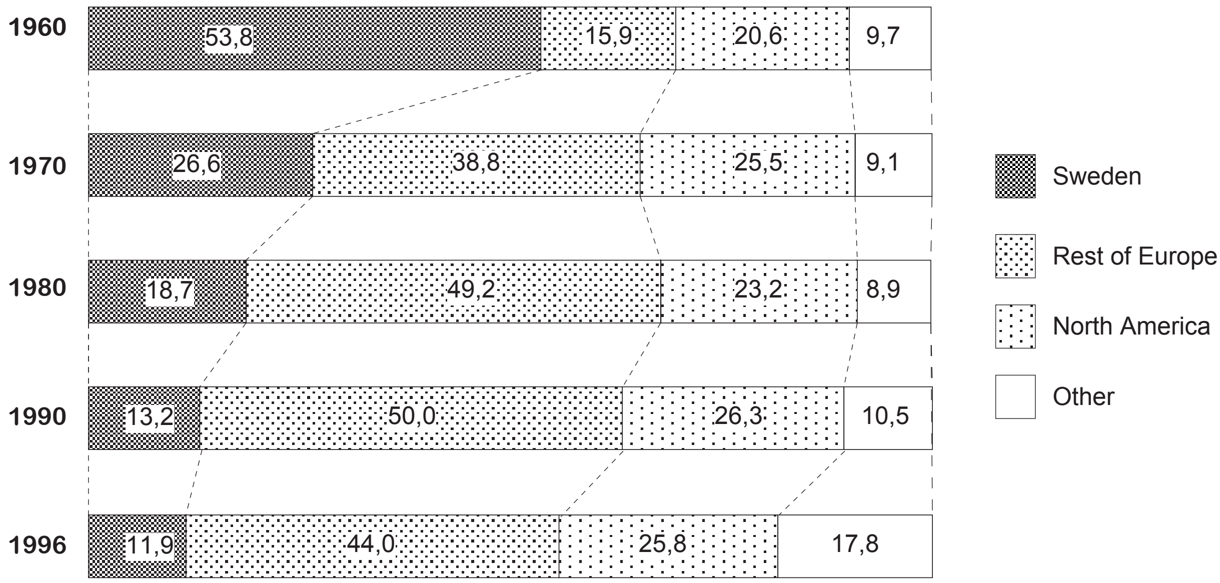


Figure 8.3: Regional distribution of Volvo passenger-car sales. Relative change 1960 - 1996, number of cars. *Source:* Volvo Annual Reports.

The general tendency regarding production is that Sweden has lost and Europe gained in the last ten years. As can be seen in figure 8.4 below, the most accentuated change of production between 1992 - 94 coincides with the closure of the Kalmar and Uddevalla plants in Sweden. The change in relative figures is influenced to a great degree by the substantial decrease in the absolute number of cars produced. The most marked reduction occurred between 1990 and 1991 when production dropped 25% from 376 000 to 278 000 units.

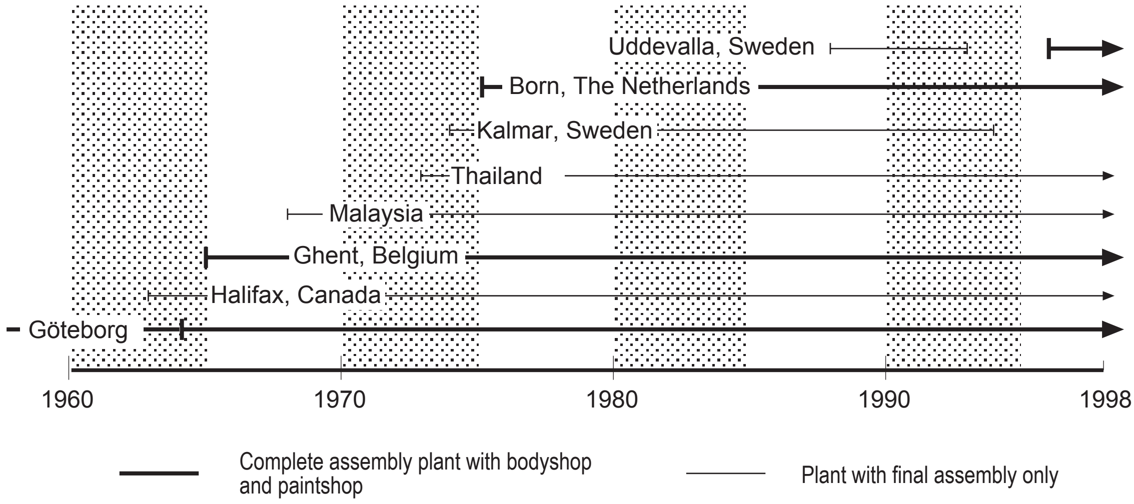
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Number of cars (1000's)	423,8	400,6	414,0	376,1	278,3	304,2	290,7	351,7	370,5	375,8	387,4
Relative distribution (percent)											
Sweden	46,1	45,0	41,6	41,5	39,9	39,9	33,2	28,1	35,7	30,6	30,0
Europe	50,3	51,4	54,9	54,4	55,3	56,3	62,9	68,2	60,4	65,5	67,2
North America	2,0	1,7	2,0	2,2	2,8	2,1	1,9	1,9	1,9	1,9	1,8
Other	1,5	1,9	1,5	2,0	2,0	1,7	2,0	1,9	2,1	2,1	1,0
	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Table 8.1: Number of Volvo cars manufactured (in 1000's) and the relative distribution of production by region 1987 - 1997. *Source:* Volvo (1998b)

In figure 8.4 below we can observe the chronological development of Volvo production plants for passenger cars. Bold lines represent integrated factories with body-shop, paint-shop and final assembly, the others are assembly units of knocked-down kits transported from Göteborg. Production was centered to Göteborg up until 1963 when the assembly started in Canada. In the following two years the main investments were made in the Torslanda plant in Göteborg and the Belgian plant in Ghent, which are still the two major production units within the company. The third most important location today is the NedCar factory in the Netherlands. This was originally a project between the Dutch producer DAF and Volvo in order to add a small car to the Volvo range, and started production of the Volvo 66 - model in 1975.

In 1991, Volvo made an agreement with the Dutch State and the Japanese company Mitsubishi to form a joint-venture (NedCar) in order to produce cars based on a common platform. This resulted in the new Volvo S/V 40 -series and Mitsubishi Carisma that was introduced in 1995.

The other Swedish factories besides Torslanda are interesting in relation to the forms of labour organisation which were used. Production in Uddevalla and Kalmar did not use the traditional assembly-line. In Uddevalla the manufacturing process was based on teams that assembled the entire car. In Kalmar the process of manufacturing was sub-divided in a number of stages in a semi-serial flow (Berggren 1998; Ellegård 1989; Ellegård, Engström et al. 1992). Both factories were closed in the early 1990's due to restructuring within Volvo. This might be seen as an indirect strategic decision in the favour of traditional assembly-line production.



Note: The Uddevalla plant is since the re-opening as AutoNova in 1996 a joint-venture with TWR, where Volvo has a 49% share.

Figure 8.4: Volvo production units for passenger cars 1960 - 1998. Included are both fully owned as well as joint ventures and subsidiaries. *Source:* Ellegård (1983); Volvo (1998a)

Since then the Uddevalla factory has reopened as the site for the Volvo - TWR (Tom Walkinshaw Group of the U.K.) project *AutoNova,* to produce the Volvo C70 sports-car. The production volumes have been low since the start in 1996 due to initial start-up problems, mainly associated with poor supplier-performance.

8.4 Volvo in 1997

The Volvo Group had almost 73 000 employees worldwide in 1997, of which the majority was within the passenger cars business area. Table 8.2 gives at hand that trucks and bus operations have grown over the last ten years while cars have seen a decrease in teh number of employees. The decrease between 1987 - 92 is a result of the concentration on core businesses where more peripheral activities have been discontinued. A further explanation might be a continuous increase in productivity.

	1987	1992	1997
Volvo Cars	34 050	28 450	27 920
Volvo Trucks	18 490	19 480	22 520
Volvo Buses	810	2 620	4 220
Volvo Construction Equipment	–	–	8 560
Volvo Penta	2 650	1 540	1 400
Volvo Aero	3 550	4 290	4 170
Other companies	6 500	3 740	4 110
Automotive operations	75 350	60 120	72 900
Discontinued operations	9 300	–	–
Group total	75 350	60 120	72 900
of which, in Sweden	55 440	39 130	43 650
outside Sweden	19 910	20 990	29 250

Table 8.2: Number of employees in the Volvo Group by product segments, selected years. *Source:* Volvo (1998b)

Besides the changing relative importance of business areas it is interesting to point to the continuous internationalisation of Volvo operations. Sweden accounted for almost 75% of the employees in 1987, a figure which has decreased to 60% ten years later. In terms of employees, the Volvo Group is on its way to becoming a company with its main activities outside Sweden.

The Volvo Group is organised in seven business areas corresponding to the areas in table 8.2 above. In the following we will concentrate on Volvo Car Corporation, and specifically on passenger car manufacturing and components which are organised according to figure 8.5 below. Under the area "car manufacturing" the four complete integrated production plants are listed, both fully owned and joint-ventures. To these can be added plants in Asia, Canada and South Africa (opened in 1999), that mainly assemble knocked-down-kits from Sweden and Belgium.

Within Volvo Car Corporation, the subsidiary Volvo Car Components is responsible for three areas of strategic components: engine, transmission and body-parts. These were all independent companies used by Volvo during the start-up period and later acquired.

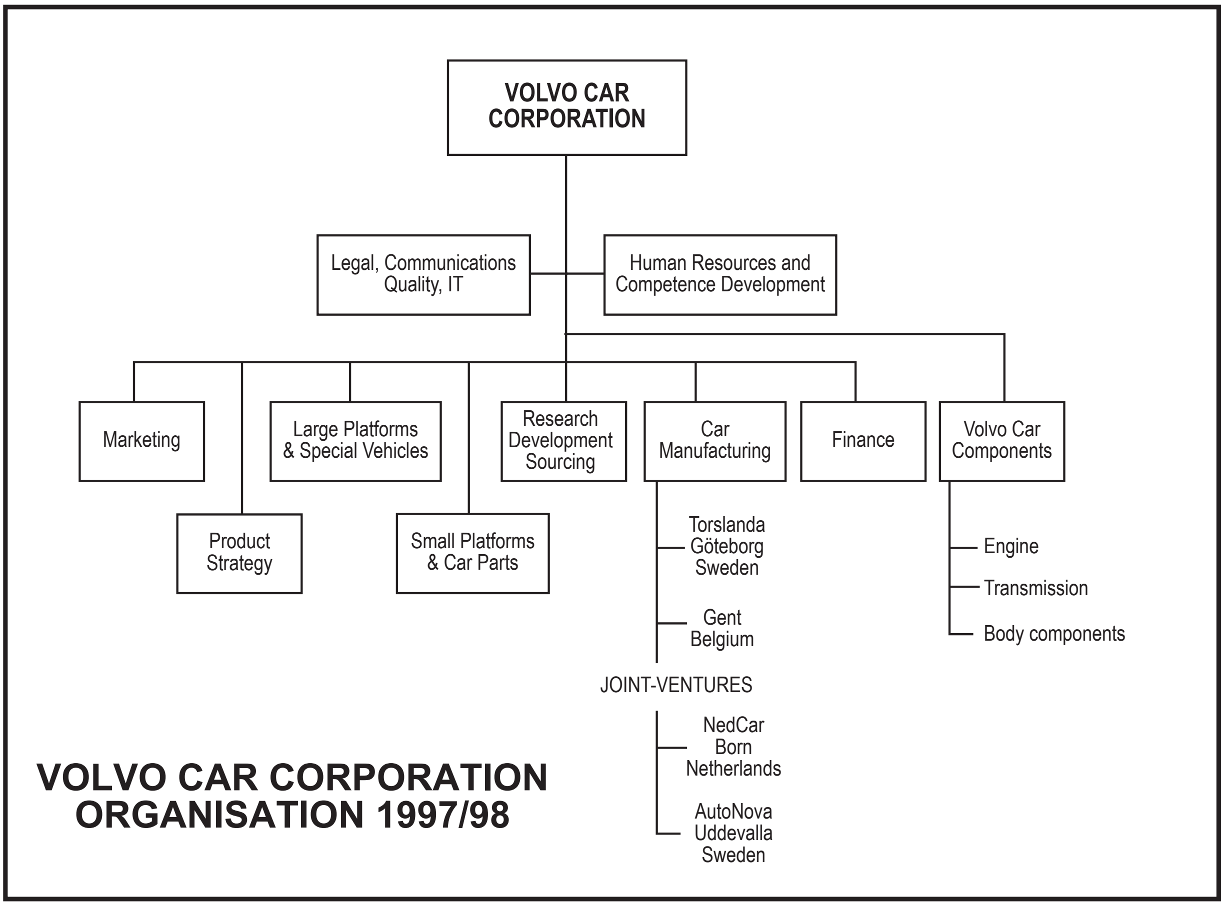
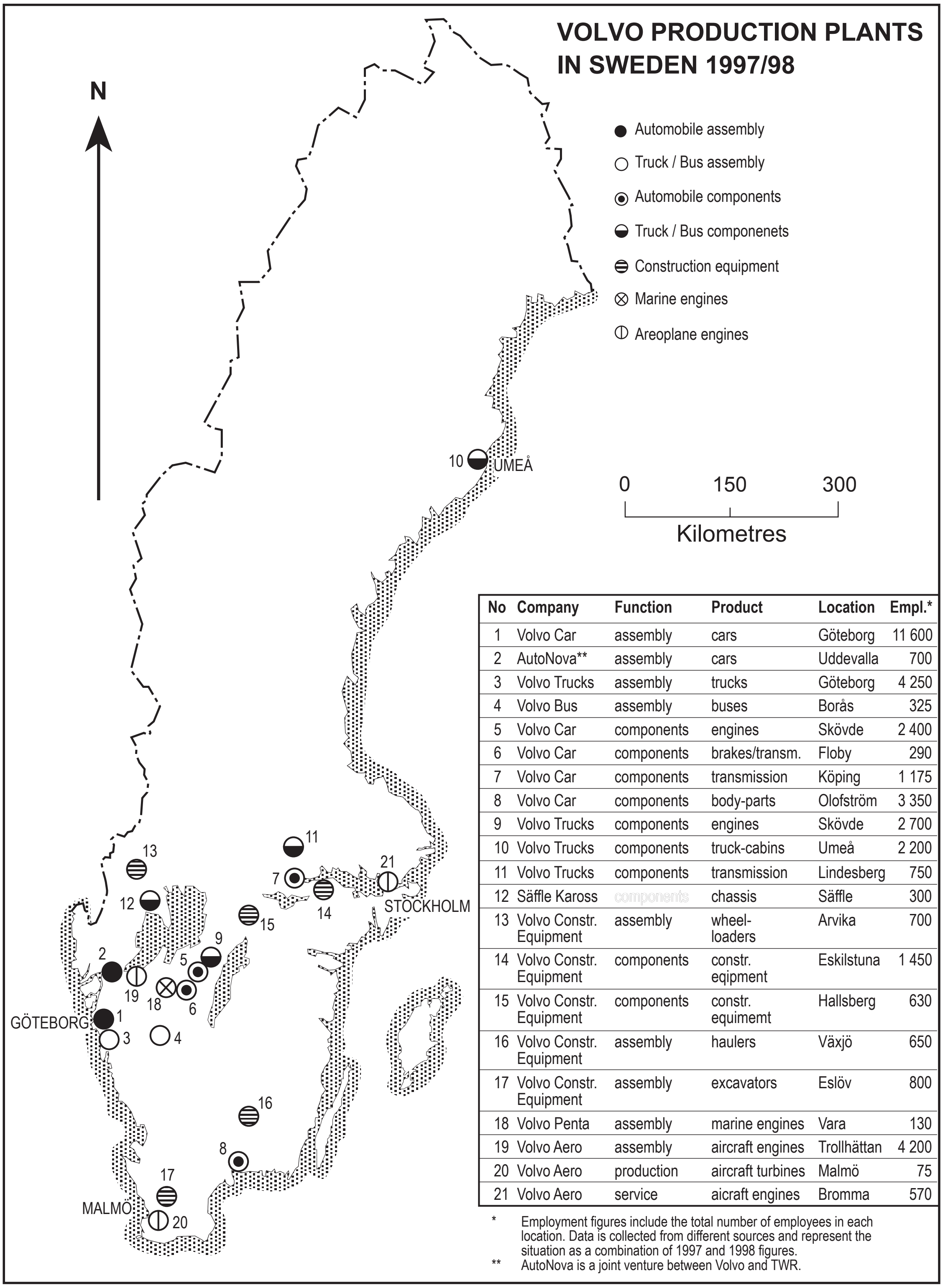


Figure 8.5: Organisation chart Volvo Car Corporation 1997/98.
Source: Volvo (1998c)



No	Company	Function	Product	Location	Empl.*
1	Volvo Car	assembly	cars	Göteborg	11 600
2	AutoNova**	assembly	cars	Uddevalla	700
3	Volvo Trucks	assembly	trucks	Göteborg	4 250
4	Volvo Bus	assembly	buses	Borås	325
5	Volvo Car	components	engines	Skövde	2 400
6	Volvo Car	components	brakes/transm.	Floby	290
7	Volvo Car	components	transmission	Köping	1 175
8	Volvo Car	components	body-parts	Olofström	3 350
9	Volvo Trucks	components	engines	Skövde	2 700
10	Volvo Trucks	components	truck-cabins	Umeå	2 200
11	Volvo Trucks	components	transmission	Lindesberg	750
12	Säffle Kaross	components	chassis	Säffle	300
13	Volvo Constr. Equipment	assembly	wheel-loaders	Arvika	700
14	Volvo Constr. Equipment	components	constr. eqipment	Eskilstuna	1 450
15	Volvo Constr. Equipment	components	constr. equimemt	Hallsberg	630
16	Volvo Constr. Equipment	assembly	haulers	Växjö	650
17	Volvo Constr. Equipment	assembly	excavators	Eslöv	800
18	Volvo Penta	assembly	marine engines	Vara	130
19	Volvo Aero	assembly	aircraft engines	Trollhättan	4 200
20	Volvo Aero	production	aircraft turbines	Malmö	75
21	Volvo Aero	service	aicraft engines	Bromma	570

* Employment figures include the total number of employees in each location. Data is collected from different sources and represent the situation as a combination of 1997 and 1998 figures.
** AutoNova is a joint venture between Volvo and TWR.

Figure 8.6: Location, function and number of employees of Volvo-owned production plants in Sweden 1997. *Source:* Compiled from: Volvo (1998b); Företagsfakta – business directory; Company interviews; Lorentzon (2000).

Figure 8.6 shows how Volvo's activities are concentrated along a line from Göteborg in the West to Stockholm in the East. The most important operations are the assembly plants for cars (number 1 on the map) and trucks (3) in Göteborg. Buses are assembled in Borås (4) east of Göteborg and the AutoNova factory is located in Uddevalla (2) just north of the Göteborg plant.

Components are centered at Skövde for engines to both cars and trucks/buses, while transmissions are located in Köping (7). Together with construction equipment components in Eskilstuna (13) they are still located in the *Mälardalen* region where much of the Swedish engineering industry has its roots, and Volvo originally had many of its important suppliers.

The most important internal suppliers within the passenger-car production are engines in Skövde, body-components in Olofström and transmissions in Köping. One important reason for their inclusion in the Volvo Group in the 1950's and 1960's was the need for control over strategic component production. This view is in opposition with modern ideas of outsourcing and concentration on core businesses within the automotive industry, a fact that is reflected in a continuous discussion within Volvo on further sales of component producers. A more detailed discussion on the development of the supplier structure follows in the next section.

Year	**1993**		**1995**		**1997**	
COMPANY	**vehicles**	**%**	**vehicles**	**%**	**vehicles**	**%**
General Motors	7 299 000	21,8	8 567 000	23,7	8 198 000	20,6
Ford	5 700 000	17,0	6 606 000	18,2	7 047 000	17,7
Toyota	4 450 309	13,3	4 556 333	12,6	4 889 955	12,3
Volkswagen	3 000 000	9,0	3 567 259	9,9	4 290 875	10,8
Fiat-group	1 600 000	4,8	1 740 000	4,8	2 886 200	7,3
Nissan	2 818 017	8,4	2 799 000	7,7	2 878 000	7,2
Chrysler	2 348 000	7,0	2 584 000	7,1	2 818 757	7,1
Honda	1 827 800	5,5	1 800 000	5,0	2 316 000	5,8
Mitsubishi	1 875 000	5,6	2 036 000	5,6	1 943 000	4,9
Peugeot-Citroën	1 751 600	5,2	1 867 800	5,2	1 803 733	4,5
Volvo	346 640	1,0	454 770	1,3	466 030	1,2
SAAB Automobile	71 000	0,2	97 300	0,3	105 100	0,3
Scania Trucks & Buses	25 170	0,1	46 460	0,1	48 200	0,1
Total World Production	33 438 000	100,0	36 215 000	100,0	39 753 000	100,0

Table 8.3: Production of motor vehicles by major companies world wide and Sweden, for selected years. *Source:* Bilindustriföreningen (1998)

This far we have discussed Volvo in a national context. To set the following case- studies in a wider frame of reference it is important to present some international figures for comparison. Table 8.3 presents production figures for the top ten motor vehicle producers in relation to Sweden and the world total.

In a global perspective Volvo is a small actor with only 1.2% of the world production in 1997. The ownership concentration within the industry has resulted in a situation where the top ten producers in the table account for 97-98% of the world production and independent producers like Volvo occupy marginal niche-markets.

The case of Volvo is still interesting as an independent marginal producer within a high-value segment and located in the European periphery in terms of both major markets and important suppliers.

8.5 Volvo supplier strategies

Since the start in 1926, Volvo has undergone a number of transformations in terms of supplier strategies, or at least what in hindsight can be interpreted as a strategic moves rather than short term solutions to practical problems necessary at the time (Kinch 1991). Following the classification made by Ellegård (1983) into different phases of development (see section 8.2) it is possible to group the changes in supply chain management practices into five stages.

During the *start-up period* in the late 1920's, Volvo had a clear strategy of focusing only on assembly and the use of outside independent and competing Swedish companies as suppliers of components (Kinch 1993). This has similarities with the much copied Japanese system of today with a high degree of outsourcing. The rationale behind Volvo's actions was mainly associated with the limited amount of capital available which forced the company to use outside suppliers rather that starting component production in-house in line with the North American model.

The following two decades can be termed the growth phase, in which increasing sales made the demand for components grow rapidly and Volvo took the first step towards vertical integration with the acquisition of AB Pentaverken in 1930. The company was the supplier of engines and did not have the capacity to invest and increase volumes independently. All other strategic components such as body and gearbox were still purchased from independent suppliers in Sweden.

Volvo experienced its most *rapid expansion period* in the 1950's and 60's. Production grew from 15.000 units per year in 1950 to over 220.000 in 1970, a change that naturally had a profound impact on supply strategies. Volvo continued to incorporate strategic suppliers and started their first own component production with the opening of Volvo Floby plant in 1958. Furthermore, Volvo started component production in both Bengtsfors and Färgelanda partly due to regional policy initiatives by the Swedish government.

The other major change during this period was the internationalisation process. In the early 1960's, the decision was taken to establish a final assembly plant in Ghent, Belgium. The main reason behind moving abroad was the fear of staying outside the newly created customs union in the EEC. Accordingly, the organisation of capacity in Belgium was followed by the search for local subcontractors to match the Swedish firms. In the 1960's for example, Volvo manufactured engines in France together with Renault and Peugeot. During the first ten years, the number of subcontractors increased in pace with the expansion of production capacity at both locations, but in the years 1972-82 the Göteborg plant stagnated in size while the assembly in Ghent expanded. Both these shifts in production capacity from Sweden to continental Europe contributed to a major change in Volvo's policy towards many domestic subcontractors, who were faced with the requirement to follow Volvo abroad in order to retain their contracts within the Göteborg assembly plant.

The stagnation of the car markets in the early 1970's was matched by a *period of diversification* at Volvo. Domestic supplier strategies were characterised mostly by the relative stability regarding restructuring, while on the international side there were a number of co-operation or merger projects launched during this period. The proposed merger between Volvo and Renault, that began to take effect during 1989-1993, also forced a major break-up of the subcontracting pattern due to the necessity to co-ordinate Volvo’s long-term product development with its larger, state-owned "fiancée". Even today, almost five years after the sudden divorce, it is still possible to trace several elements in the current supply-pattern of Volvo from the Renault period. Finally, the joint-venture starting in 1991 with the Japanese manufacturer Mitsubishi, concerning the common development in various aspects within the NedCar Corporation, can be seen to have affected the policy of suppliers to the S40/V40 model generation.

During the last decade we can identify yet another change towards *concentration on core activities* and restructuring of the automotive business. Many of the former Volvo-owned suppliers, have been sold and those remaining have been reorganised into Volvo Components Corporation, an independent subsidiary (see figure 8.5). Ideas regarding outsourcing have reduced the number of suppliers dramatically, which will be discussed in the following section. The present strategy within Volvo aims at reducing the number of activities not directly connected to the development and assembly of the car. This includes all internal component-producing units. The only exception might be the engine factory in Skövde due to its central strategic value for further product development.

Figure 8.7 presents the five stages as a circular process where the situation today shows a clear resemblance to the original ideas when the company first started its production. The rationale is to a certain extent the same, namely the need for capital. In the early days it was caused by the small size of business and today by the increasing costs for product development.

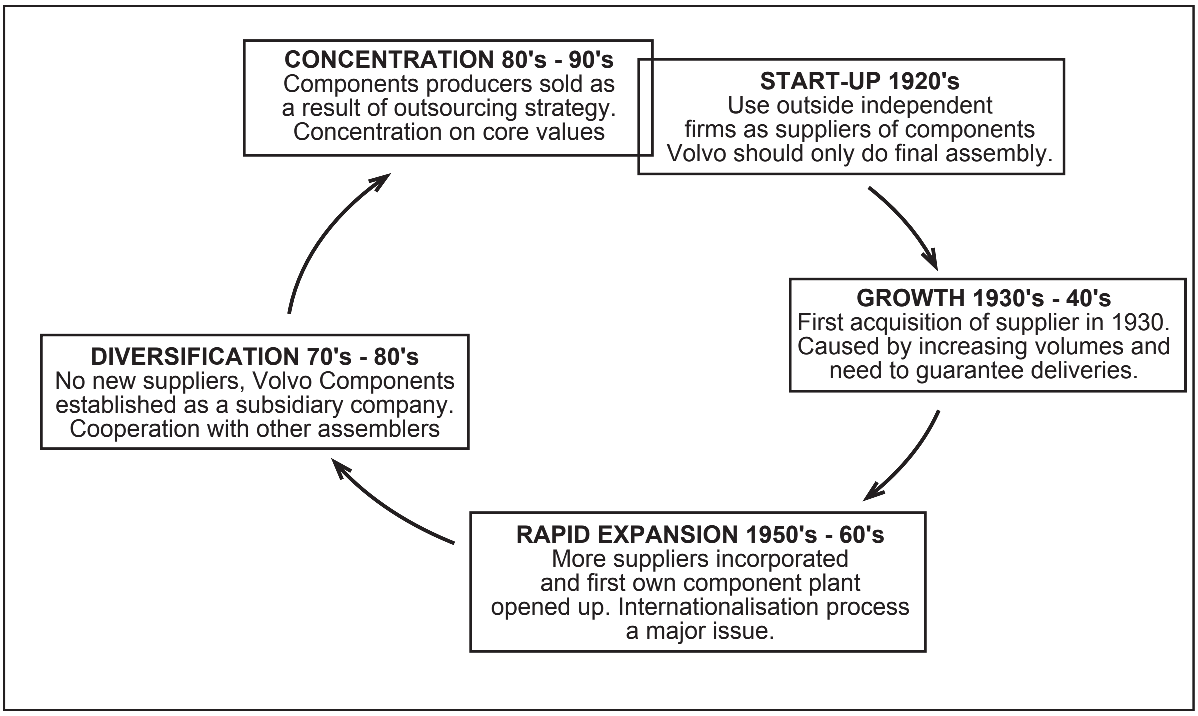


Figure 8.7: Summary of Volvo supplier strategies. *Source:* Based on Ellegård (1983).

Much of the content of the original, as well as the present supplier strategy has much in common with "Japanese production philosophy", characterised by a high degree of outsourcing and close co-operation with suppliers. One conclusion to be drawn is that Volvo's supplier strategies have undergone considerable change since the start, and that different approaches have been adapted in relation to the changing context.

If we look at the situation today we can see how the circle is closed and much of the modern supply chain concepts have striking similarities with the original strategy of using competent outside suppliers. In 1926 as well as in 1997 in global standards Volvo was a relatively small automotive company, where many suppliers overshadow Volvo in terms of size.

8.6 The structure of the subcontracting system for Volvo Torslanda assembly plant in Göteborg

As discussed above, we have witnessed a major restructuring process that has changed Volvo from a predominantly Swedish company into an international actor since the 1950s. This has affected the structure of the domestic supply-system towards more international competition. Even in the early 1960's, the Volvo Göteborg plant had almost half of their suppliers outside Sweden (Törnqvist 1963). Today, thirty five years later, the relative distribution is in favour of non-domestic suppliers, with only 43% of the companies located in Sweden. It has to be pointed out that these figures refer to the number of subcontractors, not the purchasing value, which probably would give an even higher share of foreign domination.

The most important change in the subcontracting system during these years is the number of companies involved in the process as first-tier suppliers. In 1960, more than 1500 companies delivered components to the Göteborg assembly plant, a number that has been reduced to just over 350 in 1997. This is a reduction in the magnitude of more than 75%. Table 8.4 below shows the geographical pattern of sourcing in terms of the number of suppliers in the early 1960's and in 1997.

This process is not confined to the supplier-assembler relationship. The formation of hierarchical production systems involve restructuring in the underlying tiers of suppliers as well.

	early 1960's		**1997**		**Change 60-97**
COUNTRY	**no. of suppliers**	**percent of suppliers**	**no. of suppliers**	**percent of suppliers**	**no. of suppliers**
Sweden	823	53	154	43	-669
Germany	217	14	91	25	-126
France	9	1	26	7	17
UK	224	14	25	7	-199
Belgium	4	0	16	4	12
USA	190	12	11	3	-179
Netherlands	5	0	11	3	6
Norway	37	2	8	2	-29
Denmark	33	2	7	2	-26
Switzerland	10	1	4	1	-6
Italy	1	0	3	1	2
Finland	6	0	2	1	-4
Others	7	0	17	5	10
TOTAL	1559	100	358	100	-1201

Table 8.4: Geographical pattern of subcontractors to Volvo assembly plants in Göteborg, early 1960's and 1997. *Source:* 1960, Törnqvist (1963); 1997, Volvo supplier-list.

The study by Törnqvist does not present figures on sales or firm size. These figures are available only for 1997 and summarised in table 8.5. The table indicates that the majority of the domestic suppliers deliver components within relatively low-tech sectors such as metals and plastics. This situation might become a problem in the upcoming restructuring process where many of these firms will not be able to take responsibility for the product development of large systems. If these firms want to continue in the automotive industry, they will probably have to act as second- or third-tier suppliers.

PRODUCT	Number of employees						
	1-19	20-49	50-99	100-249	250-499	500-	Total
Metals	8	11	6	13	7	5	50
Plastics/rubber	3	2	3	11	6	1	26
Chemicals/paint	5	4	4	2	1	0	16
System/module	0	1	2	2	1	3	9
Electronics	1	2	1	0	1	1	6
Textiles	1	0	1	2	0	0	4
Retail	0	2	0	0	1	0	3
Service	2	0	0	0	0	1	3
Other	1	1	4	0	4	1	11
TOTAL	21	23	21	30	21	12	128

Note. The difference in total number of subcontractors between tables 8.1 and 8.2 refers to 26 companies not possible to classify by product and/or size due to lack of data.

Table 8.5: Number of domestic subcontractors to the Volvo Torslanda assembly plant (Göteborg), by product category and firm size, 1997. *Source:* Data compiled by the author.

Besides the changes in absolute figures, we can observe how Germany, Belgium, France and the Netherlands have gained in relative terms. The most extensive losses can be assigned to Sweden, U.K. and the U.S. The relative growth of German suppliers is matched by the decrease of domestic subcontractors, while the growth in the other countries is linked to Volvo's production in Ghent (Belgium) and Born (Netherlands) as well as the remains of the Volvo-Renault merger project.

The geographical location of domestic suppliers for two time-periods is presented in figure 8.8 below. Volvo suppliers have historically been located in the southern half of the country, which is the most densely populated and industrialised.One of the most striking features of the maps is the decline in the number of suppliers between the early 1960's and 1997, although it has to be taken into account that the sources are different which permit only a general comparison between the two periods.

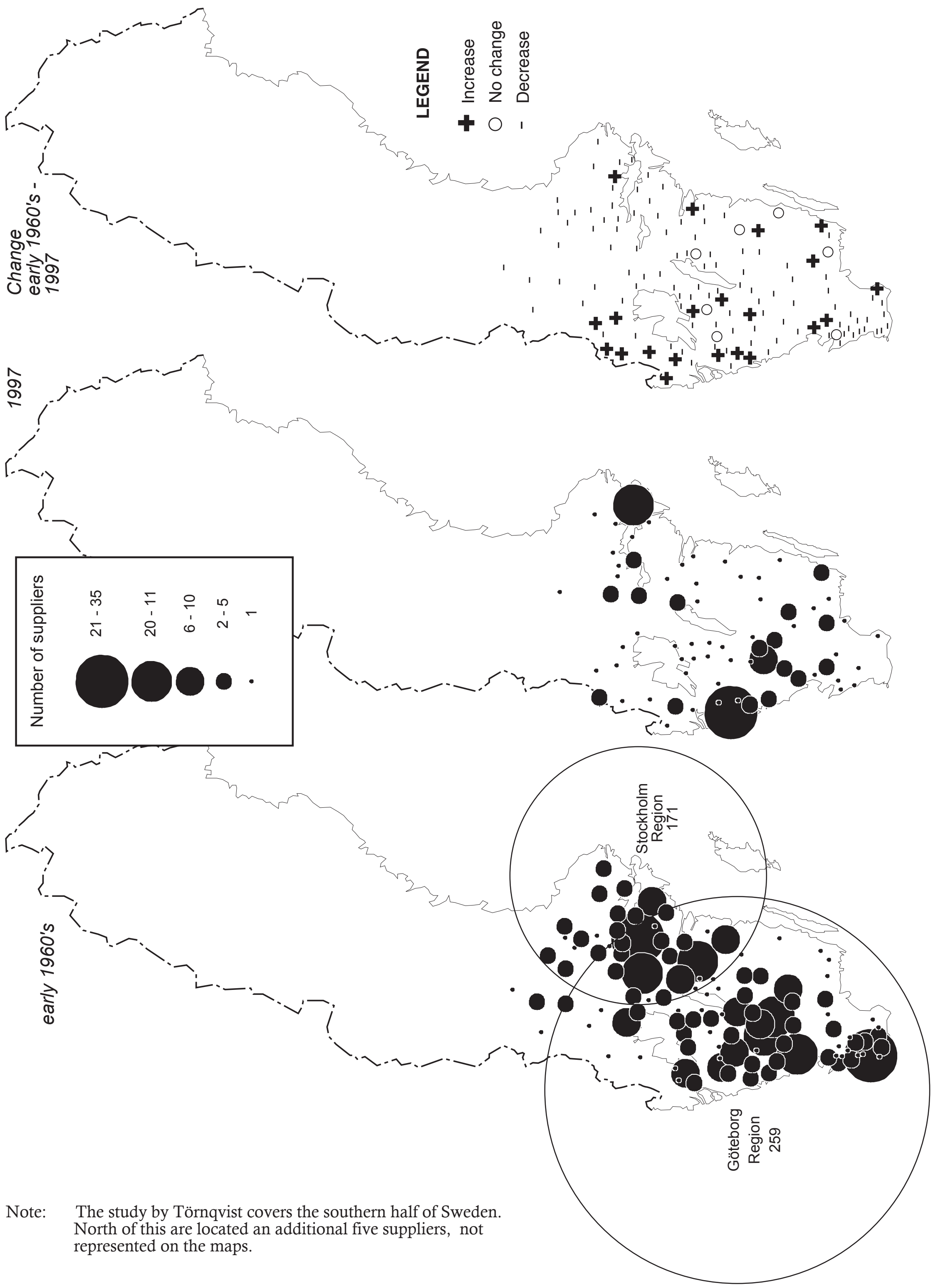
In the early 1960's, the Volvo passenger car assembly plant in Göteborg had over

800 Swedish suppliers. Except for Göteborg and Stockholm, there were three main clusters of suppliers. The South shows a pattern with many local administrative units (LAU's) having a small number of firms. Malmö is the only major center in the region. Central south-west, which is the traditional small-firm region holds a large amount of Volvo suppliers. So does the Mälardalen region, west of Stockholm with many of the early Swedish engineering companies.

All of these regions have lost suppliers during the period up until 1997. Mälardalen and the south of Sweden has decreased themost and hold only a marginal number of suppliers today. The South-West still has a number of suppliers but very few are among the most important in purchase value. The same goes for Stockholm which holds a relatively strong position in the number of companies due to its function as center for many head-offices and agents who do the actual production abroad and deliver either directly to Göteborg or via a warehouse in Stockholm.

The increase in suppliers for a number of LAU's north of Göteborg is mainly a result of new Volvo establishments during the 1960's when rapid growth and regional policy opened up for new greenfield investments in component production. Mapping the change between the two time-periods gives a relatively accurate picture of the regions of most importance for suppliers to Volvo Torslanda today.

The figure for Göteborg does not include the newly established supplier-park which would add another eight firms and further strengthen the importance of location in proximity to the Torslanda assembly plant. A further analysis of the figures show that there is a concentration of very small companies (1-19 employees) to the Göteborg region. Other suppliers in this segment are mainly agents or retail dealers with no production. Moreover, we can see how spatial concentration and links to Göteborg decrease with firm size. The exception is the size-category 100-249 employees where south-western Sweden has a clear domination. This might be explained by the fact that many of the traditional Volvo-suppliers located in the small-firm region of "Gnosjö", south-west of Göteborg is in this interval. Among the larger subcontractors there is no direct geographical pattern pointing towards agglomeration or dependence on Volvo and the Göteborg facility



Note: The study by Törnqvist covers the southern half of Sweden. North of this are located an additional five suppliers, not represented on the maps.

Figure 8.8: Geographical distribution of domestic subcontractors to Volvo Torslanda assembly plant in Göteborg, early 1960's and 1997, by local administrative units.
Source: Adaption of Törnqvist (1963:184) and Volvo supplier-database 1997.

8.7 Summary

From the time of its foundation in 1926, Volvo has grown to become the single largest company in Sweden in the end of this century. This development has gone through a number of phases including the major expansion period in the 1950's and 1960's when production could not match the demand and Volvo became the number one passenger car in Sweden.

This expansion was only partly driven by the domestic market. As early as 1962, Volvo opened up production abroad, followed by a new complete factory in Belgium one year later. These steps reflect the early importance of exports to markets inside the EEC. Export-orientation has been a major part of the Volvo strategy ever since the start, which is only to be expected given the limited home market.

The yearly production of around 375.000 cars accounts for just over one percent of the world production. This relatively marginal position in global terms puts Volvo in a situation where high development costs and increasing competition from larger firms allow for speculation on the need for future co-operative arrangements with larger producers. Up until now, Volvo has managed to finance the development of new models, although in the light of the latest S80-project, it is unlikely that upcoming models can be developed independently. The answer to this was the recent purchase of the entire Volvo passenger-car business by Ford.

Volvo has since the start used independent firms as suppliers of components. Some major suppliers of strategic components such as engine, body, drivetrain and brakes have been acquired into the company during the expansion years. This trend has changed during the last two decades and today we are facing a situation with a concentration on core activities such as product development and final assembly. The supplier base has changed according to this into fewer internal components producers and more outsourcing, a situation with many similarities to the strategy used when production started almost 75 years ago.

Due to its internationalisation strategies, the supply base has developed along with new factories in Belgium and Holland. Swedish suppliers have been able to internationalise by following Volvo into the European Union and others have been replaced by European suppliers. The main share of purchases today is made outside Sweden.

The Swedish situation is characterised by a geographical concentration to the south-west. Historically, Volvo had a large base of suppliers in the entire southern part of the country, with clusters in the traditional engineering industry regions as well as the small-firm region of Gnosjö. All of these regions have lost importance for Volvo, while others have grown. The main factors behind this restructuring process has to be found in the changing strategies within Volvo to minimise the number of direct suppliers and give more responsibility to those remaining. New demands on delivery and reliability have put tighter time- and quality constraints on the existing suppliers, which furthermore emphasises the concentration process.

9. Some general characteristics of the subcon-ractors to Volvo Torslanda

9.1 Introduction

The purpose of this chapter is to present some general characteristics of the most important domestic suppliers to the Volvo Torslanda assembly plant based on the 1996-97 investigation. The Volvo sample of 34 responding suppliers (if nothing else is indicated) is compared to other studies and official data in order put the current study into a wider context. Background factors such as firm size, products, sales and exports are presented.

Furthermore, the restructuring process within the supply chain is discussed. Emphasis is on the changing nature of products and its significance on the relationships between Volvo and its suppliers. The basic characteristics of buyer-supplier relationships in the Volvo-case are presented. Factors such as power-relations and the speed of restructuring are introduced as a general point of departure for the following, deeper penetration of the empirical material.

9.2 Firm size and location

The investigated suppliers can not be classified as particularly small. Only 10% have less than 50 employees. Almost 60% of the suppliers have more than 250 employees. This can be compared to a study of the entire Swedish automotive supply base conducted by the Swedish Industry Board (SIND) in 1990, where most firms are placed within the 20-199 interval, as presented in figure 9.1 (SIND 1990).

Employees	Count	Percent
0-19	0	0,0
20-49	3	8,8
50-99	1	2,9
100-249	10	29,4
250-499	12	35,3
500-749	5	14,7
750-999	2	5,9
1000-	1	2,9
TOTAL	34	100,0

Table 9.1: Volvo Torslanda suppliers by number of employees. *Source:* Author's survey

The SIND study was made in 1989 on a sample of 500 swedish subcontracting firms, where 212 had Volvo and/or SAAB-Scania among their customers. This was estimated to cover 60% of all domestic automotive suppliers. A comparison with the present study shows that only 17% of the Volvo-suppliers have less than 100 employees compared to over 50% for the 1989 study.

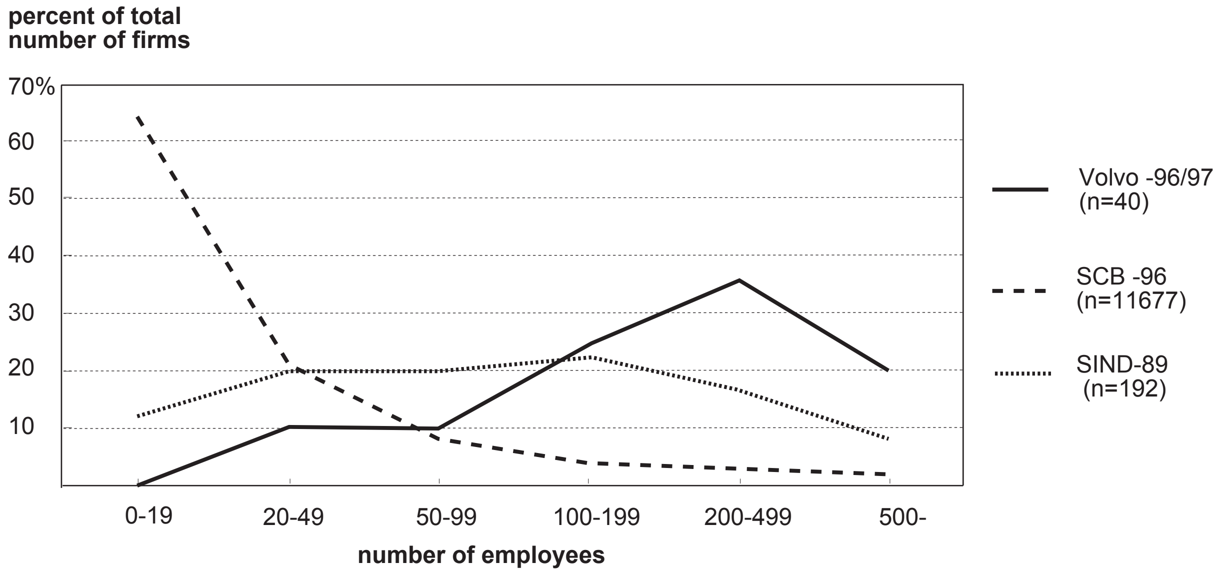
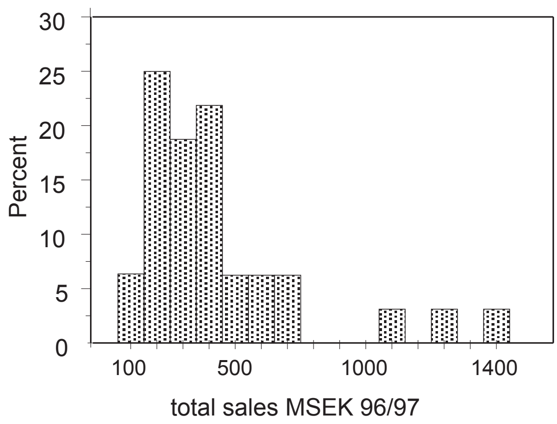


Figure 9.1: Size comparison between Volvo Torslanda suppliers 1996, the total Swedish manufacturing industry 1994 and the Swedish Board of Industry 1989 study of automotive suppliers. *Source:* Author's survey; SCB (1996) and (SIND (1990:31)

It is important to have in mind that these figures only represent the number of empoyees at the very plant where the Volvo components are produced. Many of these firms are parts of global corporations with more employees and financial resources than Volvo.

Figure 9.1 also gives an indication of the difference in size-stucture between the Volvo sample and the total manufacturing industry population. The relative distribution of firm size is almost the opposite between the two groups. Over 80% of the firms included in the total Swedish manufacturing industry statistics have less than 50 employees. One has to bear in mind that the data in this study covers the 40 *most important* Swedish suppliers in terms of purchase value, and there is a reason to believe that these firms will be relatively big in terms of employees.



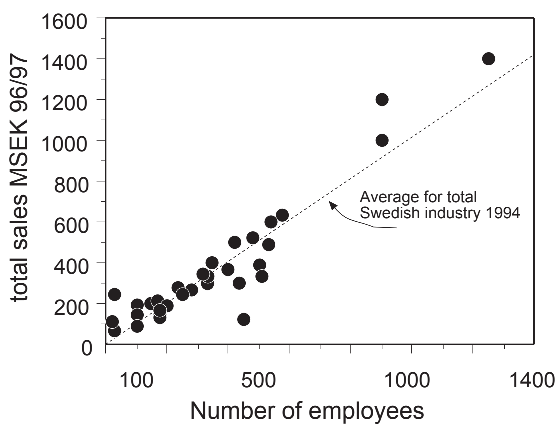


Figure 9.2: Left: Relative distribution of firms by total sales 1996/97 in million SEK.
Right: Relation between total sales (million SEK) and number of employees.
Source: (SCB 1995); Author's survey

Two thirds of the firms have total sales within the interval 100–400 million Swedish krona (SEK). These figures have no corresponding data in the SIND study. In order to position the Volvo suppliers in a wider context we will compare them with the sales for all domestic manufacturing firms.

The only available official data on sales are total figures on turover. From this it is possible to conclude that the average yearly turnover per emloyee in 1994 was SEK 1 million, which corresponds well with the Volvo suppliers as seen in figure 9.2-right. It is difficult to draw any far-reaching general conclusions from these figures, but the Volvo-suppliers do not differ significantly from the average Swedish manufacturing firm in terms of sales per employee.

One of the most discussed problems facing Swedish automotive suppliers is their inability to penetrate international markets and therby create the scale and technological competence needed to become a first tier supplier in the future (Braunerhjelm 1991). The suppliers were asked about the export-share of their automotive industry sales. Just over 10% indicated no export at all, this can be compared to the SIND study from 1989, where absence of export accounted for 29% of the firms. More than half of the Volvo-suppliers reported export-shares in advance of 20%, while the 1989 study has just over one quarter of the firms presented export-shares over 20%. The figures indicate that the largest Volvo suppliers today reported a much higher share of exports than the total Swedish supply base had in 1989.

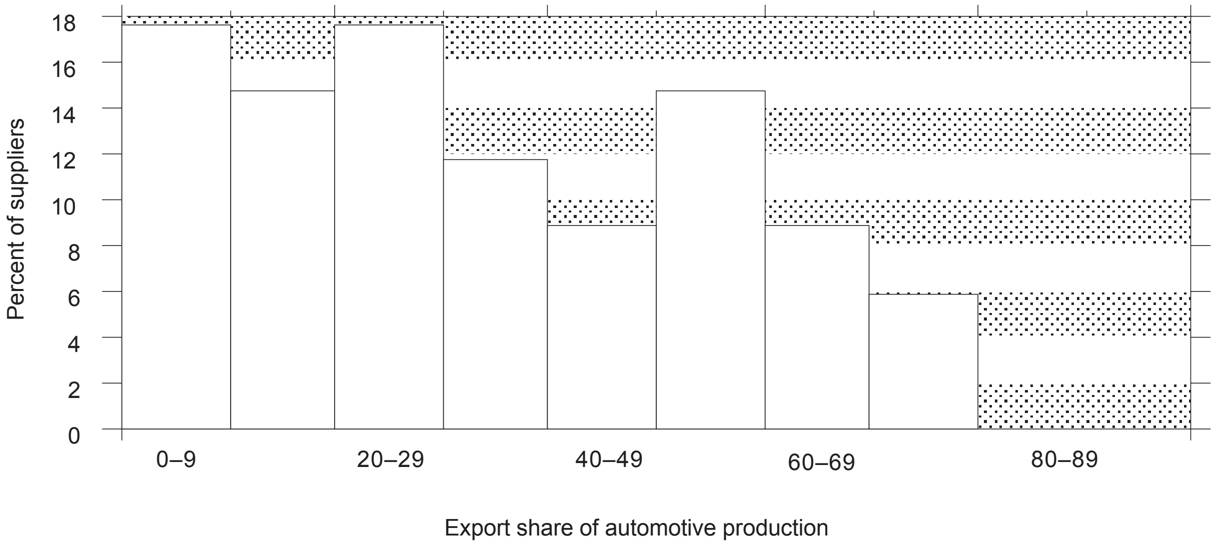


Figure 9.3: Volvo Torslanda suppliers' export share of automotive products 1996/97.
Source: Author's survey

One clear difference between the two studies is the fact that only 12 out of 212 firms in the SIND study had a foreign automotive-firm among their five most important customers. In the current study, around half of the firms have one or more foreign automotive suppliers as important customers. If we include Volvo Ghent as a customer, the share is even higher. Many of the large automobile producers are mentioned: General Motors, Renault, NedCar, Nissan and Volkswagen. Judging from the answers it appears as if the internationalisation process among the major Swedish suppliers started in the early 1990's. The Belgian production facility in Ghent provided many Swedish suppliers with an opportunity to follow Volvo into the European market, to learn and accumulate experience.

The location of the suppliers in the study is shown on the map in figure 9.4. South-Western Sweden accounts for the majority of the firms, with clusters in the Göteborg region, and in the traditional automotive supply region in Småland, south-east of Göteborg.

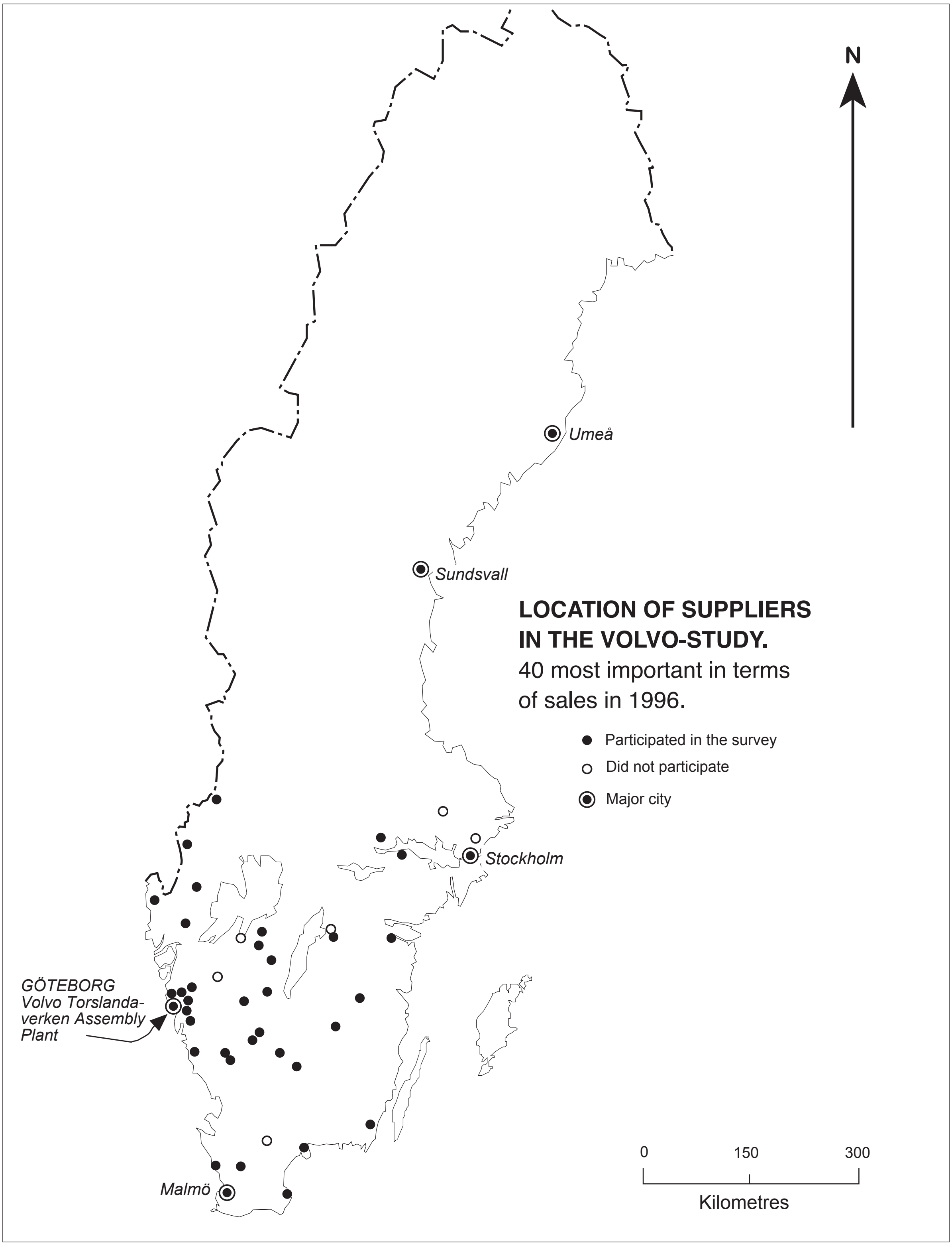


Figure 9.4: Location of the 40 suppliers included in the 1996/97 survey.
Source: Author's survey

9.3 Products

One of the problems that automotive assemblers and commentators continously points out is the low technological standard of the domestic suppliers. This is reflected in figure 9.5 where the absolute majority of the suppliers are found within the metals or plastics/rubber sector. The most important category is metal-working of different types, while more high-tech sectors such as electronics only stands for a small fraction.

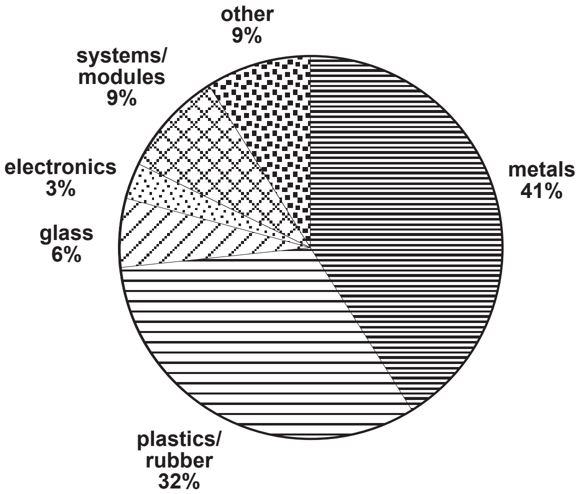


Figure 9.5: Suppliers to the Volvo Torslanda assembly-plant 1996/97 by product category. *Source:* Author's survey

These figures can be compared to the SIND study from 1989 where 15% of the automotive suppliers were categorized in plastics & rubber, 3% in textiles and 9% in iron, steel and metal-works. The categories are not totally comparable, but the general pattern points towards more plastics and fewer companies within the traditional engineering-sector.

If we look behind the traditional classifications and take into consideration the growing complexity of components, there are firms with relatively high technology products and processes. This is especially important among the "systems- or module suppliers" who integrate traditional metalworking, plastics moulding, textiles and electronic components into systems or modules.

Examples among the firms in figure 9.5 are *seats* where textiles and plastics, together with a metal frame and electronics for seat-adjustment, form a product characterised by realtively high complexity and technological content. Another example is *bumpers* where metal, foam and plastics are combined into a bumper. New models are also equipped with electronic sensors to measure the distance to objects in front of the veichle in order to avoid damage when parking.

Table 9.2 shows what type of components the suppliers produce for Volvo Torslanda. Suppliers of systems or modules which consist of several different types of components are presented separately.

metals	plastics & rubber	glass	electronics	modules/ systems	other
aluminum details	panels	windscreen	audio equipm.	seats	battery
sheet-metal details	tyres	windows		exhaust syst.	cables
cooler	acoustic details			bumpers	
gearshifts	panels			airbags	
fasterners	interior details				
tubes	tyres				
sheet-metal details	plastic moulds				
petroltank fastener	plastic/rubber details				
pedal boxes	plastic moulds				
pressed metal details	thightenings				
fasteners					
aluminium details					

Table 9.2: Products supplied by the largest domestic suppliers to Volvo Torslanda assembly plant in 1996/97, by category. *Source:* Author's survey

The products listed above are the most important in relation to Volvo Torslanda for each supplier. Judging from the table, there are very few products that can be regarded as high value, or forming the foundation for future development into new component systems. But this is a process which is currently in motion. Multinational supplier-groups, with a strategy to form system suppliers by incorporating several smaller domestic firms, have begun to have an impact on the traditional supplier structure. This trend is more pronounced in the period after the release of the S80-model in 1998.

Six of the plastics firms in table 9.2 are owned by two multinational suppliers. The U.S. global firm Lear Corporation has purchased domestic suppliers within the field of interior components in order to develop an interor module complete with their core product seats. Collins & Aikman, another global supplier-group, has a joint-venture with Perstorp Components within the field of acoustic details for reducing noise inside the vehicle. This development will most likely produce a couple of new system/module suppliers, and in the other end reduce the number of traditional first-tier plastics-suppliers. It is important at this stage to once more point to the fact that there are a number of Volvo-owned suppliers of body, engine and drive-train who are not included in the study. These firms are large and with a high level of technological development.

9.4 Customer relationships

The importance of Volvo as customer

Figures of total sales is one, rather general, aspect of the supplier structure. We have concluded that the selected suppliers appear to be bigger in terms of employees than the average manufacturing firm, but how important is Volvo as a customer? The trend in the direction of more dedicated system suppliers is often said to be closely associated with concentration and commitment towards a few large assembly-firms. If this is true for the largest suppliers in Sweden, the result would be a high share of sales directed to the automotive industry in general and the Volvo Torslanda plant in particular.

Share of total production	to the automotive industry (% of suppliers)	to the Volvo Group (% of suppliers)	to the Volvo Torslanda plant (% of suppliers)
0 -10 %	3	3	23
11 - 20 %	0	13	29
21 - 30 %	7	3	23
31 - 40 %	0	10	16
41 - 50 %	3	16	0
51 - 60 %	3	6	0
61 - 70 %	3	23	0
71 - 80 %	7	6	0
81 - 90 %	7	3	3
91 - 100 %	67	16	6
Total	**100%**	**100%**	**100%**

Table 9.3: Relative distribution of suppliers by share of production and customer.
Source: Author's survey

One conclusion from table 9.3 is that the suppliers in the study have strong relationships to the automotive industry; to a lesser extent to Volvo in general; and to a limited degree to Volvo Torslanda. In relation to the argument about dedicated systems suppliers, the absence of dedicated suppliers highlights the problem for a single assembly-plant such as Torslanda of attracting suppliers. The recent developent of the Arendal supplier park (se chapter 12) proposes one solution, with small satellite-plants where the final customisation and logistics are performed.

If we start with the importance of the automotive industry as customers to the Volvo suppliers in a general sense, it is evident that almost all of the firms sell the majority of their products to the automotive industry. Two thirds of the suppliers state that 80% or more is produced for the automotive sector, something that gives an indication of the importance of this particular industry as an "engine" behind the domestic supply base.

Volvo is a major customer, with 30% or more of the production, for 76% of the suppliers. This means that most suppliers are involved in manufacturing products for different Volvo companies such as engines, trucks and buses. One important aspect is that many of the Torslanda suppliers also have Volvo Ghent as customers and this normally involves the same products as in the case of Torslanda.

The picture for Volvo Torslanda is very clear, most suppliers sell less than 30% of their production to the plant. On the other hand, there are three extremely dedicated suppliers with almost all of their output to the one customer. Two of them are systems/module-suppliers with sequential deliveries to the Torslanda plant. This trend is increasingly important as a result of the development of the latest Volvo S80- model.

Dedicated subcontractors or independent companies?

Being a subcontractor or supplier, using the definition in this study, implies a certain level of dependence on the customer, since he is the actor who specifies the product for the supplier. As a result of this a subcontractor is always, by definition, producing specialized products for one (or many) individual customers. It means in practice that, for example, a component produced for the Volvo V70-model will not be able to be used anywhere else.

All of the Volvo suppliers in the study can be characterized as subcontractors with 95% or more of their Volvo Torslanda production being specified by the customer. This does not mean that all of the firms are totally dependent on Volvo for their survival (see table 9.3), but it gives an indication of the level of interdependence between Volvo and the largets suppliers.

Seen strictly to the Volvo Torslanda relationship, none of the suppliers are independent. They depend on the customer for product specification and production volume. But this is a far from straightforward relationship where the parent firm dictates without any influence from the supplier. The automotive industry in particular has witnessed a development towards cooperation in supplier relationships, as discussed in chapter four. This issue is more thoroughly discussed in the following chapter.

The pace of restructuring

One aspect of the restructuring of the automotive sector is the speed and dynamics of the changing supplier-base structure. At this introductory stage we will use the number of years as an indicator for the level of change. In figure 9.6 we can see how long the suppliers have been customers to the Volvo Torslanda plant. It shows that more than half of the suppliers have been working with Volvo since the Torslanda plant started its operations in 1962 and almost 90% have supplied for 20 years or more.

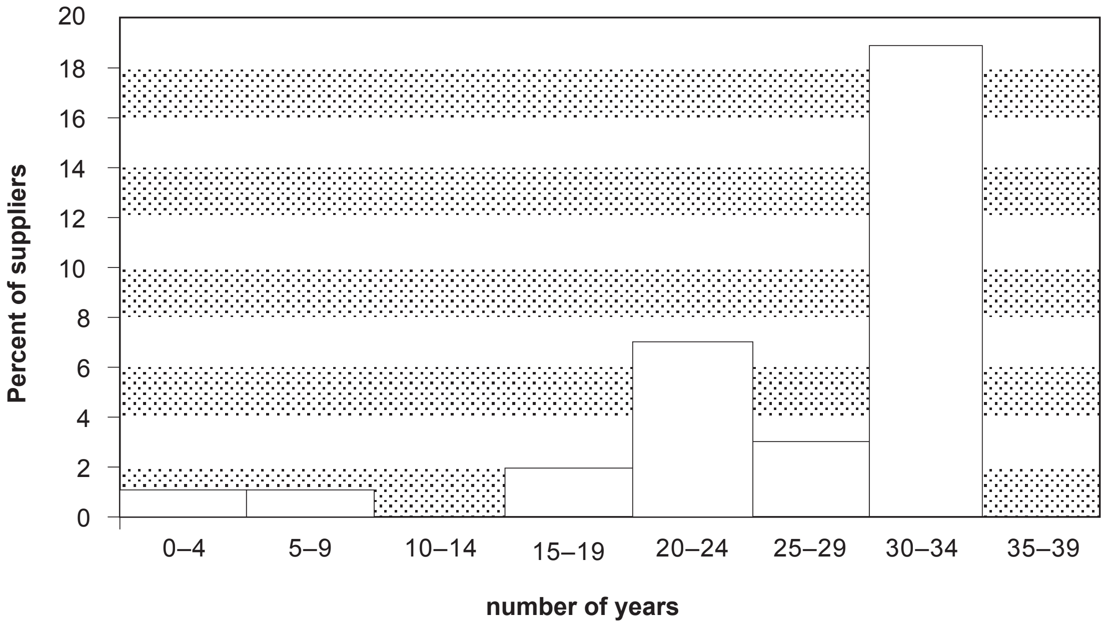


Figure 9.6: Number of years as supplier-plant to the Volvo Torslanda Plant.
Source: Author's survey

The conclusion is that the supply base is stable over time, but two of the most important systems suppliers are the two most recently established. It is important to notice that the figures represent individual plants and their relationship to Volvo Torslanda, not the entire company. The structural changes in the organisation of production will most likely influence the picture and gradually "rejuvenate" the supply base.

One explanation for the very stable supply base might be that Volvo, since the 1930's has used outside independent firms for a large part of the components. This has gradually fostered a subcontracting base with long-lasting relationships to Volvo. Another aspect of this is the fact that Sweden, with its relatively small industrial base, holds a limited number of realistic alternatives in most areas. The increasing globalisation of the automotive supply business, together with the Ford takeover of Volvo Automobile, will most probably make a significant impact on the traditional suppliers and the prerequisites for supplying Volvo.

9.5 Summary

This general overview of the suppliers within the Volvo Torslanda study can be summarised as follows:

- The majority (two thirds) of the Volvo suppliers in the study have between 100 - 499 employees. This implies larger firms than previous studies have estimated for the total automotive supply industry in Sweden. The suppliers in the sample are best characterised as medium-sized firms, rather that small firms.

- Two thirds of the suppliers have total sales of 100 - 400 MSEK. This figure has no corresponding data in any supply-study, but sales per employee equal the average for the total Swedish manufacturing industry.

- Half of the suppliers export less than 30% of their automotive production. The absolute majority of the exports are made to other Volvo production sites, mostly to the Ghent assembly plant.

- The location of suppliers is concentrated to the south-western part of Sweden. Two geographical clusters can be identified. One in the traditional automotive supply region in Småland in central southern Sweden and the other in the Göteborg region close to the Torslanda assembly plant.

- Two-thirds of the suppliers are within traditional, relatively low-value product segments such as metals, rubber and plastics. Only a few can be characterised as systems suppliers of complex products.

- Most suppliers in the study have the automotive industry as their main customer. Volvo is a significant customer for most of the suppliers although very few have Volvo as their only customer. This pattern is even more pronounced regarding the importance of Torslanda, where only two suppliers can be characterised as being dedicated to the Göteborg plant.

10. The organisation of production- and product development relationships

10.1 Introduction

This chapter will focus on the changing organisation of supplier relationships related to production and product development among the most important domestic suppliers to the Volvo Torslanda assembly plant. It will include aspects such as the degree of technological co-operation, outsourcing, different forms of production organisation and their connection to product and firm size.

Some major steps can be observed in the way that the automotive industry has changed the organisation of production, especially with respect to the supply-system. This is penetrated more thoroughly in earlier chapters, but can be summed up as follows:

- Increasing use of outsourcing and more responsibility for suppliers
- Products have become more integrated and complex, a development from single components to complete systems or modules.
- Closer co-operation between buyer and supplier.
- Formation of supplier-hierarchies.

These four aspects will be discussed and analysed in this chapter. A concluding discussion will relate to the vertical technological relationships-axis of the matrix presented in chapter 1.2. This framwork will be used to position the selected suppliers within the matrix on the basis of the empirical data in hand.

10.2 Level of supplier responsibility

As discussed in chapter nine, there is a long tradition within Volvo of using outside independent companies as subcontractors. This situation might pose problems when the current restructuring process forces former independent suppliers to work closer with Volvo and for example share information about product development or economic matters. This section will look into how far the trend towards integration and shared responsibility has developed within the Volvo supply base. The empirical data covers the period up until 1996/97, before the restructuring connected to the S80-model.

The point of departure is the traditional buyer-supplier relationship where the buyer dictated specifications to suppliers and selected through price-competition. What we could expect of the current situation is that product specification and development is performed jointly between Volvo and the suppliers, especially those with strategically important components. Figure 10.1 shows how the suppliers responded to the question about responsibility for purchasing/suppliers, product specification and product development, in their relation with Volvo Torslanda.

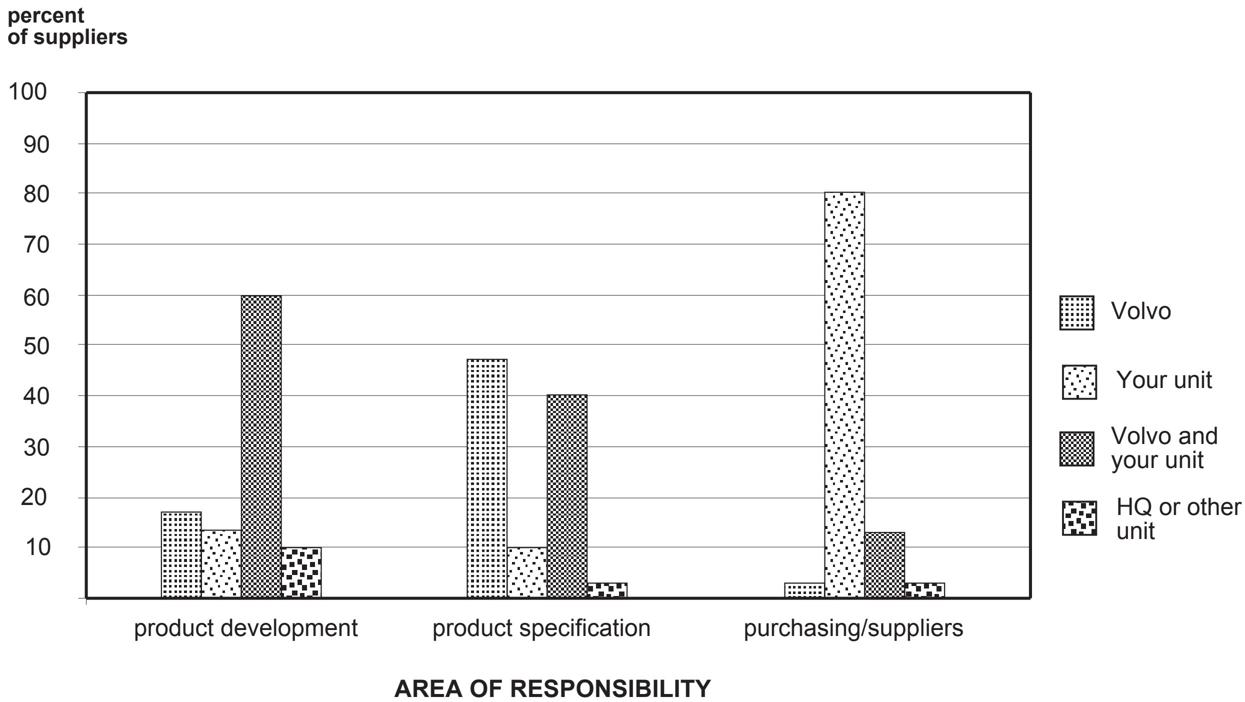


Figure 10.1: Distribution of responsibility in three different areas. *Source:* Author's survey

The expected pattern with a large amount of suppliers working in close relationships with Volvo can be found in product development where 60% of the respondents state that these questions are organised with mutual responsibility. This stands in contrast to the question about purchasing, where almost all of the suppliers indicated that responsibility for this function was placed at the local production unit alone. Product specification is an interesting question in terms of definitions, since traditional subcontracting relationships were based on the fact that the customer specified the product. The table shows that the traditional definition is valid for less than half of the suppliers today and that Volvo discusses specifications in 40% of the cases.

In the future we can expect that product specification will move in the same direction as product development, and become based on mutual responsibility to a greater degree. One of the reasons behind this lag in time is probably the fact that the models that were launched during spring 1998 were not incorporated in the answers. Many of the suppliers indicated during the phone-interview that product development of the new S80-model was built on joint discussions about specifications to a much higher degree than earlier. The fact that the product development function is the one with the highest degree of co-operation in this study, is most likely connected to the fact that it is affected by the upcoming model, due to its position in the beginning of the process of developing a new car.

The step following development, specifications and purchasing is the actual production of the automobile. Here it is possible to analyse responsibility in a more detailed way due to the fact that this is an area with clearly physical outcomes of integration ideas. In order to get a picture of how this is organised and to cover the development during the last ten years, the suppliers were asked to indicate one of five categories in figure 10.2 describing their product and the degree of responsibility for delivering complete systems.

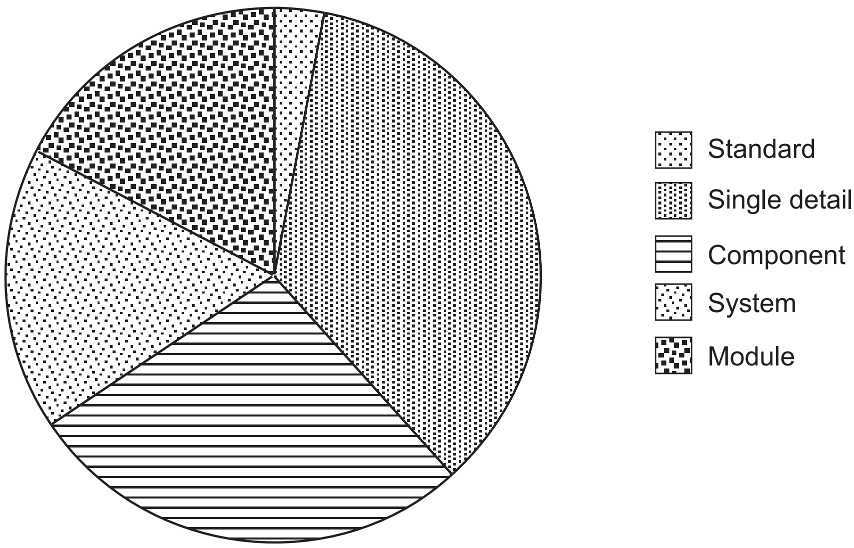


Figure 10.2: Distribution of suppliers by product category. *Source:* Author's survey

The figure shows that a relatively high number of suppliers report thaat they produce only single *details* for further assembly by Volvo. Examples of such are fasteners or other sheet-metal products. This might be characterised as the traditional form of relationship with respect to how much responsibility the assembler is giving the subcontractor.

Supplying several details assembled into a *component* is the next step on the "ladder of complexity". The component still is assembled by Volvo but the supplier has to organise the co-ordination of the details included in the finished component. Examples of these are products such as roof-rails or gear-shifts which are made up of several details depending on the model. This category accounts for almost 30% of the suppliers and together with the detail-suppliers cover over 60% of the firms studied

The next step is the major change from traditional subcontracting to co-operation and increased responsibility for development and production. Delivering a *system* is defined in the questionnaire/interviews as a number of details and components which form a system, ready to be assembled without any further handling by Volvo. This can be a complete exhaust-system with a catalytic converter or a wind-screen including sensors and heating channels.

In the last category we have producers of a concept or complete solution for a specific part or function of the car. These are termed *module-suppliers.* In order to achieve this, the supplier has responsibility for quality and deliveries, while product development is performed by the supplier in co-operation with Volvo. Examples of modules are painted bumpers with spoiler and fog-lights, complete colour-matched interiors or complete seats with safety devices ready to assemble.

The last two categories are not totally mutually exclusive, mostly because there is an ongoing restructuring process among the domestic suppliers where the aim is to create a few major module-suppliers. This positioning process creates a certain conceptual confusion and therefore the two last categories will be discussed together.

One third of the suppliers position themselves as systems- or module suppliers. Which might be taken as an indication of a future hierarchical structure of the system, such as a pyramid with a limited number of first-tier suppliers working in close co-operation with Volvo, followed by tiers of sub-suppliers. In terms of responsibility in relation to Volvo there is a clear link between product complexity category and level of responsibility, more complexity means more responsibility and a tighter connection to Volvo.

10.3 Changes in product complexity

In the chapter above we could see how changing responsibility and product complexity have produced a situation where different forms of supplier relationships are in use simultaneously within the domestic Volvo supplier system. According to theory we should expect a more clear-cut pattern, with a few big suppliers acting as direct suppliers of systems/modules with a base of suppliers underneath.

From the survey it is possible to analyse the dynamics of this restructuring. The suppliers were asked if they had moved between the categories in figure 10.2 during the last 10 years. Figure 10.3 below shows that half of the suppliers had experienced no change between product categories. These suppliers are mainly within the first three categories with a more traditional subcontracting relationship with Volvo Torslanda.

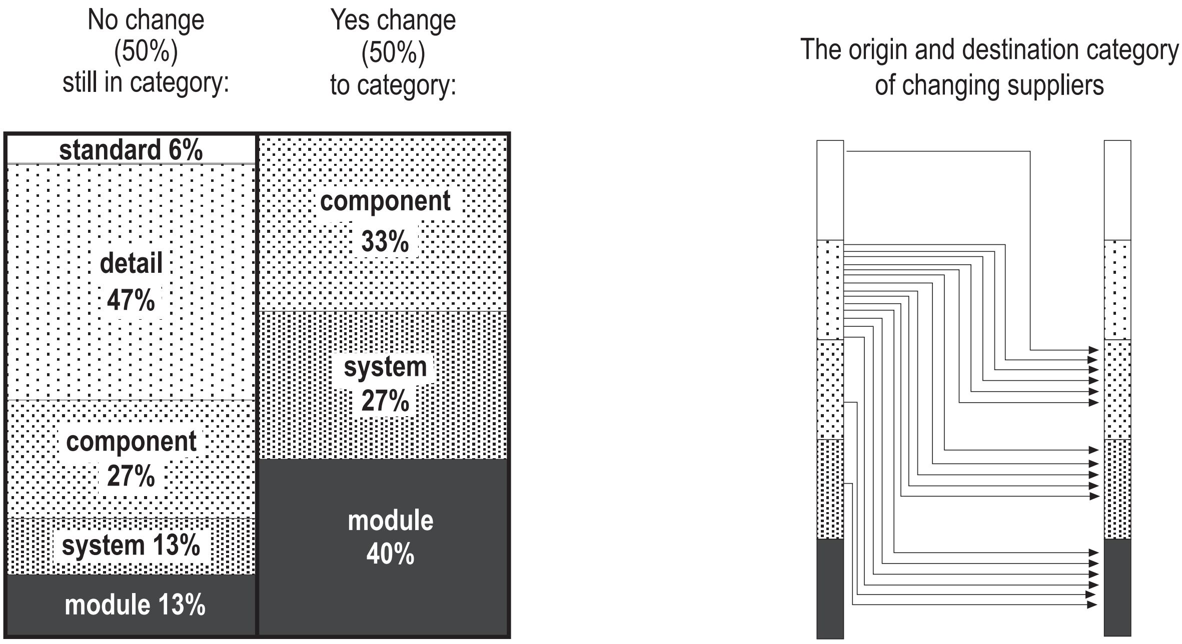


Figure 10.3: a) Percentage of suppliers per product complexity category and change between categories in the last 10-year period. b) Origin and destination of changes between categories. *Source:* Author's survey.

The suppliers who indicated a change are divided into their new categories in figure 10.3 a. In figure b it is possible to follow movements between categories for each of the 17 suppliers. It seems as if the big "upgrade" in terms of complexity in the last 10-year period has been from supplying single details to the more complex categories. The most striking change is the four suppliers that have gone from supplying details to becoming module-suppliers. This should be interpreted with caution since the module/system concepts are a bit ambiguous. If we look specifically at these four suppliers, it is possible to see that module is one of several product types which are manufactured at the same time. Three of the production units have been incorporated into large international automotive supplier corporations during the period. The general trend though is towards more complex products.

Complexity is a rather general term and gives limited help in gaining more specific insights into the product change during this period of restructuring. Relating to the general develpoment of the car as a product, one can expect that new materials such as plastics and electronic components have replaced much of the traditional metal components. Together with the increasing number of customer-ordered variants and colours, this has created a new context for modern suppliers.

The suppliers were asked if their products related to Volvo Torslanda had changed since they started their deliveries. As presented earlier, the majority of suppliers have delivered for 20-30 years, which make the answers cover a long time-period. The absolute majority (73%) of the suppliers indicated that their product(s) had become *more complex, in general.* Approximately 10% specified new materials as the major aspect of change, while a further 10% indicated no change. There is no direct relationship between firm-size and the type of change, which otherwise could have been expected due to a larger resource-base. This might be the case anyway because firm-size is measured at the respective production unit, which in turn could be a part of a larger organisation.

Judging from the telephone interviews, the term more complex is most commonly referred to when the product in itself is the same as 10-20 years ago. Gradual changes and upgrades have developed it into something which is "more complex" but not possible to relate to one single event or factor. The relatively low figure for new materials could be interpreted as an indication that domestic suppliers are active within predominantly low-tech sectors, that are not exposed to the current restructuring process to the same extent as the firms which choose to become system or module suppliers. There is no evidence for this thesis in the database, where the different types of suppliers discussed in figure 10.2 show the same general pattern.

10.4 Product development

One of the most commonly discussed aspects of the current restructuring process in the automotive supply sector is the increased share of outsourcing of both production and product development. In terms of production, it is clear from the previous section that the domestic Volvo suppliers have experienced a change towards more complex products and an increased level of responsibility.

The situation is somewhat different for product development. In terms of employees, only three production-units out of 33 indicated that they had 10% or more of their personnel occupied with product development as their main task. The same pattern occurs if we look at the share of total costs for Volvo Torslanda products that can be assigned to product development. Due to a general reluctance to report actual figures regarding development costs or investments, the respondents only gave an estimate, data is therefore presented in broad categories.

Almost 80% of the 28 answers had less than 10% of their total cost in product development and the other 20% followed in the next group with 10-25%. These are of course general figures but, together with the employment figures, it is possible to conclude that very few of the production units in the study can be characterised as having product development as the main strategy for future survival.

There is one major explanation for the relative lack of product development functions, namely the fact that many of the suppliers in the study belong to international companies with development facilities located elsewhere. Companies such as Lear, Valeo, Saint-Gobain and Pilkington do most of their basic development in their respective R&D-centres and the local Swedish supplier has only a limited function for the adaptation of the final product to Volvo.

Figure 10.4 below shows the extent of co-operative arrangements with Volvo during the product development phase and in the following process development phase respectively. The high degree of frequent co-operation during the product development phase might be an indication of a high level of joint-development with respect to new products. In this case the S80-project most likely has influenced this to a significant degree. But if we take into consideration the limited resources that the suppliers in the study report to spend on product development, the frequent co-operation could be interpreted as compensation for a lack of development capacity. Product development is most probably led by Volvo to a great extent, and smaller suppliers have engineers sitting inside Volvo in order to be close to the assembler during the product development process.

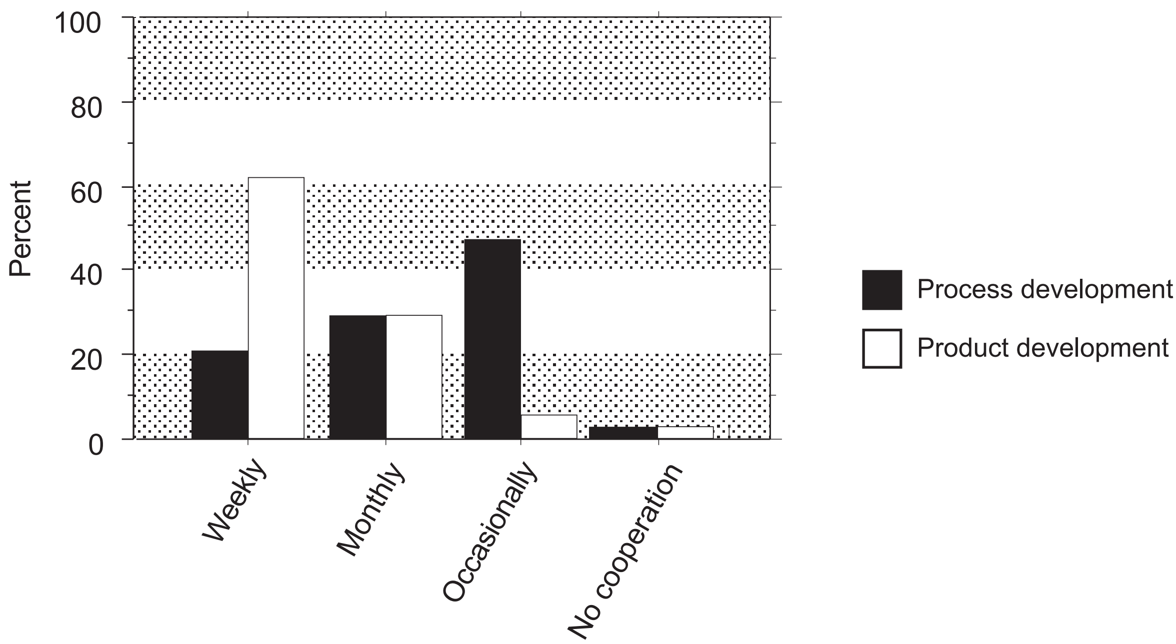


Figure 10.4: Frequency of co-operation between supplier and Volvo Torslanda assembly plant regarding process- and product development. *Source:* Author's survey

There is a clear pattern in the degree of co-operation between the product and process development phases. Process development is used here as a term to capture the process of fine-tuning product and quality issues, following the introduction of a new car model. It seems to be of less importance to co-operate with Volvo in these matters which might reflect the difference in need for face-to-face contacts during the different phases.

10.5 Ownership and power-relations

Outsourcing and the change of responsibility towards suppliers creates a new situation where the traditional buyer-supplier relationship is gradually changing towards a more network-like model. The more knowledge and competence that is transferred to suppliers the more *interdependent* the supplier relationships becomes. This is furthermore reflected in the constantly changing ownership structure where new constellations are growing rapidly in order to meet the increasing demand for financial- and knowledge resources. As many as 30 percent of the firms in table 10.1 had been acquired to some extent by a foreign company, mostly in the automotive industry.

Type of change	**Count***	**Percent**
Completely or partly *acquired* by a *Swedish* company	11	22
Completely or partly *acquired* by a *foreign* company	15	30
Expanded through acquisition of other *Swedish* companies	5	10
Expanded through acquisition of other *foreign* companies	2	4
Co-operation with other *Swedish* companies	2	4
Co-operation with other *foreign* companies	6	12
Other	1	2
No change	8	16
TOTAL	50	100

Note*: Each of the 34 respondents could answer with three alternatives if necessary.

Table 10.1: Changes regarding ownership and co-operation for the respective supplier production unit during the last 10-year period. *Source:* Author's survey

The figures in table 10.1 reflect the rapid restructuring phase up until 1996/97 when many traditional domestic suppliers were bought by international supplier companies. It is interesting to note that only 8 firms reported to have undergone no change. This process has created a situation where most suppliers are foreign owned to some extent. Figure 10.5 shows the home country of the mother company, or in the case of joint-ventures the location of the foreign partner.

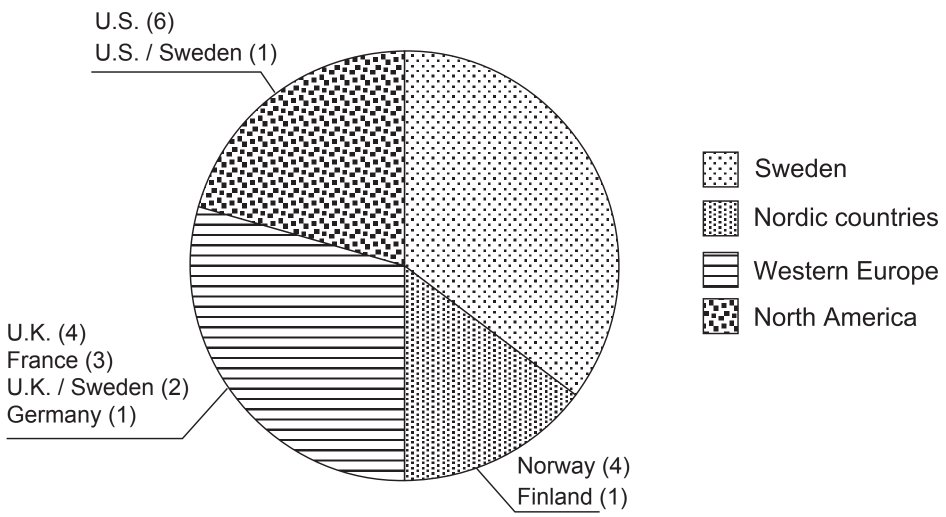


Figure 10.5: Geographical location of mother company for suppliers to Volvo Torslanda 1996/97. *Source:* Author's survey

Sweden still is the single most important country, but accounts for only 35% of the total number of suppliers in the study. Domestic ownership appears not to be directly linked to firm size. None of the Swedish-owned firms however, define themselves as systems/module suppliers which gives an indication that recent foreign acquisitions have had the clear aim of targeting strategic Swedish suppliers and form systems/module suppliers within the framework of an international corporation. It has to be said that there are foreign-owned companies among the suppliers that had undergone no change during the last 10-year period.

As seen in figure 10.5, it is mainly U.K. and U.S. firms that are behind the latest ownership restructuring phase. French- and German owned firms have a longer tradition within the Swedish automotive industry. This trend is even more pronounced in the development of the new supplier-park discussed in chapter 12.

Although ownership of the suppliers located in Sweden to an increasing degree is falling into foreign hands, there is still a relatively high degree of local influence and power over central functions. Figure 10.6 indicates that the local production unit is important in many areas. The production process is the most common function for local responsibility, while product development and marketing are handled to a higher degree by the central management, either in Sweden or abroad.

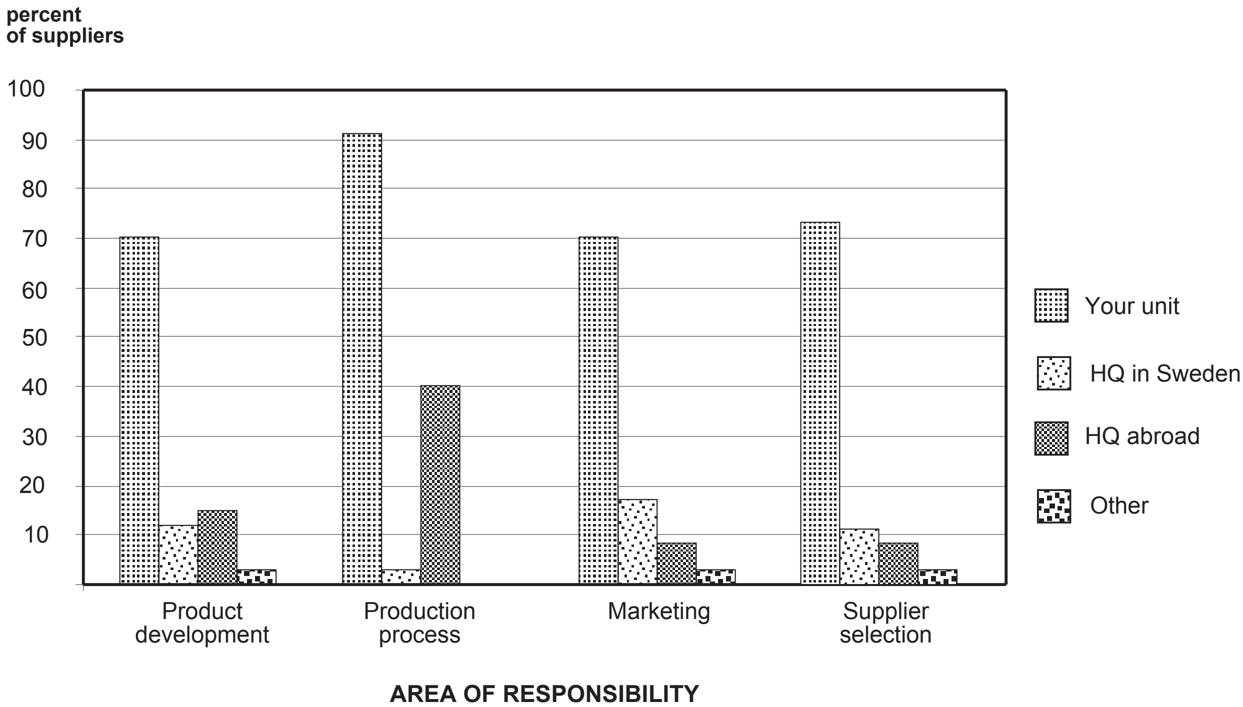


Figure 10.6: Location of responsibility for different functions among suppliers to Volvo Torslanda 1996/97. *Source:* Author's survey

The data in figure 10.6 displays the situation in 1996/97 and can be seen as a "pre-supplier park" stage where production is performed at the traditional location despite changes in ownership. The distribution of power and responsibility will most likely move more in the direction of R&D centres for the respective module-suppliers, as in the case of the new S80-model suppliers. The majority of these centres are located outside Sweden, although Hydro-Raufoss (see chapter 13) has invested in central development facilities in Göteborg.

10.6 Technological relationships and location

The presentation of the empirical data reveals the complexity of factors that influence how the Volvo suppliers located in Sweden organise their relationships with the Torslanda assembly plant. In this section, the spatial aspect is added. In order to link technological relationships and location, we will classify the suppliers into four groups depending on the characteristics of their relationship.

The starting-point is the assumption that co-operation between the supplier production-unit and Volvo Torslanda assembly plant regarding product and development questions is facilitated by geographical proximity. The degree of co-operation in the relationship is measured by a combination of the answers to four questions in the study:

1. *The degree of customer concentration.* This is measured by the share of production going to the Torslanda assembly plant, where a high degree of concentration is seen as an indicator of a close relationship where co-operation is important.

2. *Product complexity* is derived from the discussion in chapter 10.3. The suppliers are placed in one of the four product-categories: standard, detail, component or system/module. Standard products are considered as being the least co-operation dependent, while the complex systems/modules are seen as highly dependent on co-operative relations.

3. *Responsibility for product development.* This question indicates whether product development is performed jointly or separately. If responsibility for product development is split between the supplier and Volvo it is taken as an indication of a co-operative relationship.

4. *Responsibility for product specification* can be totally concentrated to the customer or to the supplier. Between these extremes are different forms of shared responsibility. Joint responsibility is seen as an indication of the importance of co-operation.

All of the suppliers have been classified based on the criteria above. The most co-operative type of relationship will be the production units with a high degree of customer concentration together with complex products and joint responsibility for product development and product specification. These are termed *integrators,* due to their function as organisers of sub-suppliers, reminiscent of a miniature assembly-firm.

The next category is distinguished from the above mainly through a lower degree of customer concentration and product complexity. Relationships are still built on co-operation with Volvo but production units are not totally dedicated to one customer. Suppliers in this category are termed *systems-suppliers,* based on their products which can be described as systems of components of strategic importance.

The largest group are the *specialist-suppliers* for accounting half of the firms. These production units are characterised by a diversification of the customer base and a tradition within a special product or process. The dominance of this group is partly explained by the fact that many firms may have co-operative relationships within categories 3 and 4, but products and customer concentration is less focused on Volvo only.

The last category are the suppliers with the least degree of technological co-operation in relation to Volvo Torslanda. They have the highest probability of becoming second- or third-tier suppliers in the current restructuring process. Many of these firms have Volvo Torslanda and the automotive industry as one of many customers. These supplier units are termed *traditional* suppliers due to their limited participation in the restructuring process towards more co-operative relationships.

In figure 10.7 the four supplier categories are presented. The size of the figure is an indication of the relative importance of each supplier-category. The figure shows that the domestic supplier-base was in the beginning of a restructuring process in 1996/97. Several different types were acting as first-tier suppliers simultaneously, something which is different from the hierarchical model where the first-tier is normally built up of integrators or systems-suppliers.

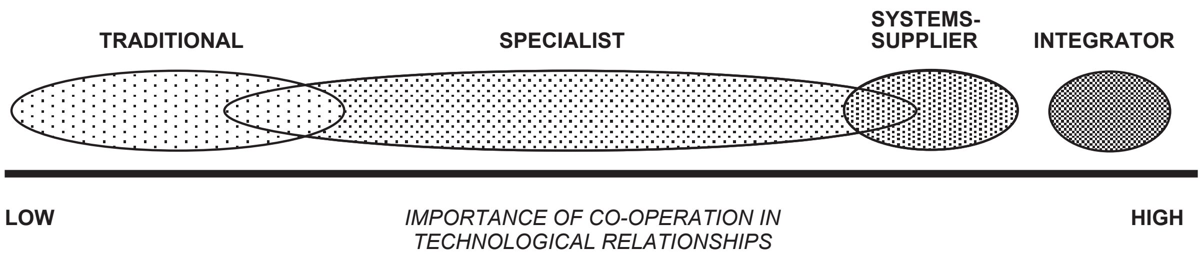


Figure 10.7: Classification of Volvo Torslanda suppliers according to the importance of co-operation in technological relationships in 1996/97. *Source:* Author's survey

It is important to remember that the objects of this study are individual supplier-plants, not entire corporations. This might lead to different interpretations and classifications in some cases. One example is customer concentration, where, on a global level, an integrator most likely will have a large number of different customers within the automotive industry. On the local level the same corporation can have a production-unit totally designated towards one customer. This is exemplified in the supplier-park case in chapter 13.

The recent debate within economic geography has focused on the relationship between learning and the importance of spatial clustering (see section 2.5). One basic line of argument is that the more complex the information the more likely that it needs to be communicated face-to-face. If we apply this to the suppliers in the study, it could be expected that the integrators- and systems-suppliers would locate closer to the customer than the others. This would enable them to make daily trips to Volvo and discuss product development problems in person, in cases where communications technology does not provide the tools needed or the information is unstructured and impossible to communicate without personal meetings.

One other aspect of the argument is that certain regions or places appear to attract information- and knowledge-intensive firms due to the local conditions or millieux. This should imply that the suppliers in the study would have more benefit from locating together depending on the complexity of the product and development process. One major objection to this is that all of the production units in the study do not perform product development at the place of production. This is true, but there are still important aspects of the learning-process connected with the local production, which can be characterised as non-standardised information, such as continuous quality improvement or new process technology tested on site. The data in table 10.2 gives an indication that the average distance to Volvo Torslanda increases with decresing importance of co-operation. It should be noted that there are a limited number of suppliers from which the average distance is calculated and the figures must be interpreted with caution.

Supplier category	Average distance in kilometers	Minimum distance	Maximum distance	Number of suppliers
Integrators	107	3	171	3
System-suppliers	136	15	263	4
Specialists	200	15	371	18
Traditional	180	15	367	9

Note: Distances calculated from tables provided by the Swedish Road Authority. The starting point is the nearest city/village and the end-point is Göteborg city center, except for one supplier located 3 kilometers from Volvo Torslanda Assembly Plant.

Table 10.2: Average distance in kilometers from suppliers to Volvo Torslanda by supplier category in 1996/97. *Source:* Author's survey; Vägverket (1985)

The map in figure 10.8 gives some evidence that there is a connection between more complex supplier-relationships and spatial proximity to Volvo Torslanda. Although half of the suppliers are located within 150 kilometers from the customer, there is a pattern within this relatively localised system.

Looking at the four factors behind the supplier-classification, the first two (customer concentration and product-type) seem to show a better correlation with distance compared to the others. The suppliers who indicated the highest share of sales to Volvo Torslanda are all located within the a 170 kilometre radius. The same pattern is displayed by the suppliers with the most complex product-type. One common denominator for the integrator- and systems-supplier units in 1996/97 was that they belonged to international corporations (Lear, Raufoss, Collins&Aikman) with a clear aim to be the leaders in the restructuring process. Their location are in most cases determined by the the traditional location of the aquired Swedish suppliers. Only in one case has production been established in the direct proximity of Volvo Torslanda.

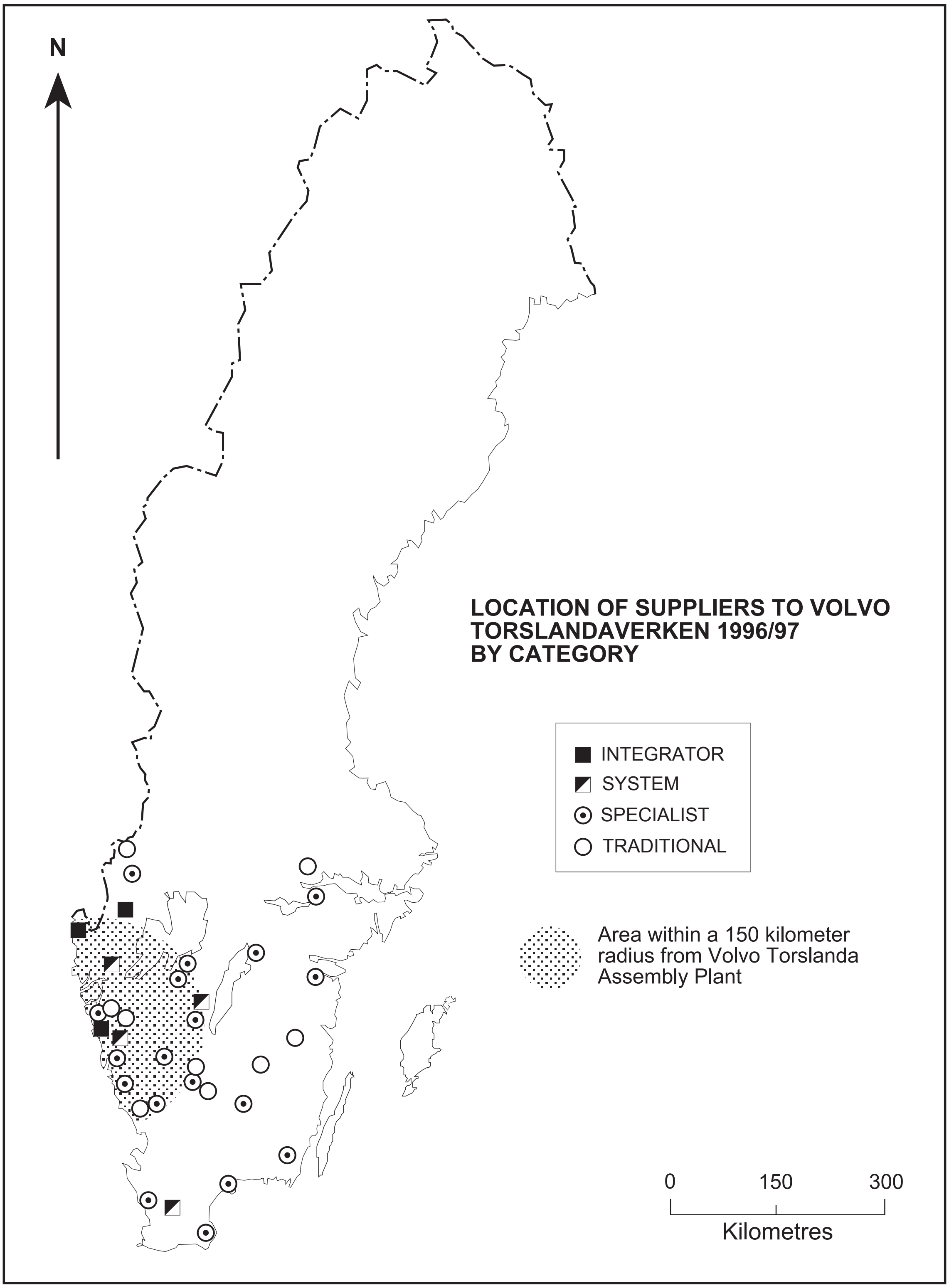


Figure 10.8: Location of suppliers by category. Grey area represents a 150 kilometre radius from Volvo Torslanda. *Source:* Author's survey

The tendency towards proximity of the integrators is clearer in the supplier restructuring process connected to the S80-model which is discussed in the next chapter. Based on the situation in 1996/97, it is not possible to draw any far-reaching conclusions regarding geographical proximity, although it can be noticed that the majority of the integrators and systems-suppliers are located north of Göteborg. This region has experienced a late development as a Volvo supply-region (see the discussion in section 8.6).

Regarding the second geographical question about the clustering of firms in regions where information- and knowledge exchange is facilitated through proximity, shared business-values and trust relations do not appear to be of any major importance in the case of Volvo Torslanda in 1996/97. The only cluster on the map is centered round Göteborg, but contains suppliers from all different categories with little or no incentive to co-operate, since their Volvo products vary in complexity to a significant degree.

10.7 Summary

The suppliers in the study constitute a heterogeneous group of companies with very different types of technological relationships towards the Volvo Torslanda assembly plant. It is not possible to find any clear indications of a hierarchical organisation, although a few international automotive suppliers have acquired domestic suppliers within strategic product-segments. This might be the beginning of a development towards a multi-tiered system. Since the data was collected in 1996/97 we have witnessed a major development towards a supplier-hierarchy in connection to the production start of the S80-model in April 1998 (see chapter 12).

- Co-operative arrangements are most common within product development, while the selection of sub-supplier is decided by the supplier to a high degree. The development process of the Volvo S80 model can have a high degree of influence on the answers.

- A third of the suppliers characterised themselves as systems- or module-suppliers. This could be taken as a first phase in the upcoming restructuring process. Of these firms, only three deliver modules or complex systems.

- Half of the suppliers had not experienced any major change in product complexity during the last ten years. The remaining 50% were mainly moving from detail-supplier to either components- or system-supplier.

- Almost two-thirds of the firms indicated that their products had become generally more complex during the last 10-year period, but only 10% specified new materials or electronics as major factors of complexity. This could be taken as evidence of the general low-tech level of Swedish automotive suppliers.

- Almost 80% of the answering firms reported less than 10% of their total cost as being related to product development towards Volvo Torslanda products.

- The ownership structure is characterised by a high degree of foreign acquisition, mainly from global U.S. and U.K. companies in the automotive sector. Only 30% of the suppliers were domestically owned.

- There is still a significant amount of power and independence linked to the local suppliers. This might change in a longer perspective if foreign owners decide to centralise R&D or marketing outside Sweden, and use local suppliers as "hollow" delivery warehouses.

On the basis of the importance of co-operation in relationships connected to production and product development, four categories of suppliers have been identified: integrators, systems-suppliers, specialists and traditionals.

There is a limited connection between geographical proximity and the supplier categories. Suppliers with more co-ordination-dependent activities are located closer to Volvo, compared to the others. There is no evidence in the study of any relocation connected to the degree of co-ordination towards Volvo on the technological axis of the supplier matrix.

11. The organisation of transport relationships

11.1 Introduction

The aim of this chapter is to analyze the development and significance of physical transport requirements and logistics factors on the spatial organisation of the suppliers in the 1996/97 study. Questions addressing transport and physical distribution are rarely treated with the same interest as organisational, technological or IT aspects in the economic geographical debate about supplier restructuring. This chapter will discuss physical coordination aspects as being of the same importance as technology in the geographical restructuring of supplier systems.

The discussion will be centered around aspects of "just-in-time" production such as: delivery frequency, lead-time and inventory levels. The geographical location of suppliers is analysed with reference to delivery frequency requirements. Furthermore, the organisational aspect of transports within the Volvo supply-system is discussed.

11.2 Delivery frequency and time-compression

One of the major effects of the use of JIT is the increasing frequency of deliveries. This is produced by a combination of minimal inventory levels and shorter lead-times in the manufacturing process. The suppliers in the study indicate, in figure 11.1, that the majority deliver once per day to Volvo Torslanda, while the ones with more frequent deliveries only accounts for some 20% of the firms. This provides us with a picture of the system before the major restructuring related to the S80-model. There are relatively few suppliers which can be characterized as having entered into a sequential JIT-arrangement, only 4 out of the 34 responding suppliers indicate such a situation.

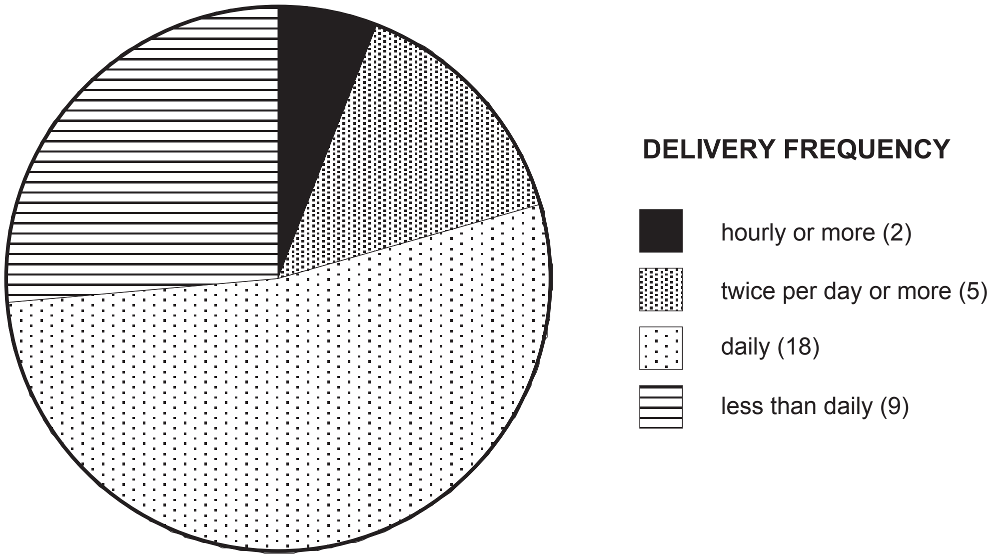


Figure 11.1: Relative distribution of suppliers to the Volvo Torslanda Assembly Plant 1996/97, according to delivery frequency . Figures in brackets indicate number of suppliers. *Source:* Author's survey

Sequential deliveries are a relatively recent phenomenon in the Swedish automotive industry, which explains its marginal importance. It is mostly assiciated with Japanese firms, primarily Toyota, which have used the concept since the 1970's in their Toyota City establishments (Sheard 1983). It has been transferred to North America and the U.K. via Japanese transplants and their suppliers (Mair, Florida et al. 1988; Jones and North 1991).

Given this "time-lag" compared to the major automotive regions regarding the use of sequential deliveries, it should still be noticed that the delivery-frequency in general has increased significantly in the last 10-year period. The figures in table 11.1 give an indication that 80% of the suppliers had experienced an increase in delivery frequency in relation to Volvo Torslanda. This is a significant development towards increased delivery frequency among the respondents, which is even further underlined by the fact that none of the respondents reported any decrease in delivery frequency.

The answers are based on the respondents' understanding and knowledge of the situation in their Volvo-relations during the last decade, which may lead to a certain degree of "guess-work". In this case though, was relatively easy for the suppliers to compare number of deliveries per week over the last ten-year period. The degree of change in presented in table 11.1.

Degree of change in delivery frequency	Count	Percent
Large increase	15	45
Increase	11	33
No change	7	21
Decrease	0	0
Large decrease	0	0
TOTAL	33	100

Table 11.1: Relative change in delivery frequency in the last 10-year period for suppliers to Volvo Torslanda in 1996/97. *Source:* Author's survey

To complete the findings on physical delivery frequency, the suppliers were asked to state the general "time-window" allowed by Volvo from order until the delivery is ready for assembly. This question was only answered by half of the respondents, mostly due to the fact that the question was seen as too general and irrelevant in relation to the daily operations. From the answers given is it possible to see that 48 hours is the most common time-demand.

One aspect of just-in-time production is the focus in inventory reduction This has two main aims, firstly to minimize the capital tied up in components and secondly to eliminate buffer-stocks to visualize problems in the production process and put the focus on product and process quality.

From the literature on JIT and supply-chain management one should expect a general decrease in inventory levels for suppliers, both for incoming components as well as finished products. Many commentators have also pointed out that JIT-production is almost exclusively initiated and introduced by the parent-firm, with an intent to push the responsibility and cost for inventory upstream in the supply-chain. This problem has not been treated directly in the study, but there is indirect evidence that this might be the situation in some of the cases.

We will start by examining inventory levels for incoming materials and finished products. The figures are estimated by the respondents during the phone interview, for those who only replied in writing there are no details regarding how the figures were obtained. Figure 11.2 indicates a significant difference in inventory levels between incoming components and finished goods. Almost two-thirds of the respondents reported to have less than a week's demand of finished goods in store, some had less than one day,s demand while the majority indicated 2-4 days.

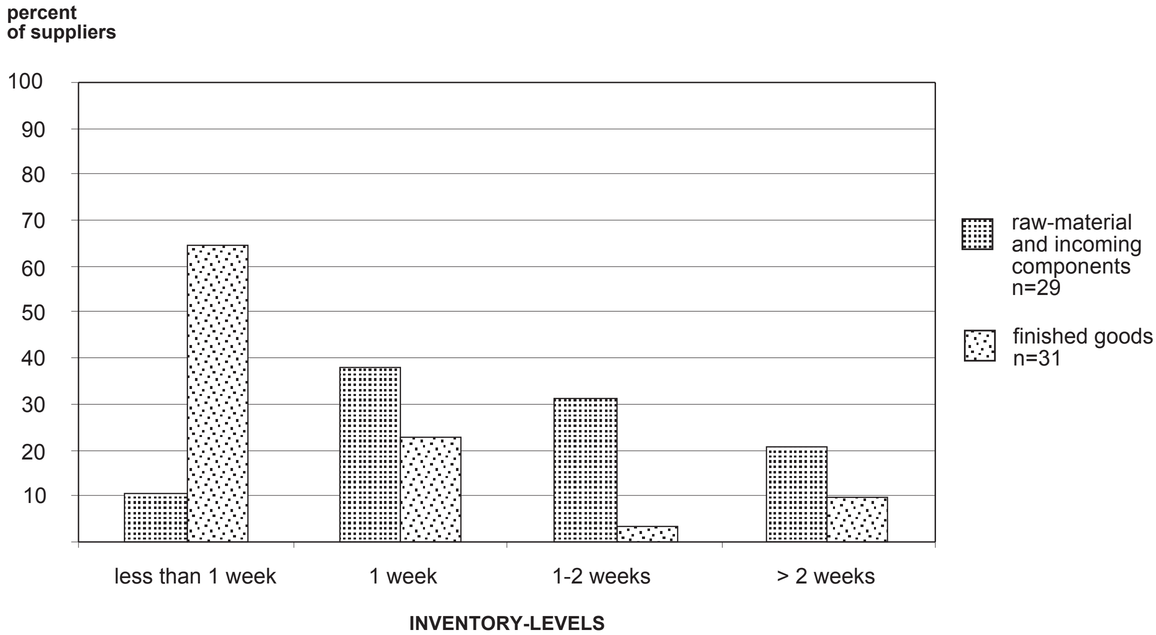


Figure 11.2: Average inventory-levels counted in days of production for most important raw-materials/incoming components and days of finished products for deliveries to Volvo Torslanda 1996/97. *Source:* Author's survey

The situation regarding incoming materials shows a more evenly distributed pattern, except for the first alternative where only ten percent indicated less than a week's inventory. There is not the same direct connection between the most delivery-intensive suppliers and the extent of raw-material inventory levels as there is regarding finished products.

One explanation might be that the tight time-restrictions for these firms have forced them to have at least one week of incoming components as a buffer in case of delivery problems. This can be interpreted as a sign that JIT-production has pushed the inventory from Volvo towards the suppliers. This is even more accentuated when looking at the delivery frequency for suppliers to the firms in the study. Of the 30 suppliers which answered, 40% stated that their most important suppliers delivered weekly. This should be compared to the fact that the majority of suppliers deliver daily to Volvo. The average delivery frequency to Volvo is 8.1 times per week while incoming materials averages 3.2 deliveries per week. In the case of sub-supplier deliveries, the figure is an average of the most important and can contain single examples of high-frequency deliveries. There is a significant difference between the figures which reflects a situation with considerably tighter time-constraints on deliveries to Volvo, than between suppliers and sub-suppliers.

This difference can not be linked entirely to JIT-deliveries and time-demand. A certain difference in inventory and delivery frequency can be expected in the supply chain due to the production process. Depending on product there might be certain technical limitations to time-compression. But judging from examples in the newly established supplier-park at Arendal, the new type of module suppliers use steamlined production processes, leaving time-consuming activities to second- or third tier suppliers.

The suppliers were asked to state if their inventory levels had changed in the last 10-year period. This is a very complex question due to many factors. Inventory levels may have increased in absolute terms during the period due to more production, while it might have decreased in relation to the total production.

Degree of change in inventory levels	**Incoming materials**		**Finished products**	
	count	percent	count	percent
Large increase	0	0	0	0
Increase	3	10	2	6
No change	7	23	9	27
Decrease	17	55	19	58
Large decrease	4	13	3	9
TOTAL	31	100	33	100

Table 11.2: Change in inventory levels in the last 10-year period for suppliers to Volvo Torslanda in 1996/97. *Source:* Author's survey

One further source of bias is that figures are based on the respondents estimations of the inventory levels. This might have been influenced by the fact that minimized inventory is one important feature of the just-in-time philosophy and that the respondents wanted to present a positive image of their business. In spite of my assurance of independence, some of the suppliers might have seen the questionnaire as a check-up on the supplier from Volvo.

Having this in mind, we might not draw too generalized conclusions, but still observe that the absolute majority of suppliers have experienced decreasing or stable inventory levels during the period. Only about 10% indicated increased levels, which in most cases was explained by a rise in production volumes.

On a general level it might be concluded that most suppliers have been influenced by the rising demand on delivery put forward by Volvo. The situation in 1996/97 can be characterised as a "relaxed" form of JIT with the absolute majority delivering daily without sequential arrangements. There are only a few suppliers with true just-in-time relations with Volvo. This changed rapidly when the production of the S80-model started in 1998, and as many as eight large suppliers started to deliver in sequential JIT to Volvo, more on this in the following chapters.

11.3 Delivery frequency and geography

This section will analyze the relationship between delivery frequency and location. The hypothesis is that the higher the frequency the more important is the geographical and temporal proximity in order to minimize transport costs and maximise reliability.

The suppliers are categorized into four groups, according to their delivery frequency and involvement in sequential deliveries.

1. Suppliers doing *sequential deliveries* need to adjust their production according to the sequence of bodies on the assembly line at Torslandaverken. This implies short lead-times from the finalised production order at Volvo until delivery, the degree of reliability in the transport is very high.

2. Non-sequential, but frequent deliveries *more than daily* indicate a need for a high degree of co-ordination between the supplier and Volvo.

3. *Daily deliveries* is the most common type of situation. This is termed *relaxed-JIT*, due to the presence of a general aim in the direction of just-in-time production.

4. Suppliers delivering *less than daily* is considered to have less need for a co-ordination of physical supply.

The findings from the map regarding the geographical pattern of delivery frequency shows that suppliers using sequential or frequent deliveries are all within or at the border of a 150 kilometre radius. This distance provides a maximum of two hours driving-time, which has to be pointed out, is a very relative measure depending on geographical and infrastructural conditions. Being able to drive with an average speed of 70 km/h is a possibility on Swedish roads with low traffic volumes and few urban areas to cross. The situation in Japan is in many cases the total opposite, with lorrys waiting in heavy traffic on narrow roads in urbanized areas (Sheard 1983; Kalsaas 1995; Hayter 1997).

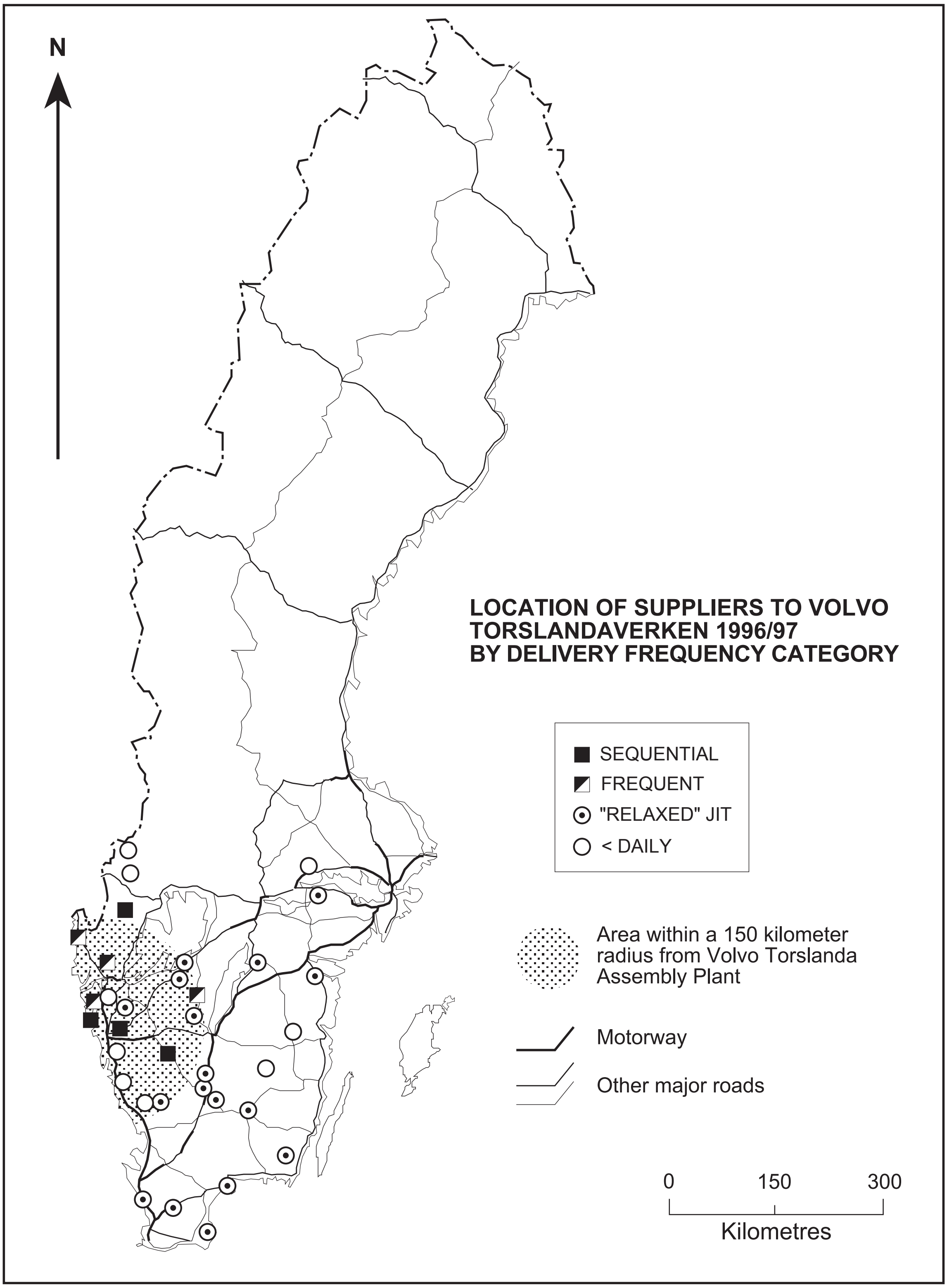
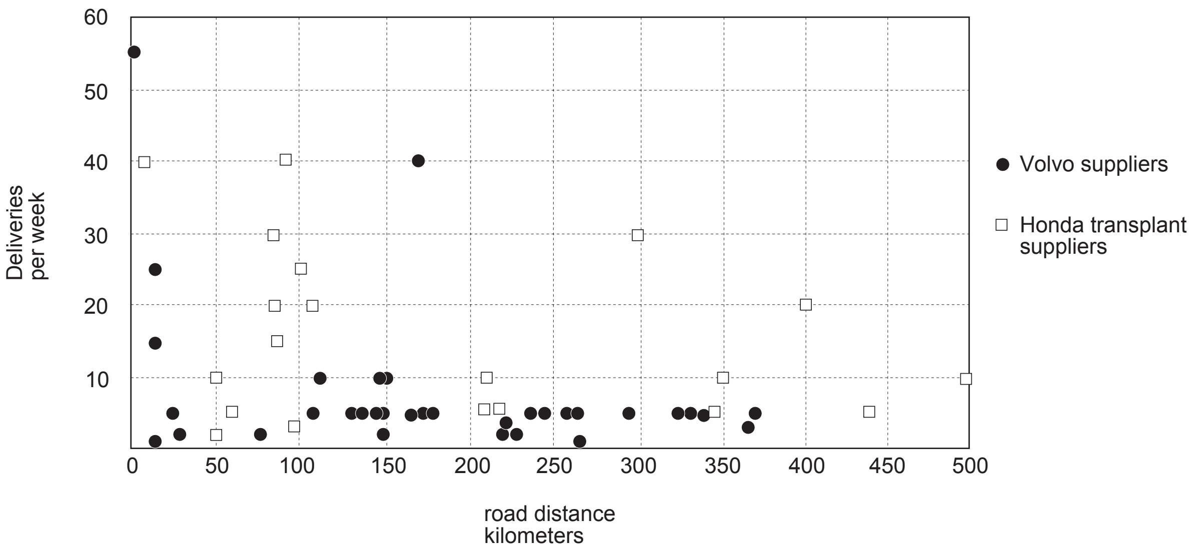


Figure 11.3: Location of suppliers by delivery frequency category. The grey area represents a 150 kilometre radius from Volvo Torslanda. *Source:* Author's survey

The other categories are evenly spread across southern Sweden, with an average distance outside the 150 kilometre radius, which is reflected in figure 11.4 below. Given the relatively limited number of suppliers in the first two categories one can draw the conclusion that the Volvo supply system in 1996/97 was characterised by a relatively "relaxed" form of JIT-production in terms of delivery frequency. With the recent development in relation to the S80-model the map presents a "transition" phase with some of the fore-runners to the integrated module-suppliers located close to the Volvo Plant.



Note: Distances for Volvo suppliers calculated from tables provided by the Swedish Road Authority. The starting point is the nearest city/village and the end-point is Göteborg city center, except for one supplier located 3 kilometers from Volvo. Distances for Honda suppliers are straightline measures.

Figure 11.4: Distance in kilometers and deliveries per week from domestic suppliers to Volvo Torslanda 1996/97 and for Honda U.S. transplant suppliers in 1990. *Source:* Author's survey; (Mair 1993b); Vägverket (1985)

From figure 11.4 it is possible to conclude that the Japanese transplant suppliers to Honda in the U.S, among whom the majority of JIT-suppliers are found, display a higher delivery frequency and locations closer to the Honda Plant in Ohio (Mair 1993). The Swedish suppliers are relatively evenly distributed up to 350 kilometers, while the pattern in the Honda-case is different. One major cluster is found around 100 kilometers from the Marysville plant followed by scattered observations between 200 and 500 kilometers. It is interesting to note that one supplier obviously delivers 30 times per week (5-6 times per day with a 5 day week) from a location 300 kilometers away.

The most extreme case of sequential deliveries over long distance among the Swedish suppliers in 96/97 was found in Bengtsfors, 170 kilometers north of Göteborg. This must be considered as a long transport distance given the time-restrictions and delivery frequency of 8 times per day (see figure 11.4) under sequential JIT-production. The production unit, a former Volvo-owned supplier now one of several suppliers within Lear Corporation Sweden moved their operations to Göteborg in May 1998.

This is the first supplier to physically move production from a traditional Swedish site to a location in close proximity to Volvo Torslanda. The reason behind the move was connected to the demand from Volvo on delivery frequency and reliability, but also to the sometimes turbulent relations between the union and the U.S. owners regarding production philosophy and working conditions.

To conclude the discussion about deliveries and geography, we can say that the location pattern in 96/97 reflects the first step in the restructuring process towards large systems/module suppliers located in close proximity to the Torslanda assembly plant. The degree of spatial agglomeration reflects a system with relatively relaxed time-demands on deliveries. Only a handful of the suppliers can be characterised as being extremely tightly connected to Volvo through sequential deliveries.

In the following section we will look more carefully into the organisation of physical deliveries and how this is linked to the restructuring process of the supplier network.

11.4 Transportation and logistics in the supply chain

Introduction

If we take into account the simultaneous increase in transport frequency and product complexity, together with decreasing inventory levels, we will see a growing importance for the organisation of physical transports. This is normally treated within the wider concept of *logistics,* which covers a wide scope of activities such as transport, warehousing, packaging and related services (Coyle, Bardi et al. 1992). The term *transportation* will be used to describe the physical movement of goods, while logistics covers the entire issue of *organizing* the supply chain.

This section will start with a discussion about the choice of transport-mode by the Volvo Torslanda suppliers. From this we will continue to look at the organisation of physical transports, followed by a discussion about the suppliers experiences of transport quality issues towards Volvo.

The choice of transport-mode

The suppliers were asked to state the relative importance of different modes of transport for incoming and finished goods. In some cases it was problematic for the respondents to overview the entire transport-chain from the sub-supplier to the supplier. In those cases, the transport-mode involved for the longest duration of the transport was selected. We should also note that we are focusing on suppliers of components to the final assembly excluding the relatively heavy transports of metal to the body-shop.

The use of transport mode shows an extremely homogeneous picture. In terms of deliveries from the suppliers to Volvo Torslanda, road transport is used in 100% of the cases for all suppliers. Considering the relatively short distances involved, and the demand for delivery frequency and reliability discussed earlier, the use of road transport for deliveries to Volvo Torslanda can be expected. The alternative would be train-transport, but the need for small and frequent deliveries on a daily basis is not compatible with the large-scale transport arrangements normally performed by rail.

It should be noted that the figures only cover suppliers located in Sweden. Most European suppliers deliver by road, although there is a substantial amount of goods transported by sea with the daily shuttle between Göteborg and Ghent.

Due to the lower degree of JIT-demand between suppliers and sub-suppliers among the respondents, we might expect incoming goods from sub-suppliers to show a more differentiated pattern regarding means of transport. This assumption proved to be correct only for a handful of suppliers. Over 90% of the suppliers reported road-transport as the only transport-mode for all of their incoming goods. Two respondents indicated rail and sea as their major means of transport for Volvo-related products.

Deliveries from sub-suppliers to the Volvo suppliers located in Sweden can be organised as a transport-chain including several modes of transport. The most common combination is probably sea-transport of trailers and lorries on route from Germany over Denmark to Sweden. Germany is the single largest source of sub-suppliers outside Sweden and transports to Sweden are almost totally road-based.

The suppliers were asked to indicate changes in transport-mode use during the last ten-year period. No major change had taken place according to the answers. Some of the minor shifts that could be observed were: increase of road transport and a relatively larger decrease in rail transport.

The general picture of transport-mode usage among the studied suppliers is characterised by a heavy concentration on road-transport, especially concerning deliveries of finished goods. Rail and sea are used only marginally for the transport of incoming materials from sub-suppliers. This has been the situation over the last decade, with however a minor decrease in rail-transport.

Organisation of supplier deliveries

We can conclude from the section above that road-transport was almost a prerequisite in order to meet the demand from Volvo regarding delivery frequency and reliability. The homogeneity of the suppliers is furthermore accentuated in terms of how deliveries are organised. As indicated in table 11.3, the majority of the suppliers belonged to the Volvo-operated "milkround" system of pick-up routes, indicated by the fact that Volvo was responsible for the organisation of transport to the Torslanda assembly plant. The remaining three suppliers managed their own logistics due to voluminous products and frequent deliveries that generated full truck-loads.

Responsible actor	Organising transport		Performing transport	
	count	percent	count	percent
Supplier	3	9	0	0
Volvo	31	91	0	0
Transport company	0	0	32	100
Other	0	0	0	0
TOTAL	34	100	32	100

Table 11.3: Responsibility for transport organisation and physical delivery for suppliers to Volvo Torslanda Assembly Plant. *Source:* Author's survey.

In the case of all of the studied suppliers, an outside transporter, either contracted by Volvo or by the supplier themselves, performed the actual physical transport. None of the firms consequently had trucks of their own. According to a study of Japanese suppliers, outsourcing of the physical transport appeared to be as extensive as in the case of Volvo, while logistics/planning activities were held inside the firm to a greater extent (Kalsaas 1995).

Figure 11.5 presents what the suppliers perceive as the most important logistics factors in relation to Volvo. *Reliability* is ranked as the most significant factor by over 70% of the respondents, while speed, price and flexibility (the ability to adjust to changes in orders) is seen as being of minor importance. It should be observed that the lines represent the *relative importance* between the alternatives. The low ranking of transport price for example should not be interpreted as if price is unimportant, but as an indication of the growing concern for reliability and goods safety in JIT-deliveries among the suppliers.

Flexibility is often linked to the discussion about new forms of supplier organisation, but is appears to play only a minor role for the Volvo-suppliers in the study. One explanation to this is that the long-term production plans have proved to be correct to a high degree, thus putting flexibility low on the agenda.

Furthermore, goods safety is seen as an important factor, especially in the second ranking. This may be explained by the changing nature of the products. More complex systems or modules include more components and need more volume when loaded. The delivered product is often ready to be assembled directly into the car, and need therefore to be handled and transported without any risk for damage.

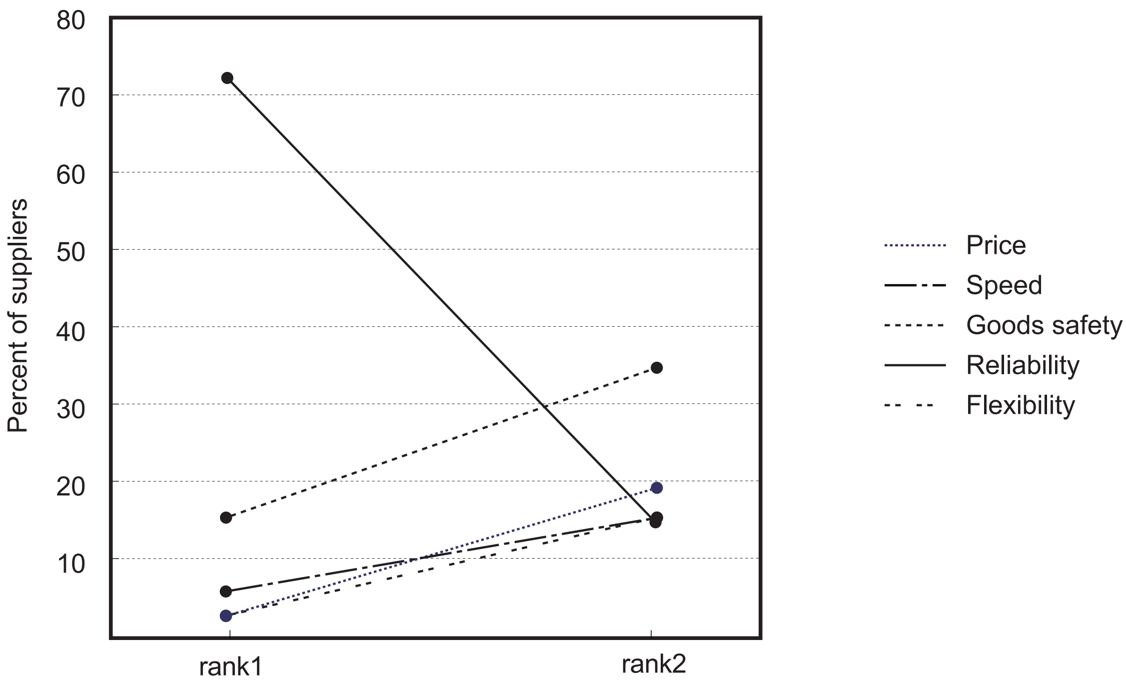


Figure 11.5: Perceived relative importance of logistics factors in the relation between suppliers and Volvo Torslanda Assembly Plant. (rank 1: n = 32, rank 2: n = 26)
Source: Author's survey.

The low rating for the price factor in logistics might partly be explained by the fact discussed above. The absolute majority of suppliers do not organise their own outbound logistics, and therefore regard price as a part of the total contract with Volvo.

11.5 Summary

Questions regarding transports and logistics in the Swedish supply system of Volvo Torslanda is characterised by its diversity of supplier-types. The fact that sequential JIT-suppliers, with hourly deliveries, are to be found together with firms delivering once per week, can be taken as an indication of the transitory phase that the Volvo supply-system is going through in the late 1990's.

The general level of delivery frequency during the last ten years has changed from deliveries once per week to deliveries every day, resulting in a situation in 1996/97 that can be characterised as a "relaxed" form of JIT. Only a handful of suppliers delivered more than daily according to sequential JIT-practices. This situation is changing rapidly with the start of production of the new S80-model in early 1998.

Reduced inventory levels is another feature of "just-in-time" production which the suppliers report to have experienced. There is a significant difference between inventory of finished goods compared to incoming parts, which can be taken as an indication that savings in inventory at the assembly-firm level have moved one step upstream to the primary suppliers. This can of course differ between products and processes, but the general picture is that second-tier suppliers had a significantly lower delivery frequency compared to first-tier suppliers.

The locational pattern of the domestic Volvo Torslanda suppliers reflects the restructuring process towards large systems/module supplier located in close proximity to the Torslanda assembly plant. There is only a few cases where proximity is of major concern with reference to logistics arrangements. It has to be put forward that the infrastructural and traffic conditions in Sweden are favourable in a European context, and even more so in relation to the situation in Japan. Direct comparisons of the locational patterns have to take take this into consideration.

Although the majority of suppliers can be termed "relaxed" JIT-suppliers, road transport is the only means of transport for deliveries to Volvo Torslanda. Rail and sea are only used marginally for transport of incoming materials from sub-suppliers, and this has been the situation over the last decade. Due to the fact that the suppliers in the study are domestic and located not further away than 400 kilometers (an average of 179 kilometers) from Volvo Torslanda, the dominance of truck-transportation not very surprising.

It is interesting to notice that road-transport as the most important means of transport dominates as regards incoming materials from sub-suppliers as well. Even though many of the respondents' most important suppliers are located on the European continent (mainly Germany), train or sea transport are only used in a very limited range of supplier-relations.

One explanation of the total dominance of road transport can be traced to what the suppliers experience as being of importance in relation to Volvo regarding deliveries. Almost three out of four suppliers ranked reliability as the most important delivery-related factor in relation to price, speed, goods safety and flexibility. Given a "just-in-time" production environment with minimum inventories this will most certainly reinforce road-transport.

An analysis of the importance of geographical proximity in the newly established supplier-park located close to the Volvo Torslanda Plant is presented in the next chapter.

12. Geographical proximity in a nutshell: the case of Volvo Arendal supplier park [12]

12.1 Background

The purpose of this chapter is to describe the development of the Volvo Arendal supplier-park project with emphasis on the importance of geographical proximity.

In the light of the increasing time-related demands on automotive suppliers, there have been several attempts to secure reliability through the development of supplier-parks adjacent to the assembly plant of the customer. One of the models has been the agglomeration of suppliers in Toyota City, a textbook example of how spatial proximity is used to ensure control over the production process. European examples are more scarce and small-scale, the new FIAT plant in southern Italy (Pulignano 1997), as well as Ford in Valencia have developed a ring of core suppliers in proximity to their respective assembly plants (FinancialTimes 1998a). Another example is the SMART-project including Daimler-Benz and the Swiss watch-making company SMH to build a small car in a completely new factory where the major suppliers are located in the same building complex as the final assembly (FinancialTimes 1997b).

One example of a greenfield automotive plant with a supplier-park strategy is the Ford/VW project south of Lisbon in Portugal (Ferrão and Vale 1995; Vale 1998). The area termed "Fordland" held about 20 first-tier suppliers in 1993, mainly due to high demands in deliveries. One conclusion of the supplier selection process was that most companies locating in Fordland had little impact on the local economy. They were either linked to an international company or functioned as a delivery warehouse for traditional suppliers located elsewhere.

A more adjacent case of the supplier-park concept has been in operation since 1994 in connection to the SAAB automotive assembly plant in Trollhättan, 70 kilometres north of the Volvo Torslanda Plant. SAAB is 50% owned by General Motors and has during the last years become closely integrated within the GM European production system.

The supplier-center was initiated by an independent firm and aimed to attract and provide business services for suppliers, mainly associated with SAAB. This has since then developed into a company(Se-De International), with responsibility for the co-ordination of sequential deliveries to the SAAB factory. From the initial aim of

[12] This chapter is based on company interviews with Mr. Lars Bolminger, Dept. for Strategic Sourcing, Volvo Car Co. and Mr. Leif Segerberg, Volvo Transport Co., unless otherwise stated. Data was collected in June 1998 and is consquently not influenced by the Ford takeover of Volvo Automobile in April 1999.

attracting automotive suppliers to the region, there has been a change of direction in the work of the company. Today, they act as a third-party logistics firm with the main business within the co-ordination and sequentiation of the flow of components from approximately 20 European suppliers to SAAB. Se-De International had 50 employees and and a turnover of SEK 38 million for 1998 [13].

According to the Managing Director, this arrangement has two main advantages. Firstly, it will provide flexibility in supplier selection. A change of supplier would most likely be more complicated if the company in question had established physical production locally. Secondly, this arrangement provides the possibility for the logistics firm to co-ordinate the transports more efficiently.

A number of the suppliers have extended the use of the sequentiation warehouse and moved some of the final assembly there. One example is the automatic welding of exhaust-systems for a German supplier who previously shipped the finished systems from Germany to Trollhättan. Today it is possible to load the parts of the systems much more efficiently, and thereby minimising transport costs, as well as delivery and quality problems.

In contrast to SAAB, the Volvo supplier park was initiated by Volvo itself and its purpose was to attract physical production to the area. Transport and other services may be provided for by Volvo Transport Corporation, which is located within the same area. Volvo owns the land on which the supplier park is located, a fact that probably simplified the planning and co-ordination of the process of attracting suppliers.

The basic rationale behind the decision to start the supplier-park project can be related to the time-compression strategies within Volvo. During the 1990's, the company has worked towards three weeks of lead-time, from the order to the delivery of the specific car to the customer across Western Europe. In order to meet this goal, all divisions of the company have been involved in a restructuring process. Within the field of supplier relations, there are two major areas of importance; *the Pan-European transport system,* and the *changing role of the suppliers*.

Due to the location of production in Sweden and Belgium, there is a need for a highly efficient and reliable transport system on an European scale. The Göteborg assembly-plant receives more than 50% of its input components from outside Sweden, including sea-transport in some form. To guarantee reliability, Volvo uses a "milk-round" system for the pick-up of goods from the suppliers in Sweden and those parts of Europe which delivers to Ghent. This arrangement is supposed to guarantee 48 hours' transport time from any European supplier to the Volvo assembly plants in Göteborg and Ghent.

In the daily operations, suppliers have one week to perform the following sequence:

[13] Information from interview with Mr. Per Persson, Managing Director at Se-De International AB, May 1998.

receive and process the final order ⇨ procure inputs ⇨ manufacturing ⇨ pack and prepare for transport ⇨ transport to Volvo

Judging from this factor alone, there are obvious advantages in being located close to the customer. The shorter the time for transport, the more time the supplier can use for the other parts of the process without having to rely on a large buffer-inventory. Most European suppliers can adhere to this demand today within the framework of the Volvo pan-European transport system.

Except for this general time-demand, there is a process towards modulisation of the production, as discussed earlier. The fact that these modules are high-value, voluminous and in many variants makes storage problematic, both in terms of space requirement and the capital tied up in finished products. This is instead organized through *sequential synchronous deliveries* with minimum inventory. The result of this arrangement is that suppliers of modules have to deliver with extremely high frequency and in small lots. The temporal constraints in this type of arrangement are very tight and spatial proximity is one of the strategies that Volvo is using in order to secure reliability. The main incentives behind the supplier-park project can thus be summarised as follows:

- A general goal to achieve a three week lead-time from customer order to delivery for the entire European production system. This involves a pan-European transport system where a supplier-park can function as a hub.

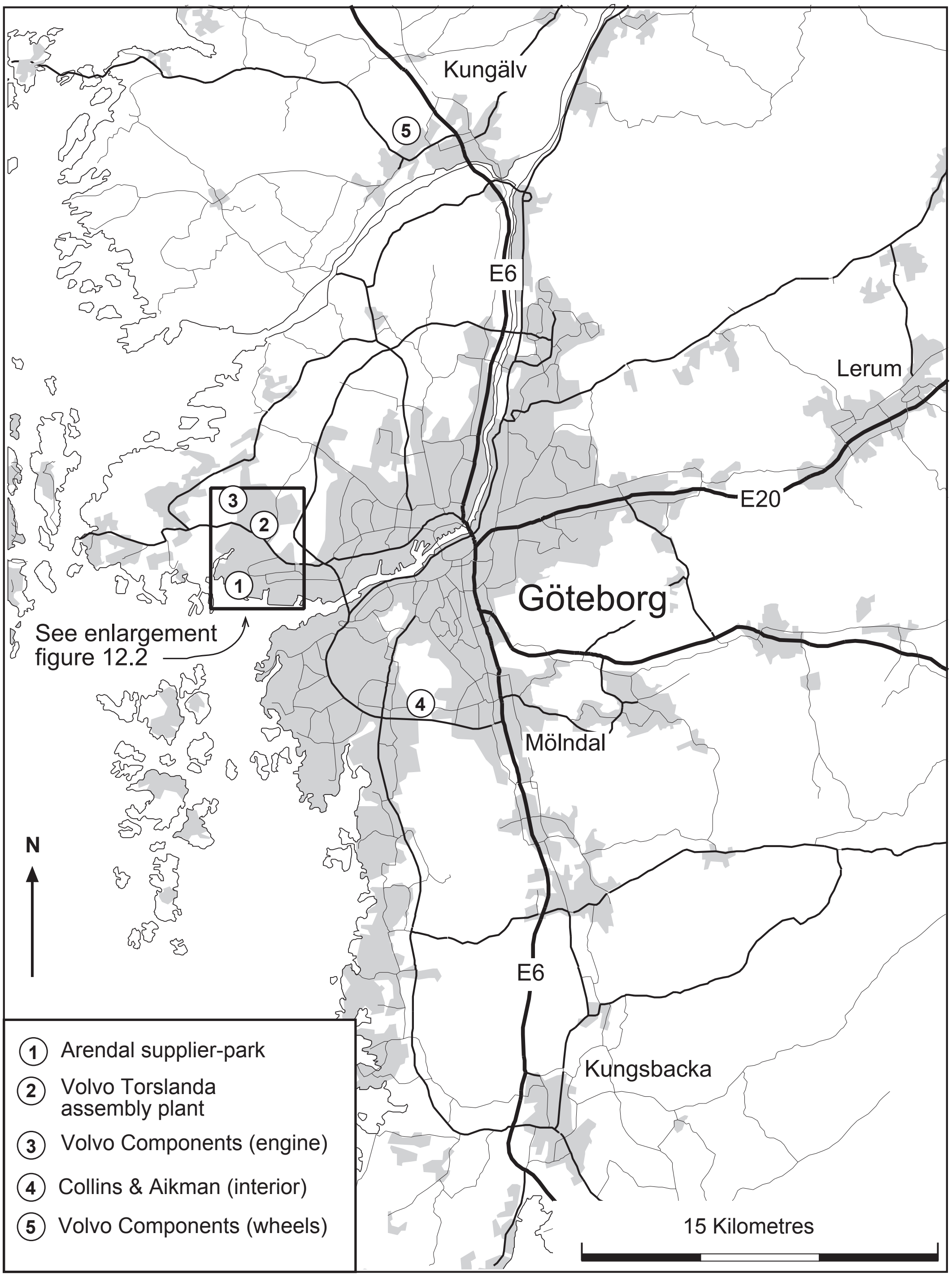
- Specifically, and most important, is the trend towards sequential deliveries and modulisation. A selection of suppliers will take on more responsibility and have to deliver according to sequential JIT-requirements.

12.2 The development process of the supplier park project

The first steps towards a supplier-park were taken in the early 1990's by outside actors, mainly construction companies, who used proximity to the Volvo plant as a means to develop and market land as industrial estates. They were actively promoting the sites as a "just-in-time" supplier-park. However, the results of these efforts were relatively poor, and did not attract enough interest from suppliers to be able to establish a site dedicated to the automotive industry (Larsson 1993).

Volvo itself expanded their logistics activities during the late 1980's and started to develop a transport terminal at the former shipyard site of Arendal, located just 5 minutes by truck from the Torslanda plant. This area provided space enough to host suppliers and gave the physical possibility to develop the idea of a supplier-park.The process to create a supplier park started within Volvo in 1996 as a part of the development process of the S80-model. At the time, the Arendal site was occupied only by Volvo Transport Corporation and Hydro-Raufoss, who used one of the buildings for storage and sequentiation of bumpers from Norway and Belgium.

During 1997, all of the industrial buildings on the site was upgraded and transformed to suit the needs of the preferred suppliers. This was made parallel to the process of selecting and attracting the suppliers of components, which should be delivered in sequence to the S80 model. In the second half of 1997, all of the suppliers were located, and Volvo had developed 35.000 m^2 of new industrial buildings.



Note: Collins & Aikman supplied in sequence to the S/V 70 - model. The production of this model was concentrated to the Ghent-plant during 1998.

Figure 12.1: The Göteborg region and location of sequence suppliers to Volvo Torslanda assembly plant 1998. *Source:* The base map is taken from the digital version of "Röda Kartan" supplied by the Land Survey of Sweden.

In the process of supplier selection for the sequential components there was a clear demand from Volvo that the award of a contract was linked to location in the supplier-park. Only a few other suppliers are delivering in sequence from locations elsewhere (see figure 12.1). This is mainly due to the fact that they delivered to the S/V 70-models in sequence from their existing location. The actual production of the S80-model started in april -98, from this point the suppliers were expected to deliver according to Volvo JIT- requirements.

12.3 Function of the supplier-park

Firm size and products

At the time of production start-up of the new S80-model, there were eight suppliers located in the park. The main aim of these units is to prepare for sequential deliveries by sorting, and in some cases pre-assembling incoming components. In table 12.1 below, the name, country of origin, product and number of employees of the units located at the Arendal site is presented.

Company	Country	Product in sequence	No. employees
Hydro-Raufoss Automotive Plastics	Norway	Bumpers	120
Lear Sweden Interior Systems AB	U.S	Door panel, dashboard	100
Delphi-Packard	U.S	Cables, electronics	50
Becker Sweden AB	U.S/Germany	Interior roof, tunnel console	40
Walbro Automotive	U.S	Fuel tanks	25
Borgers Nord AB	Germany	Trunk carpet, parcel shelf	20
Tenneco Automotive Sweden	U.S	Exhaust system	20
Rieter Automotive Sweden	Switzerland	Carpets	10

Table 12.1: Production units by home country, product and number of employees located at the Arendal supplier-park. June 1998. *Source:* Author's survey.

In terms of size, the firms can be divided into two groups, Hydro-Raufoss and Lear with 100 or more employees and the other six, which are considerably smaller. This is explained by the fact that the operations of these two companies are significantly different from the others. Hydro-Raufoss runs a complete production facility, and Lear uses the Arendal site to store and sort additional products not delivered in sequence. Among the six other suppliers, Delphi-Packard is developing towards a multi product facility, while the rest can be characterized as dedicated one-product units.

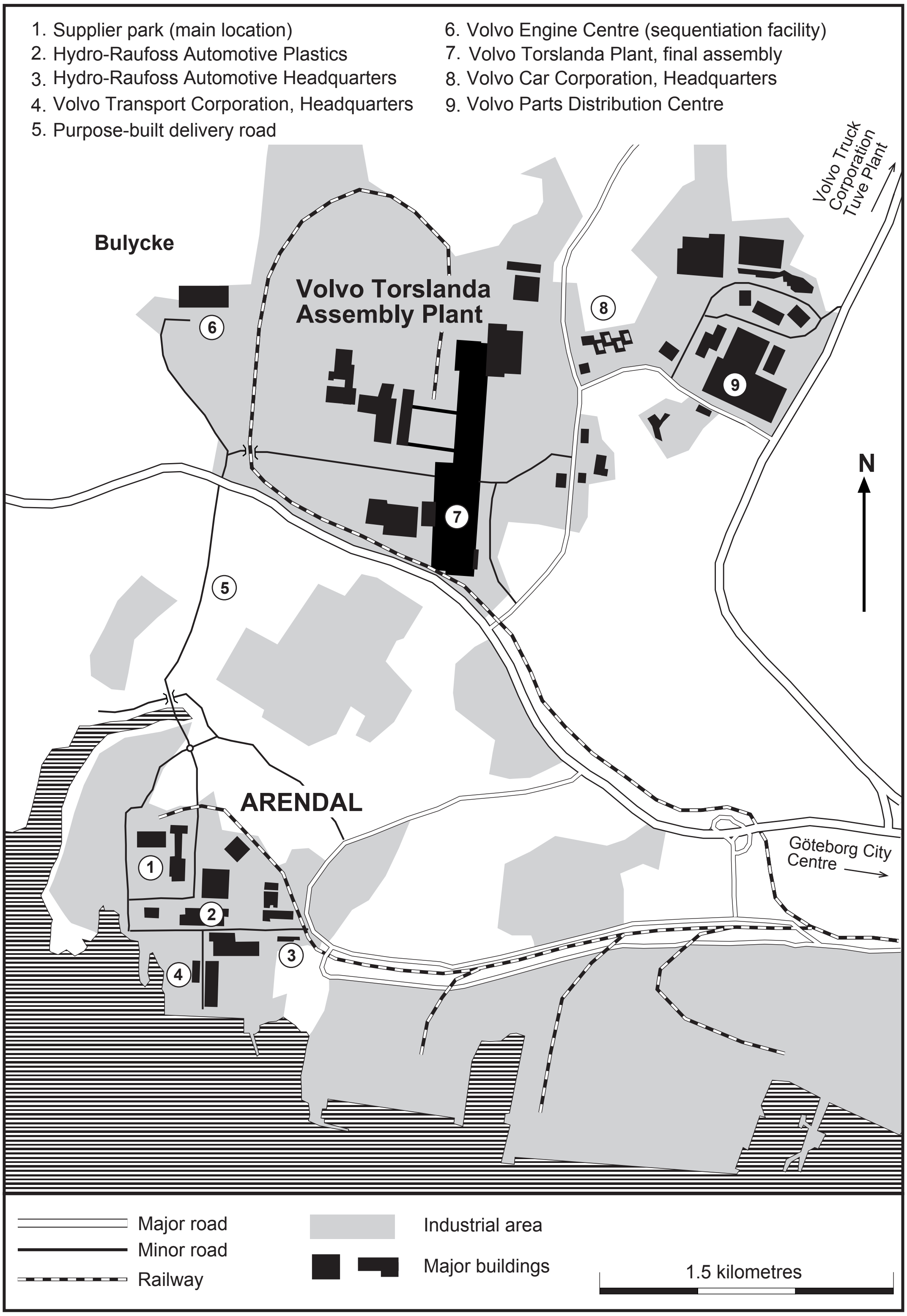


Figure 12.2: Arendal supplier park and Volvo Torslanda Assembly Plant. *Source:* "Gula kartan" Land Survey of Sweden; Author's field survey.

The products supplied from the Arendal site are selected by Volvo as being suitable for sequential deliveries, and are typically:

- Voluminous, requiring large storage space and a high transport cost per unit.

- Model and/or color specific, resulting in a large number of specific variants. They are too many to pre-produce and store, both in terms of space and the accumulation of capital.

The majority of the products belong to the second category and are related to the interior design or the color of the car. Painted bumpers have features from both groups, while "non-visible" components such as exhaust systems and fuel tanks can be placed in the first category.

In the current debate on the automotive industry there has been much attention on the development towards out-sourcing and more responsibility for suppliers. This is clearly reflected in the new supplier-park concept. Approximately 60% of the value of purchases comes from the eight Arendal suppliers plus Volvo Components (engine) and Lear Seating. This indicates the high value of the products.

An example of such a product is the front bumper module, which today contain the following components: aluminium structure, plastic foam, painted (in the color of the car) plastic shield, spoiler, lights and sensors. Just two car-generations ago all of this was put together by Volvo themselves. All of the suppliers at the Arendal sites can be characterized as module-suppliers although with different levels of complexity and value added.

It is important to point out that only one of the production units is included in the sample of suppliers discussed earlier. Except for Hydro-Raufoss, none of the suppliers delivered to Volvo Torslanda from a Swedish location before the S 80-model. Lear Corporation is a special case due to their spatial organisation. Several Lear units were acting as first-tier suppliers before the S80 model. The majority of these deliveries are now coordinated via the Arendal facility.[14]

Production process and technological level

The main function of the newly established units in the supplier park is, as mentioned above, to act as a point of delivery rather than as a traditional production facility. This is reflected in the degree of technical complexity of the components delivered from the supplier-park units. The only facility with actual production is Hydro-Raufoss who recently upgraded their operations from a warehouse to a complete production unit

[14] In connection with the move from Bengtsfors in spring 1999, Lear relocated its operations from the Arendal supplier park to a building inside the Volvo Torslanda Plant.

(see chapter 13). Among the other suppliers, there is a range of activities from pre-assembly of components (such as the welding of exhaust-systems) to simple storage and sequentiation of finished products.

Company	**Type of activity**	**Product development**	--- **Origin of purchase value in percent** --- local	national	european	intern'l	total
Hydro-Raufoss	production	yes	0	3	95	2	100
Becker	pre-assembly	yes	2	10	86	0	100
Borgers	pre-assembly	yes	5	30	65	0	100
Rieter	sequentiation	no	4	0	96	0	100
Tenneco	pre-assembly	no	0	35	65	0	100
Lear	pre-assembly	no	5	80	15	0	100
Walbro	pre-assembly	no	0	0	85	15	100
Delphi-Packard	pre-assembly	yes	0	0	100	0	100

Table 12.2: Type of activity and relative distribution of purchases (value) for production units at the Arendal supplier-park. June 1998. *Source:* Data compiled by the author.

Table 12.2 shows the type of activity and the geographical distribution of purchases for the production units located in the supplier park. It is evident that the majority of the suppliers have a relatively simple production process, which includes only marginal value-adding of the incoming products before they are sorted and delivered for final assembly at Volvo.

There is one company which does only sorting and sequentiation without any assembly at all, while the majority of suppliers have pre-assembly to some extent. This can range from relatively simple adding of clips and fasterners to more complex automatic welding of exhaust pipes the or assembly of displays into a complete dashboard.

As indicated in table 12.2, four of the suppliers have product development located at the Arendal site. The extent and content of these activities has not been studied, but there are only limited and Volvo-product specific development functions located in the park. The only major exception is Hydro-Raufoss who moved their entire development function to the Arendal site in connection with their investment in a new production facility in 1997. Lear Corporation has their development function in Göteborg together with a number of production facilities across southern Sweden acquired during the last 3-4 years.

Purchasing patterns and local linkages

As indicated in figure 12.2, we can observe a low level of local and national sourcing. This is probably explained by the production process discussed earlier, where the Arendal units only work as a point for sorting and delivery of ready-made products from other production units, mostly in Europe.

With the exception of Lear, having in mind their national presence, the absolute majority of input components are transported from the European continent. Some of the other cases of national purchasing are explained by internal transactions from other units located in Sweden. Some suppliers have a long tradition of supplying Volvo, and have thereby built up a big national supply-base.

One significant pattern in purchases is the low level of local and international sourcing. Local in this context refers to Göteborg and adjoining local administrative units (see figure 12.1). The first conclusion that can be drawn is that no major local supplier has been involved in the establishment process of the supplier park. This situation was commented by the people responsible for the development of the park at Volvo as: "*a very low level of interest from local domestic companies to establish contacts with the new module suppliers*". It has to be noted though, that this process is in its initial phase and local linkages may develop to a greater extent when the situation has settled.

The domination of European suppliers reflects the production structure of the companies in the park. Components are produced at the traditional location in Europe as before and then transported in batches to Göteborg. Given the early phase of the establishment of production, this is probably what could be expected. In a longer perspective we may see a situation where the local units become more independent in relation to the mother company and able too choose more local suppliers, if preferred.

Organisation of transports

The single most important aspect of the Arendal supplier park is the organization of high-frequent sequential deliveries from the supplier to the Volvo assembly plant. This involves extremely high levels of reliability in the transport function and is therefore under the responsibility of an independent Volvo company, Volvo Transport Corporation (VTAB). Delivery frequency for the sequentiated components is normally 6-10 times per day. This means delivering every hour during full scale production. Some suppliers such as Lear with more deliveries outside the sequentiated modules, have significantly more deliveries per day, although the time-restrictions and number of variants are not as rigid as for the sequence deliveries.

The figures on purchasing patterns presented in table 12.2 make it evident that the main function of the supplier-park in this initial stage is to handle the logistics of incoming batches from the European continent, and to transform these into car-specific components to be delivered hourly.

These logistics and transport functions were one of the areas where Volvo expected to gain some economies of scale by offering to handle the incoming transports for all the suppliers. But the situation today includes a mix of arrangements such as:

- The local supplier is responsible for the organization and uses outside firms or Volvo for the physical transport.
- The mother company in Europe is responsible and has a contract with Volvo Transport Corporation for the organization and physical transport.
- The sub-supplier is responsible for deliveries to the supplier at the Arendal site.

Independent of the form of logistical organization, there is a need for co-operation within the park in order to utilize the space as efficiently as possible and minimize the environmental impact from the generated traffic. According to Volvo, this is the issue where internal cooperation between the suppliers in the park is most likely to take place. There are potential economic and environmental benefits if the companies could co-ordinate their shipments of incoming materials from the European continent.

Power relations

One interesting aspect of the restructuring process in the automotive components sector is the concentration of ownership, both on a global scale as well as on the national level. In this particular case we have small local units belonging to large international or global corporations, which put a relatively small automotive manufacturer such as Volvo in a new position in terms of power.

From table 12.3 we can conclude that total sales for the companies behind the eight suppliers equalled 58 Billion US Dollars in 1997, which is more than twice the figures for the entire Volvo Group. The single most important is Delphi Automotive, followed by the Norwegian Petrochemical and Metals group Norsk Hydro who owns Hydro-Raufoss Automotive[15] as one part of their light metals division.

[15] Norsk Hydro sold 60% of Hydro-Raufoss Automotive Plastics to Gränges AB in 1999.

Local subcontractor unit	Parent company	Sales Million USD	No. of employees
Delphi-Packard	Delphi Automotive Systems	28 400	216 000
Hydro-Raufoss Automotive Plastics	Norsk Hydro ASA	12 000	38 000
Lear Sweden Interior Systems AB	Lear Corporation	7 342	50 000
Tenneco Automotive Sweden	Tenneco	7 200	50 000
Rieter Automotive Sweden	Rieter Group**	1 320	12 300
Becker Sweden AB	Becker Group*	1 300	8 400
Walbro Automotive	Walbro Corporation	620	4 700
Borgers Nord AB	Borgers GmbH	323	2 700
TOTAL		**58 505**	**382 070**
Volvo Group		*22 953*	*73 000*

* Becker Group U.S and Becker Group Europe were acquired by Johnson Controls in April 1998. Figures for Johnson Controls are not presented in the table. Sales figures are estimates for 1998.
** Figures for Rieter Group represent 1996.

Table 12.3: Total sales and number of employees 1997 for respective supplier mother company and Volvo Group. *Source:* Official company internet sites, PR Newswire - company news Internet service.

This situation is crucial, because it is a direct reflection of the combined process of concentration and internationalization in the automotive supplier business. Sweden has been affected by this restructuring process relatively late. A study by the Swedish Industry Board in 1990 (SIND 1990) presented 15 large groups as important owners of automotive suppliers in Sweden, and out of these only four were foreign-owned. This picture has thus changed dramatically over the last few years, when foreign supplier-multinationals have acquired many of the former domestic first-tier suppliers.

For the S70/V70-model which is the generation preceding the current S80-model, there were only two major Swedish-owned supplier-groupings among the 40 most important domestic suppliers. Global actors such as Lear Corporation and Collins & Aikman controlled ten of the former Swedish-owned large suppliers. This is even more pronounced in the development of the supplier park as indicated by the table 12.3 above. New global firms, such as Walbro, Delphi and Tenneco, have entered the supplier list for the S80 model. Together with the other firms in the park, they supply approximately half of the value of the car.

The development towards outsourcing of manufacturing and product development functions to large global suppliers may pose problems for the assembly firms, especially a small company such as Volvo. The problem for the principal could in the long run be that suppliers develop competence and financial resources which put them in a favourable situation in the negotiation process for future projects.

Traditional views of buyer-supplier relations as being unequal in favour of the out-contractor might be contested in the light of the restructuring process at Volvo.

Another aspect of the high degree of large foreign owners behind the plants in the supplier-park is the possibility for closure in case of problems or when the project/contract is finished. The investment in the Arendal-site is marginal in relation to the total figures of the respective company, with the exception of the Hydro-Raufoss' investment in a new production plant. In the perspective of creating in total 600 jobs until year 2001, one might reflect on the pace of firm-establishment. The quick process of establishing operations would most likely, given the type of activities involved, reverse at same pace if the conditions change.

12.4 The supplier-park concept and the development of a creative environment for automotive-suppliers

Introduction

One recent debate within the field of economic geography has focused on the importance of industrial agglomeration and regional development. In a review of the research within this field Malmberg, Sölvell et al. (1996) makes a distinction between forms and forces behind industrial agglomerations. The theoretical discussion is reported in chapter 2.

We can summarize the forms of agglomeration as being either of a *general type* or consisting of *related firms and industries*. This distinction is important because it indicates the importance of internal division of labour and the degree of functional linkages within the region. The forces behind the creation of such agglomerations have traditionally been explained by *transaction cost* efficiency and system flexibility. This has been challenged by the introduction of *knowledge* as being equally important as costs in today's highly competitive industries.

The basic line of argument put forward by Malmberg, Sölvell et al. (1996) is that regional clustering of related industries and firms facilitates knowledge accumulation. This is especially important in relation to types of information which are not possible to standardise and communicate over distance, where factors such as trust and common social values are important.

In the case of the Arendal supplier-park this framework can be used to discuss the extent in which it is possible and/or preferable to promote the development of an "creative environment" in the sense of knowledge distribution and generation within the automotive components industry. The current situation, though, differs significantly from the theoretical prerequisites discussed in the literature:

- The rationale behind the agglomeration of suppliers is the demand from Volvo to locate close to the assembly operation. This has, at least in an initial phase, resulted in a situation where all contacts are made through Volvo. There is no internal co-operation or division of labour. The only areas where transaction costs might be saved are on transport arrangements.

- Linked to the point mentioned above is the lack of co-operation between related firms. Due to the fact that all of the suppliers perform the same function, there is no incentive for joint development projects and knowledge accumulation within the supplier-park.

With the above remarks in mind, it is obvious that the driving force in this particular case is the strategy formed by Volvo, which is currently focused on the day-to-day problems of production coordination and physical deliveries. In order to move from the current situation towards a strategy with more internal co-operation and joint development projects, creating an environment for knowledge accumulation, future competitiveness and regional development are some basic factors need to be taken into account.

Firstly, there is a need for related and supporting industries to locate in the area in order to broaden the base for knowledge accumulation. Secondly, more development, and other knowledge intensive functions need to be present. One basic prerequisite is that the social networks and local conditions are favourable for co-operation and communication, including institutions such as local authorities and institutions of higher technical and business education.

Related and supporting industries

As can be expected from the strategy defined by Volvo, there are very few firms in related businesses such as sub-contractors or service providers located in the park. There is only a handful of companies providing services directly to the suppliers in the park. One of the companies are engineering consultants specializing in the automotive sector, while the others supply relatively uncomplicated services such as security or office supplies.

The most important actor is Volvo Transport Corporation (VTAB) with their headquarters and transport terminal located in the supplier-park area. Their main activities are centered around the co-ordination of Volvo shipments to and from Sweden. With respect to the suppliers located in the park, VTAB is responsible for all of the sequential deliveries to the Torslanda plant. Some of the suppliers also use VTAB for their inbound deliveries. There is also a service for smaller suppliers who deliver in sequence from other locations, where VTAB holds a stock of components for sorting and delivery. Transport and logistics might be a future area where the park can attract and develop new businesses thanks to the proximity, both to other suppliers, but also to Volvo Transport Corporation.

Product development and knowledge accumulation

One of the basic prerequisites for the development of the supplier-park from the previous function as a logistic center to an environment for knowledge accumulation is the presence of knowledge-based activities. One important point of departure would be the location of more product development inside the park, within the existing companies as well as in the form of independent firms.

Half of the firms in table 12.2 reported that they had product development on site. The others have at least one person posted inside Volvo working with development projects. But these are very much unique Volvo products, and the benefits of co-operating within the supplier-park are limited.

Volvo has a long record of cooperation with the local institutions of higher education, especially Chalmers University of Technology which educate many of the engineers employed by the company.

The situation today can be summarized as: firm-specific knowledge accumulation, where each unit in the supplier-park either has it's own responsibility or has to work via the mother company abroad.

12.5 Summary

This chapter of the thesis has presented the development of the Arendal-supplier park project with special emphasis on the relationship between production strategy and spatial proximity. Furthermore we have discussed the supplier-park idea in term of the possibility to develop a creative environment for knowledge accumulation within the automotive supply industry.

Spatial proximity is the basic rationale behind the location of the supplier-park. This is mainly linked to the use of *sequential deliveries*, where each module produced by the supplier is matched against one specific car on the assembly line. The spatio-temporal limitations in such an arrangement are very tight and unless a huge warehouse is used, there is need for high frequency and reliability in deliveries.

All suppliers can be regarded as *small or medium-sized* in terms of the number of employees. It is important in this respect to point to the fact that the size of the first-tier supplier does not reflect the financial and technological capabilities of the local production unit, as aal of the suppliers located in the park are *foreign-owned*. This is a significant change in power-relations, probably linked to the international concentration process within the industry. Fewer and bigger supplier groups dominate the market. The swedish motor vehicle industry has entered this process relatively late, and has thus only recently come to adjust to a situation in which domestic supplier groups have been taken over by international companies.

Regarding the conditions for the development of a creative environment in the supplier park there are obvious limitations. Most important is the fact that the entire project is driven by Volvo with the specific purpose of co-ordinating the physical deliveries of components. The issues of knowledge accumulation, inter-firm co-operation and regional development have not been on the agenda. This also means that the companies in the park all have the same function, that of serving Volvo, with no direct incentive to cooperate with each other.

13. A dedicated JIT-supplier: the case of Hydro-Raufoss Automotive.[16]

13.1 Introduction

In this chapter we will examine one specific company. The reason behind the choice of Hydro-Raufoss Automotive is that they provide a good example of organisational and technological change, directly connected to the restructuring process at Volvo. It has to be noted that this case is extreme in many aspects, especially in terms of customer concentration (to Volvo) and JIT-delivery strategies.

The chapter starts with a brief historical overview of Hydro-Raufoss, followed by a presentation of the current structure of the company. After that comes a discussion of the different production facilities and the spatial organisation of the automotive production.

The majority of the information is collected via personal interviews at the Volvo-related plants in Norway, Sweden and Belgium. Telephone interviews have been used to update the chapter with the latest changes in company structure in relation to Volvo.

13.2 Historical background and the present organisation of Hydro-Raufoss Automotive

Raufoss Ammunisjonsfabrikk started its operations in 1896 producing ammunition in the town of Raufoss, 100 kilometers north of Oslo in Norway. The company entered the non-military sector in the 1920's as a supplier to the Swedish ball-bearing producer SKF, at the time a supplier to the European automotive industry. Their first Volvo-deal in 1957 can be seen as a major breakthrough for automotive production at Raufoss, although it consisted of the assembly of Jeeps coming in complete pre-packed kits from Volvo (Kalsaas 1995).

The chronological development of Raufoss production is presented in figure 13.1 below, from their first automotive OEM contract with Volvo in 1965 until the situation in the end of 1998.

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16 In early 1999, Hydro-Raufoss Automotive Plastics merged with it's former competitor, Plastal a supplier of bumpers to SAAB. The former owner, Norsk-Hydro, sold 60% of the company to Gränges AB, who owned Plastal. The new company is named Gränges Autoplastics AB. This will not be included in the following, since the data and interviews cover the situation up until the end of 1998.

Ever since the first contract, Volvo has been the most important customer in the automotive sector. The main competitive advantage for Raufoss was their competence within aluminium technology. This gave them the ability to develop bumpers that could match the growing importance of safety in the 1970's. The modern bumper-systems produced today are based on the introduction of plastic covers on bumpers in connection with the Volvo 700-series in the early 1980's. This has shifted the technology from aluminium only, towards plastics and in particular the painting of plastic covers.

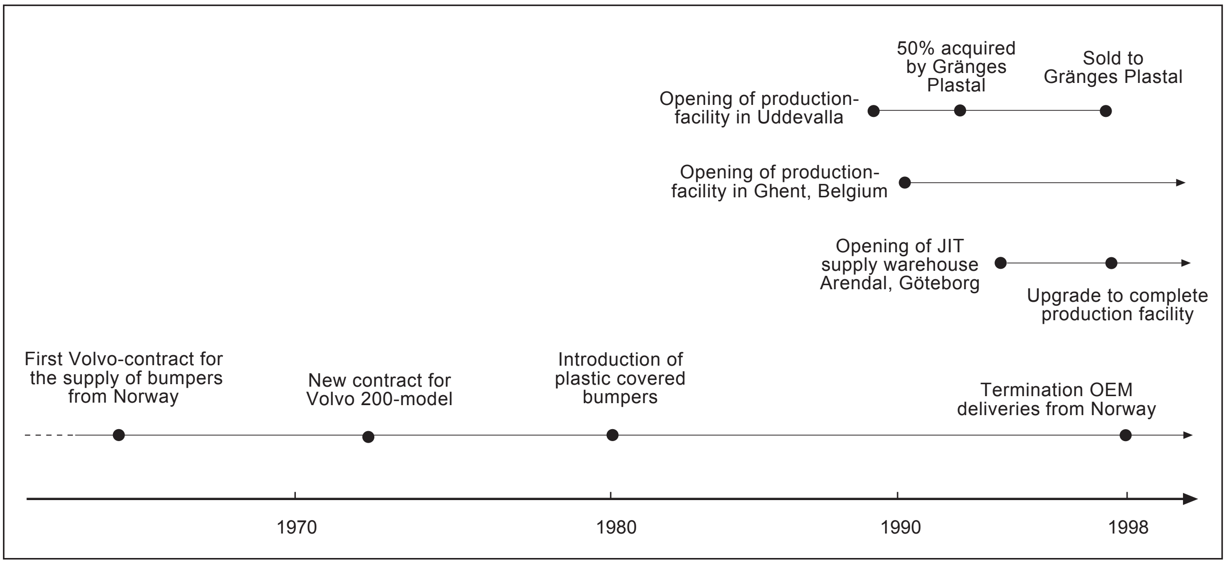

Figure 13.1: Development of Hydro-Raufoss Automotive production 1965 - 1998.
Source: Kalsaas (1995); Various company interviews at Hydro-Raufoss.

In order to meet the delivery demands from Volvo, Raufoss started local production in Belgium (Ghent) and Sweden (Uddevalla), followed by the establishment of a delivery warehouse on the location of the present Arendal supplier-park adjacent to Volvo Torslanda assembly plant in Göteborg.

Raufoss have traditionally been characterised by its military production and therefore state ownership interests. The automotive business, with its non-military market, was organised as a subsidiary named Raufoss Automotive, and partly taken over (40%) by the Norwegian energy and aluminium giant Norsk Hydro. The new name became Hydro-Raufoss Automotive. In 1997 Norsk Hydro acquired the entire automotive division, although Raufoss continued to be a part of the brand name.

Hydro-Raufoss Automotive (HRA) one of five division within Norsk Hydro. The automotive business is further divided into three business areas:

- *Plastics:* Bumper-systems with Volvo as the main customer. Production plants in Ghent (Belgium) and Göteborg (Sweden) dedicated to supply the adjacent Volvo assembly plants with sequential JIT deliveries. These plants have recently been changed into subsidiary companies, while the Norwegian plant is still within the mother company.

- *Space frames:* Aluminium space frames and chassi parts for the European automotive industry. Customers are both automotive assemblers and first-tier suppliers.

- *Structures:* Bumper beams both for Hydro-Raufoss Automotive Plastics in Göteborg and Ghent as well as for external first-tier suppliers of bumper systems in Europe. They also supply seat frames and roof rails to the U.S. and European automotive industry.

The total sales for Hydro-Raufoss Automotive was 2.3 billion Norwegian Krona (290 million USD) in 1997. Bumper systems made up almost 25% of the total, and together with the bumper beams accounted for half of the total sales.

The HRA Plastics operations in Ghent and Göteborg are dedicated to Volvo and located just a few minutes driving from their respective customer (see figure 13.2). This proximity is a result of a strategy to develop systems or modules combined with synchronous sequential deliveries every hour.

The other business does not show the same correlation between main customer and geographical proximity. This might be explained by the fact that none of the other customers demand sequential JIT deliveries.

Customers are also more fragmented across Europe, while the Plastics products are extremely dedicated to one customer. One interesting geographical aspect to note from the map is the lack of production facilities in Germany, the main automobile production country in Europe. This is changing due to the opening of a production plant for aluminium components (not complete bumpers) in Southern Germany during 1998.

The rest of this chapter will concentrate on the plastics division Hydro-Raufoss Automotive Plastics (HRAP) and its operations in Norway, Belgium and Sweden respectively.

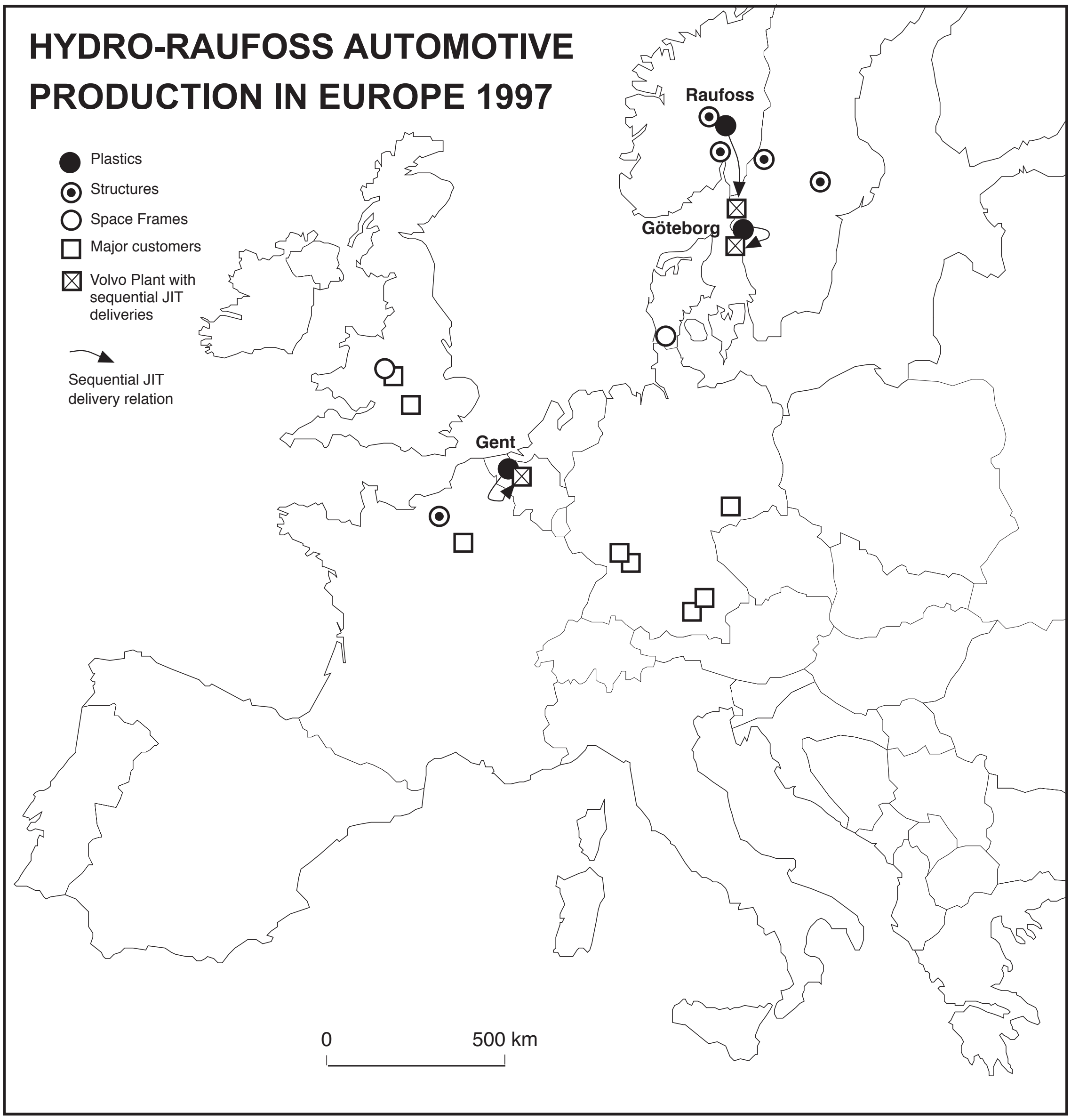

Figure 13.2: The location of Raufoss Automotive production facilities and major customers in Europe 1997. *Source:* Company interviews and official company information.

These sub-divisions are made owing to the close relationship between Volvo as the main customer, and the development of the HRAP operations in Europe. The emphasis of the discussion in focused on the development from the mid- 1980's and onwards, including changes in strategies, production capacity and the relationship with Volvo. We will start with the original production plant in Raufoss, Norway, which has been the base for automotive parts production until the recent restructuring in 1997-98.

This process has changed the pattern of production and power within HRAP from the traditional core in Norway to the production plants in Göteborg and Ghent.

The development and functions in these two locations will be discussed in the light of the continuously changing demands from the customers regarding product development, quality and delivery.

13.3 Raufoss - Norway

Traditional production without time-compression requirements [17]

The production plant in Raufoss, located approximately 100 kilometers north of Oslo (see figure 13.2) was the sole supplier of bumpers to Volvo until the start of production in Uddevalla in 1989. The location is explained by the fact that Norway in the late 19:th century needed to find strategic locations for military production, and Raufoss provided a secure place. Up until the mid 1980's this location did not pose any major problem in terms of distance to the main customers. The distance to Volvo in Göteborg is approximately 400 kilometers. At this point in time, Volvo did not require sequential deliveries of bumpers which made it possible to have production in a relatively remote location such as Raufoss.

Another aspect that reduced the need for geographical proximity was connected to product technology. The bumper was a relatively simple product up until the mid 1980's. The aluminium beam was the basic element and most of the assembly of fasterners and the plastic cover was performed at the Volvo assembly plants. This meant that the product was relatively easy to store and transport without risking damages. The Raufoss supplier base was mainly local. Other Scandinavian suppliers within the aluminium and engineering sectors were also used. Norsk Hydro was the main supplier of aluminium, which is the main part of the finished product.

Changing products, technologies and delivery requirements[18]

Seen in the light of the present situation, it was only a matter of time before the Raufoss location could not serve the demands from Volvo in Göteborg and Ghent. Volvo's strategy of sequential JIT-delivery of bulky and/or variant specific components, in combination with the demand for Raufoss to take over assembly and produce a more complex product, put the light on the tempo-spatial limitations of the relatively remote Norwegian location.

[17] Information on the development up until 1995 is, unless otherwise stated, taken from (Kalsaas 1995).

[18] The rest of the Norwegian case in this chapter is based on interviews with Mr. Per Harald Stokstad, logistics/planning manager and Mr. Kjell Olsen, IT-systems manager, Hydro-Raufoss Automotive Plastics, Raufoss, Norway. May 1998.

This resulted in the establishment of a new production-unit in Belgium, located only five minutes by truck from the Volvo Ghent assembly plant. At the same time Raufoss delivered bumper-systems painted and assembled in sequence to the factory in Göteborg without a local production-unit, an arrangement that caused delivery problems. The solution to this was to open up a warehouse in close proximity to the Göteborg assembly plant where the finalised bumpers could be stored, sorted and delivered in sequence. An arrangement which is used by several of the new suppliers in the Arendal park. The sequentiation warehouse at the Arendal site was supplied from the Norwegian location (Raufoss Automotive Structures supplied aluminium beams and Raufoss Automotive Plastics supplied the painted plastic covers) and in the case of emergencies complete bumpers were transported from the Belgian plant.

Product development for both Göteborg and Ghent was controlled via the head office in Norway, the center of power up until 1996 - 97. Thereafter followed a decision to invest in a new bumper-production facility in Göteborg worth approximately SEK 400 million.

Function of the Raufoss factory after the investments in Göteborg

The upgrading of the sequentiation warehouse in Göteborg into a complete production-unit, together with the movement of R&D to the same location caused a fundamental change for the Raufoss Automotive Plastics unit in Norway. The need to find new areas of business was the birth of the idea to *supply bumper spare-parts just-in-time* across the world. The background to the project can be summarised within two main problems-areas for the distribution of spare-parts:

- The plastic covers are traditionally shipped to the customer/repairshop unpainted (black). It is then painted locally, which in a majority of cases has been problematic in terms of quality.

- The growing number of colours and models makes it impossible (or at least extremely space-consuming) to store painted covers in a warehouse.

Using their competence from earlier JIT-deliveries of OEM components, Raufoss is working on a project to supply the bumper beams JIT to the customer. This includes no buffers and the actual beam-cover is moulded and painted to customer order. Logistically, it is planned to take five days from order until the painted bumper cover is delivered to the local representative. Raufoss will deliver to the Volvo central warehouse in Göteborg, whereafter it is Volvo's responsibility to keep the time-schedule.

The strategic part of the entire project is the flow of information. Orders have to come from a local dealer in, for example, Belgium to Volvo and on to Raufoss. When the bumper cover is produced it has to be transported to Göteborg, go through the central warehouse and distributed within the Volvo system to Belgium. The goal is to enhance delivery reliability and product quality for spare-parts using the same requirements as the delivery of components to the production-line. The project had its first practical test in May 1998 and with regard to the result of this and other tests it might be an opportunity for the Norwegian factory to continue its operations.[19]

In the light of the latest restructuring process, the factory in Raufoss has lost work and product development responsibility in the Automotive Plastics area to the Göteborg Plant, where a new product development function was started in 1998. The only supply of complete bumper systems from Raufoss is for the AutoNova plant in Uddevalla (the Volvo C70-model). The deliveries are made in sequence even though the distance Between Raufoss and Uddevalla is 300 kilometers. It is made possible mainly due to the assembly concept at the AutoNova plant, where each car is built by one team of workers. This allows for longer lead-times making this arrangement possible.

13.4 Ghent - Belgium [20]

Background

Raufoss Automotive Belgium NV was founded in 1990 and is located in Ghent. The main objective of the plant is to deliver bumper systems according to sequential JIT-demand from the Volvo factory. The rationale behind the location in Ghent is linked to the increasingly rising demand for reliable and frequent deliveries which could no longer be supplied by the Norwegian production plant. One of the results of having Volvo as the only customer for the Plastics division meant that the opening up of a complete assembly by Volvo in Ghent in 1972 to a large extent influenced the decision to follow Volvo to Belgium.

The Ghent factory had 180 employees and a yearly production of approximately BEF 1.6 billion in 1997. The main customer is the Volvo assembly plant in Ghent with 85% of the sales, while the last 15% is divided between other parts of Volvo and Hydro-Raufoss, as indicated in figure 13.4.

[19] According to telephone interview with Per Harald Stokstad in november 1999, Germany and the U.K. are supplied 100% by bumper spare-parts JIT . The rest of the European market for Volvo-bumpers will be covered during the first half of 2000.

[20] This section is based on a plant visit and interview with Mr Filip Bral at Hydro-Raufoss Automotive, Ghent, Belgium in August 1996. The information was updated through a telephone interview in October 1998.

The production process

The Belgian plant has a fully integrated production process from the raw material to a "ready-to-assemble" bumper-module. Figure 13.3 provides a simplified picture of the production process. The flow of material is shown together with the production time for each part of the process. Starting in the lower right corner of the figure we can follow the process from plastic granulates that are moulded into bumpers. The process takes 105 seconds per bumper and Raufoss have 4 moulding stations. The actual moulds are a strategic part of the manufacturing process and are owned by Volvo. At the time of the first interview in 1996, the moulding process was considered a bottleneck and run seven days a week, with three shifts in order to build up a sufficient stock during weekends. At the time of the follow-up in october 1998, this problem was solved, and production was down to five days per week in two shifts.

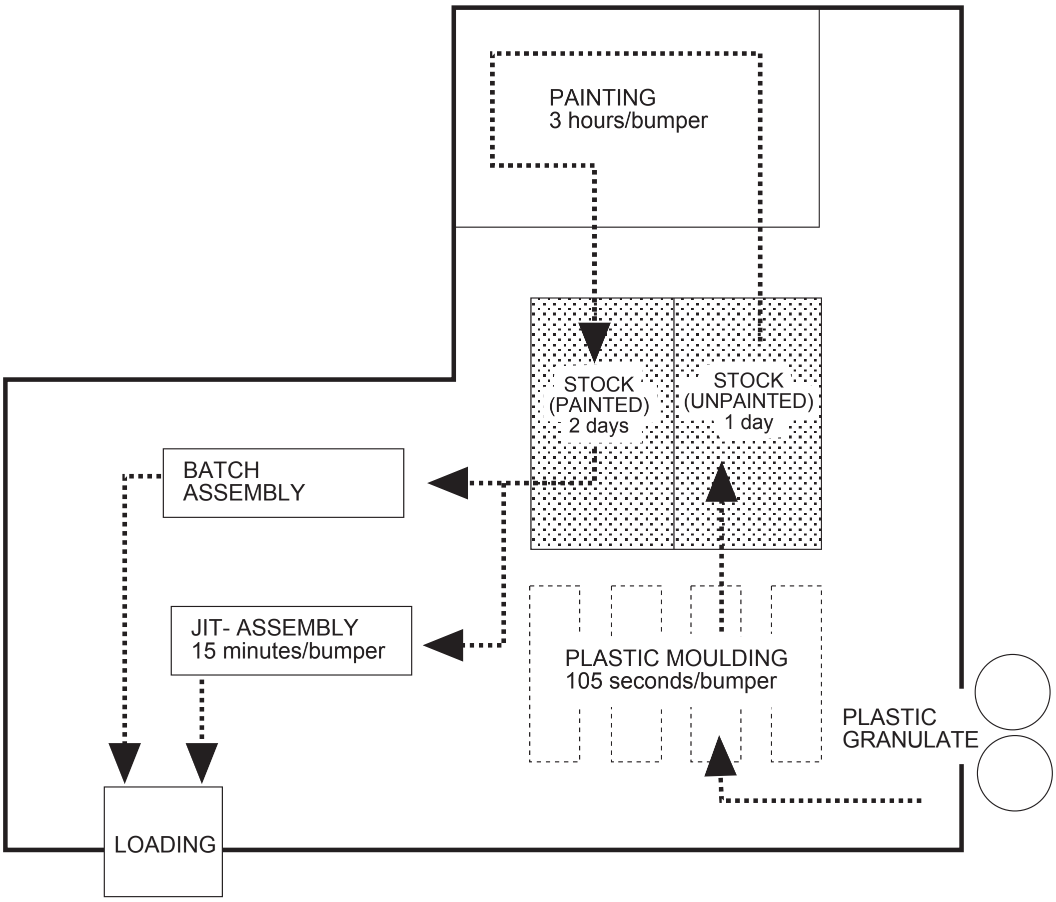

Figure 13.3: Generalised plan of the production system at the Raufoss Ghent plant.
Source: Interview and plant visit with Filip Bral in August 1996.

The work-in-progress inventory is automated and consists of two parts, the unpainted and the painted part. We will come back to the stock of painted bumpers later. In an ideal situation there is a one-day stock of moulded plastics waiting to be painted.

Painting is the most time-consuming activity in the process. It takes three hours for a bumper to go through the paintshop, which includes a number of steps such as cleaning, preparation, painting and drying. The operation is normally run 5 days per week in 3 shifts. The painted bumpers are placed in a buffer that holds components for approximately 2 days use, which is a 1-day increase compared to the situation in 1996. This is mainly due to the fact that painting, since then, has become the relative bottleneck in the process.

The last step, final assembly, is separated into two different types: JIT-assembly in sequence to the Volvo plant in Ghent and batch- assembly to other customers (Raufoss Göteborg and other Volvo companies). The final assembly takes 15 minutes per bumper and includes the joining of the plastic bumper and the aluminium beam, completed with foam and fasteners. The finished bumper is put on a specially constructed rack with space for front and rear bumper. The sequentiation-racks are loaded onto a trailer for delivery to Volvo Ghent. The JIT-assembly follows the pace of Volvo (5 days 2-shift), while the batch assembly is made during the night shift.

The geographical organisation of the production system

The production system is relatively simple with a few raw material suppliers and a limited number of customers. There are four main input components to produce a bumper: plastic granulates, paint, aluminium beams and foam. Figure 13.5 shows the components of the system. Purchases are distributed geographically as follows:

Country of origin	% of value	% of volume
Norway	50	60
Netherlands	20	15
Belgium	15	5
Sweden	5	10
Germany	5	5
Others	5	5
TOTAL	100	100

Table 13.1: Distribution of purchase value and volume to the Hydro-Raufoss Ghent unit 1998, by country of origin. *Source:* See figure 13.3

Norway is the most important supplier base due to the fact that Raufoss head office and traditional suppliers are located in the region (see figure 13.3). In the current restructuring process, Hydro-Raufoss Plastics headquarters and development facilities moved to Göteborg, which consequently has meant a repositioning of the center of power towards Sweden. The four main components stands for approximately 95% of the volume and the locational pattern is determined mainly by Raufoss central purchasing policy. There is only one example where a foam-supplier close to Ghent have been selected, mostly because of the transport costs for the bulky, light and relatively low-cost product.

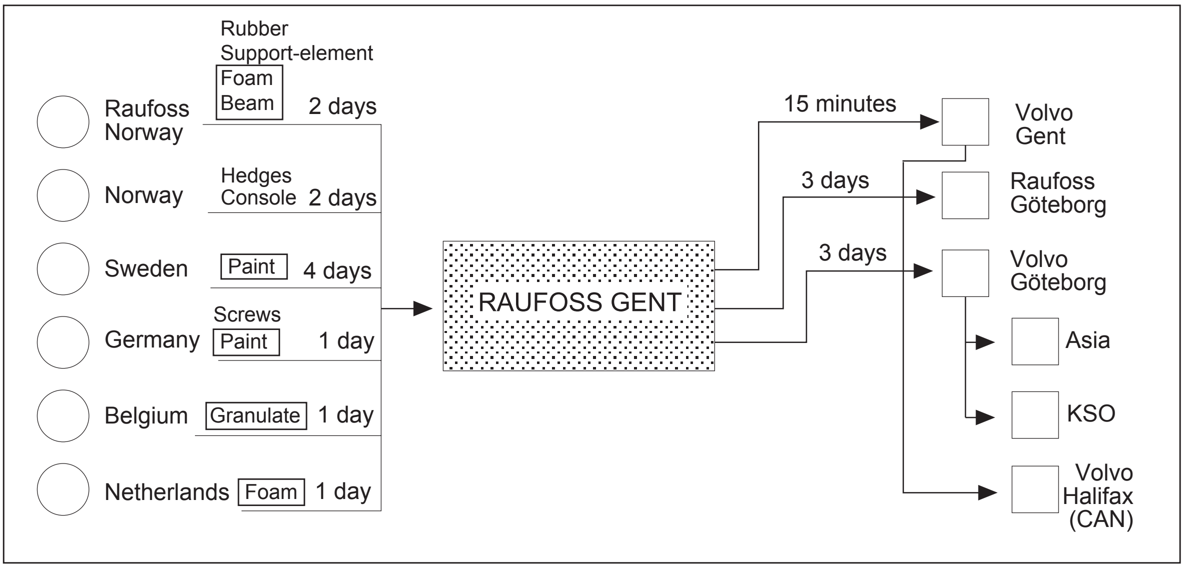

Figure 13.4: Supply chain and customers of Hydro-Raufoss in Ghent 1998. Labels indicate lead-time, text in boxes indicate most important components.
Source: See figure 13.3

The most important customer is the Volvo Automotive-plant in Ghent, to where 85% of the production is directed. Raufoss Göteborg buys bumpers for the S/V 70-model, because Raufoss Ghent has the only mould for certain special orders. Other customers are Volvo-related such as: Volvo Asia, KSO (knock-down kits and specialty vehicles) and Volvo Halifax (Canada)[21].

21 The Volvo Halifax plant closed its operations during 1999.

Time-compression and logistics in the production process

Time compression and delivery requirements are very different between Volvo Ghent and other customers. The JIT-production towards Volvo Ghent is organised similarly to the one in Göteborg, with 14-day call-offs and sequential-orders 5 hours before delivery to the assembly line. Raufoss delivers 17 times per day using two drivers and two trailers taking up to 40 bumper-sets each. The trailers are either at Raufoss being loaded or at Volvo being unloaded. The transport time to Volvo is 10 minutes.

Apart from the obvious advantage of being located close to Volvo, there are a couple of other aspects behind why Raufoss can fulfill the JIT-requirements from Volvo:

- *Stability:* the daily call-offs from Volvo are not changed in more than 5% of the cases. Although 14-day call-offs do show a bigger discrepancy.

- *Security:* with a 2 day buffer of painted bumpers.

- *Simplicity:* only 4 main input components and a stock of material for 3-4 days production.

The delivery and time-related requirements from Volvo Ghent is not directly reflected in the relation between Raufoss Belgium and their suppliers. Questions regarding logistics and transport from suppliers are handled by Raufoss in Göteborg and Norway

Product and process relations

Raufoss Belgium has very limited contacts with Volvo Ghent are questions regarding product development. These matters have to be passed along the formal R&D channels at Raufoss and Volvo in Göteborg. Raufoss Belgium is responsible for the process development, both inside the factory and in relation to Volvo Ghent. This means that product development is made in Norway or Göteborg and responsibility for the production process is delegated to Belgium. The only formalised contacts with Volvo are the daily quality audit meetings held at Volvo. These are not compulsory for suppliers, but absence will of course be noted.

Summary

Raufoss Belgium is an interesting example of a highly specialised JIT-production-unit within a larger production system. The main aim of the Ghent facility is to manufacture and deliver according to extremely high demands set by absolute dominant customer; the Volvo assembly plant in Ghent. This is maintained though a relatively simple process with few inputs, relative stability in orders, 2-day buffers and location within 10 minutes transport-time from the Volvo plant.

The JIT-requirements are not directly channeled down the supply chain. Non of the Raufoss-supplies can be characterised as being highly committed to one customer. Delivery problems are instead solved through different logistical arrangements, one example is the plastic granulates which are stored by the supplier outside the factory and delivered daily. This arrangement is facilitated by the fact that the inputs are generally simple and of relatively low-value.

Power used to be centered to the HQ in Norway and the Belgian factory can be seen as a "satellite" in most respects. Following the restructuring and investment in Göteborg, there will be a change of power towards the Swedish unit. The situation for the Ghent factory is not influenced in any great detail by this.

The function of Hydro-Raufoss in Ghent is mainly to serve as a production point with limited R&D responsibility. Delivery requirements are extremely demanding with sequential production and delivery every 30 minutes. In terms of geography, this form of production is highly associated with proximity in order to maintain both delivery standards as well as quality levels and personal communication.

13.5 Göteborg - Sweden [22]

Introduction

Hydro-Raufoss Automotive Plastics started its activities in Göteborg in 1993 with the establishment of a sequentiation warehouse for JIT-supply of bumpers to the S/V 70-models. The function of the facility was to receive bumpers from the other Raufoss production-units and thereafter store, sort and deliver according to the sequentiation orders from Volvo. Due to increasing demands from the main customer regarding flexibility, delivery and quality of the painting process, there was need for investment in a new production facility within Hydro-Raufoss. The decision was taken to convert the warehouse in Göteborg into a new complete production-unit including moulding

22 This section is based on plant visits and interviews at Hydro-Raufoss Automotive, Göteborg, Sweden, with Mr Ingemar Olsson in September 1994 and Mr. Henrik Karlsson in August 1996 and October 1998.

and painting, equivalent to the facility in Ghent.

The new production-unit opened in August 1997 and had 170 employees and a turnover of approximately SEK 250 million in 1997/98. The rapid development of the Arendal site can be seen in the number of employees which counted to ten in 1994, compared to the projected 200 at the end of 1998.

Production in Göteborg is totally directed towards Volvo Torslanda, with only a marginal portion (1-2% of the value) to Volvo Parts for the after-sales market.

Production process

The new production-unit is a complete integrated factory with both moulding, paintshop and final assembly. Although the actual layout and machinery are different, the general production process is the same as in Ghent (see figure 13.3). Production is synchronised with the Volvo assembly line, which means 2-shifts for the S/V 70-model and 1-shift for the new S 80-model. Due to the fact that the process is still in a trial-mode and that the quality in the painting-process is a bottleneck, moulding is done in 3-shifts, and in some cases on weekends to build a sufficient stock.

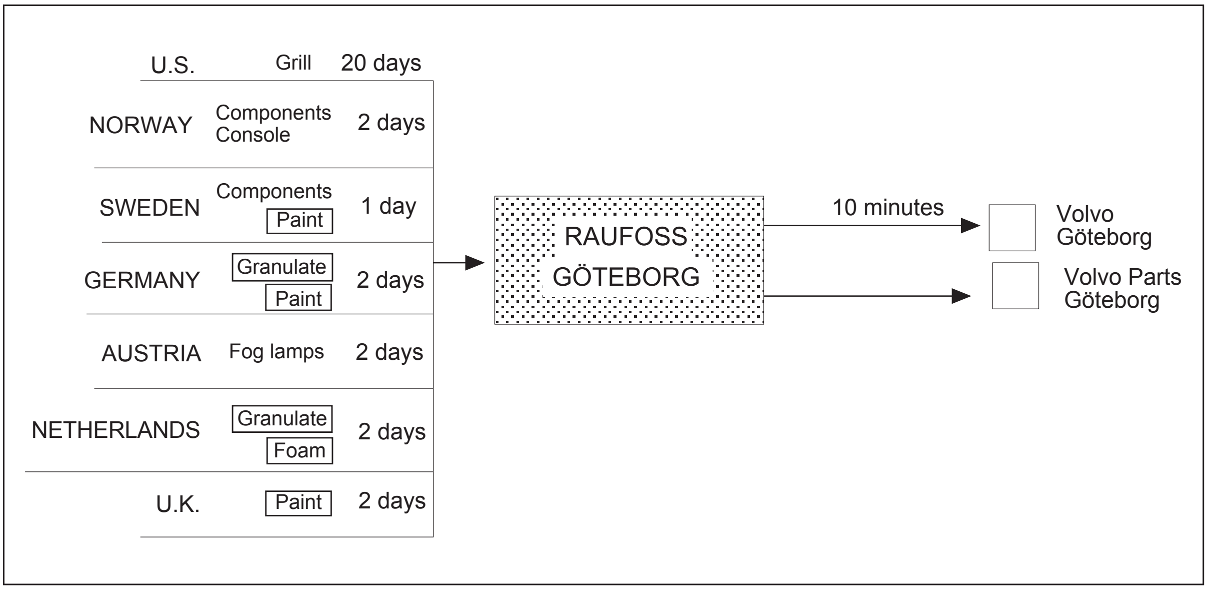

Figure 13.5: The supply chain and customers of Hydro-Raufoss in Göteborg. Labels indicate lead-time, text in boxes indicate most important components.
Source: Interviews with Henrik Karlsson in May 1996, June 1998.

The general outline is the same as in Ghent, including the following steps; moulding → buffer → painting → buffer → assembly → delivery. The most significant difference is that the paintshop is new and able to correspond to the demand from Volvo regarding the new S 80-model. This is not the case in Ghent, and a future upgrading of the paintshop is planned to take place.

After the painting process, there is a two-day buffer of painted covers, in total 14 different colours for the two models. Assembly of the final bumper module including all details is made in sequence to Volvo orders. One major difference in product between the 70- and 80-models is that the new cars have the aluminium beam put on the body by Volvo. This means that Hydro-Raufoss for future models will concentrate on the plastics product and the aluminium part of the product will go to Volvo directly from Hydro-Raufoss Structures in Norway .

Figure 13.5 shows the main components and the customer structure for the Arendal production plant. Note the concentration on one customer, who receives 98-99% of the total output. Incoming components are similar to the ones in the case of Ghent, with the important exception of the aluminium beam which is not included in the S80-products in Göteborg.

Geographical organisation of the production system

It has become clear that the investment in Göteborg shifted the geographical organisation of the production system in a fundamental way. During the time as sequentiation warehouse almost all of the incoming material consisted of finished bumpers from the Raufoss production facilities in Norway, Belgium and Sweden (Uddevalla), The only suppliers unique for Göteborg was components such as fasteners, bolts and clips.

This setup is very different from the current situation where the entire production process is conducted at the site. Most important is the fact that inputs which used to be finished products from one company are now a large number of incoming components from a number of outside independent suppliers. One of the basic changes in the supplier base is the growing importance of Sweden and the decline of Norway and Belgium.

One major factor behind the growth of Swedish suppliers is the move of production from Norway to Sweden and the possibility to use this occasion to change the supplier structure in favour of more local suppliers. The other main factor is the strategy by Volvo to encourage suppliers to deliver more complex products. This has the effect that Hydro-Raufoss is taking over former Volvo-suppliers who used to deliver directly to the assembly-line. As the bumpers becomes more complex, much of the final assembly is made by Hydro-Raufoss, while the former Volvo subcontractor becomes a second-tier supplier. The procedure of transferring the suppliers from Volvo to Hydro-Raufoss is preceded by a quality approval, this might be seen as a method for Volvo to have control and influence over second-tier suppliers.

The demand for sequential deliveries is the main rationale behind the location of Hydro-Raufoss in Arendal only 10 minutes from the Volvo assembly plant. In this case, spatial proximity is essential for the delivery and production setup. These tight time-limits are not directly reflected in the supplier structure of Hydro-Raufoss, who have suppliers located across Europe, although the majority are within one-day of transport. One exception is the supplier of the front-grill which is a North American company, with approximately three weeks transport time to Sweden. This is a problem within the present time-compressed environment.

Besides the physical delivery requirements, there is an obvious advantage of being located close to Volvo when there is need for personal contacts. This means that the people assembling bumpers at Hydro-Raufoss know the people at the point of assembly at Volvo. Every-day problems are solved at shop-floor level and there is only a five minute drive in order to be at Volvo and take action to solve problems. Close contacts at managerial level are also facilitated by the proximity to Volvo.

Yet another aspect of location is the function of the Volvo Arendal supplier-park in which Hydro-Raufoss is located. The presence of seven other sequential suppliers has not yet developed into any formal co-operation projects, but there have been discussions concerning sharing employees and competence.

Time compression and logistics

It is the delivery requirements that constitute the basic rationale for being located in close proximity to the Volvo assembly plant. The general organisation of production and delivery is the same as in Ghent with several levels of time-requirements:

- *delivery instructions* which are made up for one year at a time, and are updated monthly.
- *call-offs* cover the following 14-day period with three "frozen" days. This means that the last three days are fixed in the production plan at Volvo.
- *sequential delivery instructions* set the exact order (in terms of model, colour etc) in which the cars are put on the assembly line. These are received 3-4 hours in advance.

Parallel to the case of Ghent, this arrangement is based on *stability* in production plans, *security* in the form of a two-day buffer of finished products and a relatively *simple production process* in terms of the number of inputs and customers.

Hydro-Raufoss delivers finished bumpers each hour, but receives inputs once a week. This means that the first-tier supplier in this case acts as a "time-buffer" between the extremely frequent deliveries to Volvo and the more relaxed arrangement towards the sub-suppliers. The outcome of this is that Hydro-Raufoss has an average one-week's supply of incoming components and up to three weeks for granulates and paint. What is evident here is that the total supply chain is not involved in the tight just-in-time requirements that faces the primary supplier, and the costs for inventory have been transferred one step upstream in the production-chain.

Questions of transport become strategic in a sequential JIT framework. In this case, Volvo is responsible and organises the transport of the finished bumpers from the Arendal facility. The delivery of incoming components to Hydro-Raufoss is organised by themselves using outside transport-firms (e.g. Volvo Transport) for the physical movement of the goods.

The product and the production process

Before the start-up of production in Göteborg, all of the product development activities took place in Raufoss. In the same fashion as in Ghent, all R&D matters had to go through the headquarters in Norway. These conditions are changing because the headquarter for Hydro-Raufoss Automotive Plastics has moved to Göteborg together with the investment in the new production plant.

Today, the entire company is managed from the Headquarter in Göteborg with approximately 15 employees. The actual development is still done in Norway due to the competence that has been built up in Raufoss. This has the rather paradoxical effect that even though the company headquarters now is located 500 meters away it has not changed the involvement in practical product development activities.

It is mostly within every-day problems that direct contacts between the Arendal unit and Volvo Torslanda are made. Table 13.2 shows how different types of contacts generate different intensity in terms of personal contacts.

TYPE OF CONTACT	CONTACT INTENSITY (average)
R&D, product development	monthly
Production	3 times per week
Quality issues	at least daily contacts

Table 13.2: Importance of personal contacts in different fields. *Source:* See figure 13.5

As can be seen, the most frequent contacts are within the field of quality. This involves short visits to the assembly line in connection with every-day problems. These are simple to manage thanks to the short distance between the production-units. Raufoss does not have to assign one person responsible for quality, since the short distance means that anyone involved in the actual problem/project can visit Volvo and handle the question on site.

Summary

The Hydro-Raufoss Automotive Plastics plant in Göteborg has been in operation since 1993 with the aim of delivering in sequence to the Volvo Torslanda assembly plant. The period up to the end of 1998 has seen a major change in the function of the unit, from a warehouse for storage and sorting to a complete integrated production-unit.

Products and delivery requirements are still the same but profound changes can be seen in the supply structure and of course in the internal production process and number of employees. After the investment in Göteborg, has the supply system changed in favour of Sweden.

In terms of power, the unit is still very much of a "production-satellite" controlled by the head office. This might change as the headquarters have moved from Norway to Göteborg, though still heavily dependent on Norway for development capacity. The fact that Volvo Torslanda counts for 99% of the output is another factor which will influence power-relations and the future strategies of the company and the Göteborg facility.

13.6 Concluding discussion

The case of Hydro-Raufoss is an example of the spatial and organsational development of an automotive supplier in order to meet the increasing demand for product quality and complexity together with extreme delivery requirements. In figure 13.6, this process is described with the use of the supplier matrix discussed in chapter one. The vertical axis shows the degree of technological co-ordination involved in the relationship between each unit at Hydro-Raufoss and the main customer Volvo. This involves research and development as well as daily problems regarding the production process. The horisontal axis displays the degree of coordination of physical deliveries between Raufoss and Volvo.

We can see from the the figure that all of the production units are either at the extreme right or moving towards the extreme left. This comes from the general strategy to closely follow the demand for sequential JIT-deliveries put forward by Volvo. The logical outcome of such a strategy is that the production units will either become extremely important in terms of deliveries towards Volvo or, as in the case of the Norwegian plant, disappear from the field as a first-tier supplier.

The physical delivery dimension demonstrates a clear connection to the importance of geographical proximity towards the customer. The two production units that perform sequential JIT-deliveries are located only minutes away from the respective Volvo plant, a situation which puts them on the extreme right in the figure. It is important to stress the difference between JIT as a general principle and sequential JIT deliveries. The latter, together with minimum inventory principles, is the main driving force behind the spatial restructuring of the supply-system of Hydro-Raufoss Automotive Plastics.

The development of the Ghent plant is relatively stable due to the fact that its function in relation to Volvo has been more or less constant since establishment in 1990. Production and delivery according to demand from Volvo Automobile in Ghent has been the main task for the plant ever since the start. It implies a position on the extreme right when it comes to physical delivery and time-compression in the production chain but only medium importance in areas of product development or production-process development. The main reason behind this is the position within Hydro-Raufoss where all of the research and development facilities have been located in Norway, and from 1997 in Sweden.

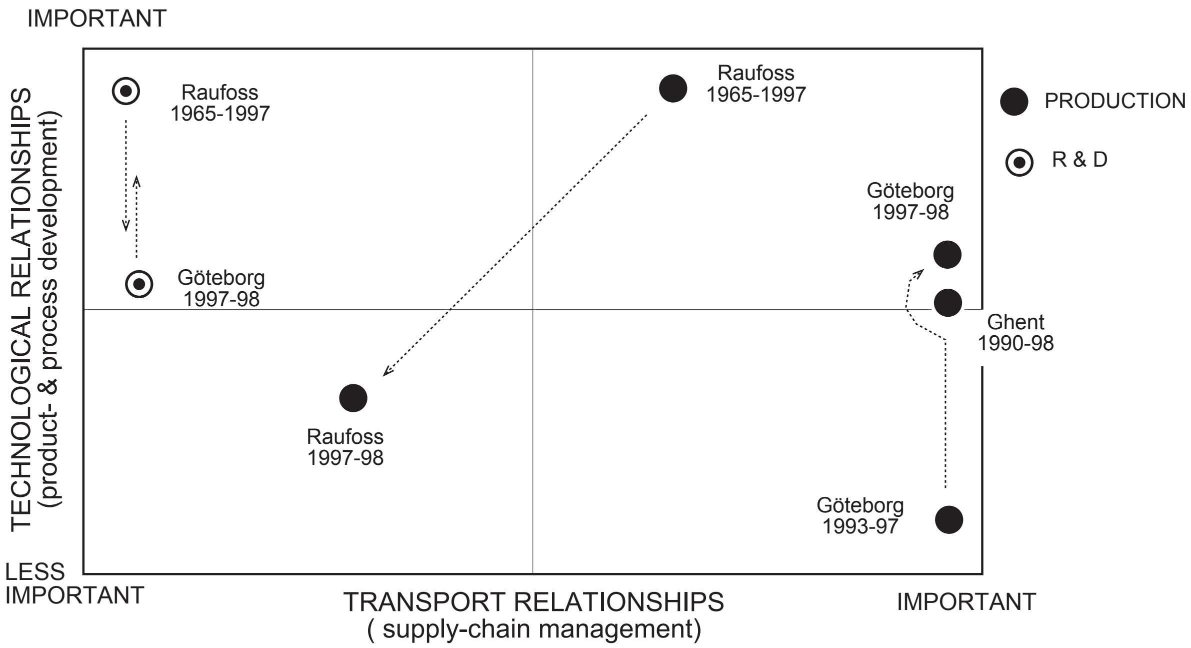

Figure 13.6: The shifting positions for production and R&D units within Hydro-Raufoss Automotive Plastics 1965 - 1998. Axles denote the degree of co-ordination in relation to the customer (Volvo Automobile) regarding product/production and physical delivery. *Source:* Author.

In the figure, the Göteborg plant is positioned adjacent to the Ghent plant. The arrow shows the development from a sequentiation warehouse without production capacity, to a complete production unit such as the one in Belgium. With the movement of the R&D facilities from Norway to Göteborg there might be reason to suspect that the Göteborg production-unit will gain more direct influence over development issues as the organisation will mature and the traditional influence of Norway decrease.

The plant in Raufoss made the most dramatic move in the figure when the investment in Göteborg cut off the possibilities for orders to new Volvo models. They are still supplying with special orders and as a buffer for the S/V 70 model for which they still have production equipment. In the future the Raufoss unit will continue to develop their competence within JIT-supplies by entering the aftermarket and deliver customer-ordered spare-part bumpers together with Volvo across Europe under just-in-time conditions. This project is still under development but is an interesting example of how competence within the OEM-sector can be used in other spheres of the automotive industry.

If we consider the vertical dimension of the matrix, here are signs of more movement compared to the horisontal axis. This is linked to the investment in

Göteborg, including the movement of the Plastics headquarter. Göteborg has become increasingly important for the Volvo-related bumper systems produced by Hydro-Raufoss Automotive Plastics (HRAP).

This is even more important in this case than in general due to the extreme product specialisation and customer concentration showed by HRAP. All new products are developed in joint development groups, where the R&D resources in Norway are central due to the historical centralisation of development capacity. This might change over time if HRAP choose to develop the Göteborg HQ, or if the mother-company Norsk Hydro decides to sell the automotive division, which is relatively remote from their core activities.[23]

One geographical aspect of the R&D restructuring is that the Göteborg location provides significantly better accessibility to the Volvo product development facilities. The short distance means that face-to-face contacts can be established within 10-15 minutes if needed, a situation which is very different from the previous where all R&D questions had to be channeled through the head office in Norway.

The concentration of production of complete bumper-systems to the main customer Volvo is very clear, and might pose problems in a longer perspective. Especially the Göteborg-facility which is located relatively far from other major potential customers (except for SAAB in Trollhättan).

The restructuring process within the company reflects the continuing ownership concentration within the automotive supply industry in general. Since the first discussion with the Göteborg office in 1994, there has been a number of changes regarding ownership within Hydro-Raufoss Automotive. One conclusion is that the demand from the automotive industry creates fewer and bigger first-tier suppliers with the financial backup and technological competence that allows for increasing investments in product development activities and technological know-how.

Hydro-Raufoss Automotive Plastics has taken this to the extreme with one-customer dedicated production units and specialised products. At the same time, new investments are made in Sweden, which is relatively remote in European terms. The future of the company, as it is today, lies very much in the development of Volvo Automotive. One alternative direction might be to enlarge the concept of dedicated sequential JIT-production plants to include other customers besides Volvo.

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[23] See footnote 16, p.199

14. The geography of changing automotive supplier relationships: a concluding discussion with focus on domestic suppliers to Volvo Torslanda

14.1 Introduction

The aim of this concluding chapter is to bring together the general discussion in the first half of the thesis with the empirical studies presented in chapters nine to thirteen. It is structured according to the four research questions posed in the first chapter. The first question, regarding the organisation of supplier relationships with the Volvo Torslanda assembly plant is discussed in section 14.2. In the following section, the time-dimension is in focus. The extent and content of time-related supplier strategies will be examined and compared to the development path in different regions.

In section 14.4 the central question of the thesis is discussed, namely the importance of geographical proximity in the restructuring process of the domestic supply system of Volvo Torslanda. A model of the relationship between supplier-types and location will be presented. This is discussed further and put into a wider context with the point of departure in the Volvo-case. Proximity as a concept will be analysed, especially the difference between geographical and temporal proximity.

The chapter ends with a discussion about the future of automotive supplier relationships, their organisation and geographical outcomes. Of special interest is the comparison of general models of buyer-supplier relationships with the Volvo case in order to see to what extent a case study can add to the understanding of the restructuring process in the automotive supplier industry.

14.2 The organisation of supplier relationships

Several models and concepts regarding the restructuring of automotive buyer-supplier relationships are presented in chapter four. In order to describe the current trend, authors use concepts such as *obligational contracting* (Imrie and Morris 1992), *voice strategies* (Helper 1991) and *partnership* relationships (Lamming 1993). The common denominator for all of these is the increasing importance of *collaborative relationships.*

In order to meet increasing demands from the automotive companies regarding lower prices, better quality, outsourcing, increased responsibility for product development and more frequent deliveries' the supplier business has witnessed a rapid restructuring process. The most prominent manifestation of this development is a concentration process where fewer and larger suppliers are positioning themselves as first-tier suppliers. These companies develop their businesses by taking on responsibility for production and development previously done inside the car-manufacturers' own plants. The end result is a hierarchical model of organisation, where large corporations act as co-ordinators of second-tier suppliers. A model that is commonly referred to as a Japanese form of supplier organisation.

Another aspect of the restructuring process are the changes related to product, production-process and technology. In order to attract customers, most models, especially in the middle and upper segments, are marketed in a large number of variants, colours and customer-ordered interiors. The fact that production is made on demand rather than based on forecasts, means that there is a substantially shorter time-span for the production of a much wider variety of car-models today compared to ten or twenty years ago.

The car producers have responded to this increasingly complex task of co-ordination of both information and goods by outsourcing to suppliers. One recent trend within the automotive industry is towards *modulisation,* where suppliers are responsible for the assembly of several components into a module. The final assembly of the car will then be reduced to combining a small number of modules ready-to-assemble into a complete car.

We can summarise the discussion so far by concluding that supplier relationships in the automotive industry have witnessed a number of changes in the recent two decades:

- The development of a hierarchical model with distinct supplier-tiers
- Fewer and bigger suppliers in the top layer
- Increased responsibility for first-tier suppliers
- Increasing number of product-variants
- Products are increasingly more complex, from single components to modules
- Internationalisation of ownership

We will use this general picture as a backdrop for the discussion of the domestic Volvo-suppliers in the study. Regarding the establishment of a supplier hierarchy, it is possible to see a clear break in supplier strategies in connection with the supplier selection process for the S80-model. The empirical data covering the development up until 1996/97 show very little evidence of such a process. From the discussion in chapter nine it is possible to conclude that almost all of the firms in the study had been first-tier suppliers to Volvo for the last 20 years or more, an indication of the slow pace of restructuring up until the model change associated with the S80 in 1998.

It is possible, though, to trace the start of the concentration process of the domestic system in the 1996/97 data. The most "advanced" production units, with respect to the factors identified above, are the most recently established. In one of these cases the company was a traditional Volvo-supplier, later acquired by a global supplier-company. Although it can be argued that this is not a case of a recent establishment, the changes in production and delivery have been considerable.

The organisation of a supplier-hierarchy in association with the development of the S80-model, resulted in the establishment of the supplier-park almost adjacent to the Volvo assembly plant in Göteborg. The strategy of module-supply and sequential JIT-deliveries resulted in the location of ten systems or module suppliers who accounted for almost two thirds of the total value of deliveries to the new model. This includes the new sequence-terminal for engines and drive-train located outside the supplier park, and managed by Volvo Components Corporation. The new structure involves a major change compared to the situation in 1996 where over 150 domestic first-tier suppliers (only independent) were needed to cover more than half of the total value of purchases to the final assembly at Torslandaverken.

The structure of the domestic supplier system after the introduction of the S80-model has not been possible to study within the limits of this thesis. It is highly probable, though, that many of the 154 domestic suppliers in 1996 have become second- or third tier suppliers, creating the foundation of a hierarchical structure in Sweden. Involved in this development is also the concentration of development and production capacity to a limited number of large suppliers. The example of Lear Corporation and their acquisition of five former Volvo-owned supplier units is the most comprehensive. During 1998, Lear Corporation established a sequential delivery unit in the Arendal supplier-park to coordinate deliveries from all of the former suppliers. This function was relocated inside the Volvo Torslanda factory in connection with the move of the seat production from Bengtsfors in the spring 1999.

One of the driving forces behind the concentration process is the need for first-tier suppliers to meet the trend towards more responsibility for product development and global presence. In order to follow the large global car-producers demand for product-development, production and supply, a supplier needs to have both top-end technology as well as a solid financial backup. In the study of the largest Swedish Volvo-suppliers this restructuring is visible only in to relatively limited extent. Half of the suppliers indicated that they had moved towards more complex products during the last decade. It may not be possible to conclude that all of this is due to direct outsourcing from Volvo. The process could instead be termed "indirect outsourcing", meaning that suppliers have gradually taken on more responsibility when new material or technologies have been introduced. This would have been conducted internally by

Volvo in the traditional system, and later specified to the supplier when a new component was needed.

It is important to point out that not all suppliers are establishing themselves as module-suppliers. The main movement among the Volvo suppliers before the S80-model was from single components towards more complex products. Only a third of the suppliers characterised themselves as systems or module suppliers. This can be interpreted as a first phase in the upcoming restructuring process. One important and often neglected group of suppliers are the ones that display no change towards more complex products or increased responsibility. A handful of these may defend their position as first-tier suppliers due to some specific competence, but the majority are most likely to be found in the lower tiers of a future hierarchical supply system, or move to other industrial sectors.

This is reflected in the fact that the majority of the suppliers in 1996/97 indicated that their products had become generally more complex during the last 10-year period, but only 10% specified new materials or electronics as major factors of complexity. This could be taken as an evidence of the relatively low technological level of traditional Swedish automotive suppliers. A further indication of the lack of domestic suppliers in high technology sectors is the absence of investment in product development. Almost 80% of the answering firms reported less than 10% of their total cost as being related to product development towards Volvo Torslanda products.

Although the most important suppliers have become larger in terms of capacity, volume and product complexity, the number of employees at the units for final delivery is relatively small. Most module suppliers located in the supplier-park have less than 100 employees, while at the same time are subsidiaries of large international corporations. This reflects another important finding in the study, namely the growing internationalisation of the supply base. The ownership situation has changed dramatically during the 1990's, especially since the establishment of the Arendal supplier-park. In the beginning of 1990 the majority of the automotive suppliers located in Sweden were controlled by domestic owners. Today, almost ten years later, we are facing the opposite situation. Only one third of the suppliers in the 1996/97 study, and none of the units in the supplier park are controlled by predominantly Swedish capital.

The question of foreign ownership has become even more pronounced since the takeover of the Volvo Automobile operations by Ford in April 1999. In the longer perspective this will, most likely, have significant consequences in the area of supplier strategies. Common platforms and assembly operations within the Ford-group will create conditions for larger orders and lower unit-costs from the suppliers who can match the demand. From the point of view of this study, there are no signs of any short-term consequences for suppliers to the current Volvo-models. One conclusion is that the most significant changes in the supplier structure are linked to the introduction of new models. This indicates that the Volvo/Ford deal will not have a major impact on the Volvo suppliers until the first jointly-developed model.

We can conclude that the domestic supply system of the Volvo Torslanda Plant is in the middle of restructuring process, where a number of different supplier-types are present simultaneously. This will most likely change in the near future into a system with several distinct layers of suppliers, led by a small number of integrators with global presence.

In order to summarise the current situation, four supplier-categories can be identified on the basis of the 1996/97 study:

- *Integrators* have their main function as co-ordinators of the component-flow into complete modules. Products are complex and the production unit is concentrated to the supply of the Torslanda Plant. The level of responsibility for product development is high. Product specifications and development are performed through a high level of co-operation with Volvo.
- *System-suppliers* differ from the above mainly by product complexity. Less complex products require less co-ordination activities, both towards the suppliers and Volvo. These production units are not dedicted to Volvo Torslanda to the same extent as the above.
- *Specialists* compete with competence related to one or several products or processes. Have a relatively broad customer base within other fields outside the automotive business.
- *Traditional* suppliers form the last group. Products are more standarised and the customer-base wider compared to the other groups. The development and manufacturing process is less dependent on cooperative arrangements with Volvo. Firms in this category are the ones most likely to become lower tier suppliers.

The suppliers in the 1996/97 study have been categorised according to factors related to the product and the production process. This alone shows no strong correlation with location in close proximity to Volvo Torsladaverken. If we add the suppliers in the Arendal supplier-park, we can distinguish a clear shift in supplier-types. All of the new units in the park can be characterised as integrators, or subsidiaries of global integrators.

The distinction between independent complete production units, such as Hydro-Raufoss and local warehouses connected to a large supplier is important. Is it possible to define the local unit as a first-tier supplier, or is the location of the mother company a more appropriate unit of analysis? It highlights the question of definitions and concepts. One conclusion from this work is that the traditional view of a supplier or subcontractor has changed. It is less likley that we find *one specific company* that performs the sub-contracted work *according to specification* from the buyer. The relationships are characterised to a great extent by a *network* of production units, controlled by large internationally-owned corporations. These have access to product development capacity which allows them to *develop new products together* with the car-manufacturers.

This development follows the general models of buyer-supplier relationships and is applicable to the domestic Volvo supply system as well, but is still in the process of change. The concetration process within the automotive supplier sector has produced a number of large corporations dedicated to the automotive industry and we can speak of automotive suppliers as *a category of its own.* Firms that fit into the traditional general sub-contractor category will be found in the lower tiers of the supply pyramid in the future.

Product characteritics and the organisation of the production chain has been one group of factors used to explain the development of the Volvo supply system. In the next section this view is completed with the impact of new logistics and transport arrangements on the geography of the Volvo suppliers.

14.3 Time in focus - new conditions for transport and logistics

So far we have concentrated the discussion to organisational changes related to product characteristics and production process strategies. The other major aspect in this thesis is the significance of new time-restrictions on supplier relationships. Volvo has, together with the rest of the world's automotive producers, worked towards shorter lead-times. These efforts have been directed towards the entire production process from raw-material to the final customer.

One effect of this has been an increasing focus on the supply chain. The rationalisation of time-usage is one major tendency among Volvo suppliers. This can be seen in the widespread adoption of the just-in-time production philosophy, which aims at a continuous reduction of unnecessary time and material in the production process. The implementation of this in the production process of a car-producer affects the supplier relationship. The most important aspects are:

- Less inventory due to rationalisation and minimisation of buffers.
- Increased delivery frequency to match the growing product variety and decreasing inventory.
- The relative rise of reliability, at the expense of cost and speed, as the important factor in transport systems.

Reduced inventory levels is one feature of "just-in-time" production that the suppliers in the study have experienced. There is a significant difference between the inventory of finished goods compared to incoming raw material and components. Almost two thirds of the suppliers indicate that they have less than one week's inventory of finished products, while the same low levels for incoming parts is reported by only ten percent of the suppliers. This can be taken as an indication that savings in inventory at the assembly-firm level has moved one step upstream to the primary suppliers.

This can vary between products and processes, but the findings on delivery frequency support the general picture. The firms in the study show a significantly lower frequency of deliveries from their suppliers compared to deliveries of finished products to Volvo Torslanda. The average delivery frequency for the suppliers in the 1996/97 sample was 8.1 times per week, while their suppliers averaged only 3.2. Some of the discrepancy may be explained by the size of deliveries, but the major part can most likely be assigned to the process of shifting inventory upstream in the supply chain.

In the case of Hydro-Raufoss the difference in delivery frequency and inventory is especially pronounced since complete production from raw material to final product is performed on the site in Göteborg and Ghent respectively. Important inputs such as plastic granulates, paint and foam are delivered every second day, while finished products are delivered 4-5 times every hour. The fact that the major inputs are few and of relatively low-value, has made it possible to have a buffer of inputs with a limited amount capital tied in inventory.

Although Hydro-Raufoss is located in the Arendal supplier-park, the example is not representative for the other units on the site. No other supplier has located a complete production-unit at the Göteborg site, rather warehouses of different kinds. These act as intermediary sorting-stations between the traditional production-site and Volvo Torslanda. The establishment of these operations can be seen as an extreme case of shifting inventory upstream in the supply chain, adding a new inventory function.

This is explained by the fact that Volvo expects all of the Arendal-suppliers to perform sequential deliveries. In order to maintain reliability in deliveries, with a time-window of only a couple of hours from final order to delivery, establishment of local sequentiation-warehouses has become a widely used method.

The general level of delivery frequency during the last ten years has changed from deliveries once per week to deliveries every day, resulting in a situation in 1996/97 which could be characterised as a "relaxed" form of JIT. There were only a handful of suppliers who delivered more than daily according to sequential JIT-practices. This situation has changed significantly since the start of production of the new S80-model in early 1998.

It is important to point to the distinction between just-in-time as a general philosophy towards reduction of time-usage, and sequential production and delivery. The latter is closely linked to the way production is organised inside the assembly plant. Of vital importance for delivery requirements are the amount of time from when the final sequence of cars is fixed, until the product is delivered. The wider the "time-window" the more time for the supplier to manufacture and deliver.

In the case of Volvo Torslanda, the main limitation is in the paintshop. It is not possible to guarantee 100% quality, which places the point of sequenciation after the painted body has been quality approved.

The use of sequential deliveries is the single most important factor behind the geographical restructuring of the supply system after the introduction of the S80-model. This will be more thoroughly discussed in the next section.

Although the majority of suppliers can be termed "relaxed JIT-suppliers", lorry is the only means of transport for deliveries to Volvo Torslanda. Rail and sea are only used marginally for transport of incoming materials from sub-suppliers, and this has been the situation over the last decade. Due to the fact that the suppliers in the study are domestic and located not further away than 400 kilometers (an average of 179 kilometers) from Volvo Torslanda, the dominance of truck-transportation is not very surprising.

It is interesting to notice that road-transport as the most important means of transport dominates for incoming materials from sub-suppliers as well. Even though many of the respondents' most important suppliers are located on the European continent (mainly Germany), train or sea transport are only used in a very limited range of supplier-relationships.

One explanation of the total dominance of road transport can be traced to what the suppliers experience as being of importance in relation to Volvo regarding deliveries. Almost three out of four suppliers ranked reliability as the most important delivery-related factor in relation to price, speed, goods safety and flexibility. Given a "just-in-time" production environment with minimum inventories this will most certainly reinforce road-transport.

Questions regarding transports and logistics in the Swedish supply system of Volvo Torslanda is characterised by its diversity of supplier-types. The fact that sequential JIT-suppliers, with hourly deliveries, are to be found together with firms with deliveries once per week, this can be taken as an indication of the transitory phase which the Volvo supply-system is going through in the late 1990's.

The major breakpoint was the introduction of the S80-model in 1998, where Volvo has selected a strategy characterized by a few large first-tier supplier delivering according to sequential JIT-practices. This has started a process where suppliers will be organised in layers where logistics and transportation to a larger degree will be arranged outside the traditional Volvo-organised system of pick-up routes. It might even create a situation where first-tier suppliers located in the Arendal supplier-park find incentives in terms of goods volume to cooperate on logistics solutions which give alternatives to the road-based european deliveries.

Time has obviously come into focus in the last ten years. First in the form of general just-in-time strategies and later via the introduction of sequential deliveries. The most important efficiency measurements for transport is not speed or distance, but rather driving-time and reliability.

14.4 The impact on geography: does proximity matter?

It is obvious that the domestic supply-system of Volvo Torslanadverken has undergone considerable change during the last decade. Both in terms of products and technology, logistics and supply chain mangement. The 1996/97 study shows that the domestic supply-system was in the process of restructuring. Some production units were on the way towards more complex products and tighter relationships towards Volvo, while others indicated a relatively stable situation.

From the discussion in chapter eleven it is possible to detect a limited correlation between the increasing degree of co-ordination with Volvo and geographical proximity. But the small number of production units in the integrator and system-supplier groups make generalisation difficult. There is no evidence in the study of any relocation activities. The changing demand, in production as well as deliveries, was met by other measures rather than by relocation.

The daily co-ordination of product-development activities were in many cases handled by a number of development engineers, placed inside Volvo for the duration of the development of one specific model. This is an example of the importance of proximity, without the need to relocate an entire factory or R&D-department. In many of the interviews, suppliers recognised proximity to the assembler as an important question, but very few expressed any plans to relocate their own activities. One important explanation of the locational stability of the domestic supply-system was the combination of good infrastructure, favourable traffic-conditions and the relatively relaxed form of "just-in-time" used by Volvo. All of the first-tier suppliers located in Sweden were able to meet Volvo-requirements from their current location. *Important but not necessary,* may serve as a good summary of the geographical dynamics of the supply-system in the 1996/97 study.

This situation changed dramatically with the introduction of the new S80-model. At the beginning of the supplier selection process, Volvo decided to include geographical proximity as an important strategic factor. This was associated with the increasing use of *sequential production.* The spatial outome of the process was a cluster of dedicated sequence-suppliers in the new supplier park, located just five minutes driving-time from the Volvo Torslanda assembly plant.

The introduction of a new model was the key element in the restructuring of the supply-system. Contracts are agreed for the continuation of one specific model, which gives the assembler the possibility to make major changes when a new model is introduced. In this case, location in the direct proximity of Torslandaverken was a basic prerequisite for a company that wanted to supply any of the modules selected by Volvo for sequential delivery.

Location in the supplier-park was not necessarily equivalent to full scale production. Hydro-Raufoss was the only supplier with complete production in the park during the initial phase of the S80-model. The other units could be charcterised as *sequentiation warehouses* with different degrees of final assembly, ranging from relatively complex customisation to the sorting of incoming components according to sequence orders.

Figure 14.1 summarises the restructuring process using the supplier-matrix presented in chapter 1.1. In the figure, the top matrix describes the supplier-structure in 1997/98. The bottom matrix should be seen as the "average" supplier-structure in the early 1990's. There are three major factors to take into consideration when looking at the figure:

- *Symbol-type,* shows the object and time-period of investigation. Black is used for the 1996/97 study of 40 suppliers, black and white stripes represent the Arendal-suppliers in 1998 and finally the circle with a dot which is the case of Hydro-Raufoss 1993-98.
- *Symbol-labels,* letters A–F represent supplier-types related to their function in the Volvo Torslanda supply-system.
- *Symbol-size,* shows the importance of each supplier-type, measured in number of production-units. These are useful, mainly as indicators of the relative proportion within each of the sub-studies.

The discussion will focus on the top matrix, where the current situation is presented. Arrows show major changes, longer lines denote pronounced shifts and shorter lines indicate the general direction of movement. The position of each symbol is a combination of importance of technological- and transport-relationships towards Volvo Torslanda. A supplier-type positioned at the top of the vertical axis is charaterised by the importance of product- and development relationships, while a supplier-type at the far-right position is characterised by important transport relationships.

We will start by analysing the suppliers in the 1996/97-study. Categories **[A]**, **[B]** and **[C]** are more thoroughly discussed in chapter ten. Production units of suppliers located in Sweden that indicated the highest degree of co-operation in their technological relationships with Volvo were termed integrators. These are grouped together with specialist-suppliers to form a general category which has developed towards relatively complex products but has not been involved in extreme sequential deliveries, hence the position at the centre of the horisontal axis. The exception to this is represented by a black circle labeled **[F]** in the top right corner. These two production units produced and delivered in sequence to the S/V70 model in 1996/97.

Compared to the situation in the early 1990's, it is possible to trace a general direction among category **[A]** -suppliers towards higher delivery demand, often caused by the purchase of a domestic supplier by a large international actor.

The largest group of domestically located suppliers are the specialist suppliers labeled **[B]**. Their competitive advantage are not directly assigned to extremely tight deliveries or complex products. One or several fields of products or process knowledge are characteristic for the specialists, which give them a position in the middle of the figure. Most of the suppliers had experienced a general move towards JIT deliveries and an increasing degree of co-ordination with Volvo, although not significant enough to induce any spatial restructuring. The arrow illustrates a general movement towards the increasing importance of both transport- and technological relationships, although slowly and with different trends within the category. The group had the same size both in the early 1990's and in 1997/98. There are several units that have developed from specialists to systems-suppliers, and an equally large group coming from the **[C]** category.

Suppliers in category **[C]** are characterised by a low level of change as regarding the factors discussed above, such as more responsibility, increasing co-operation with the customer and more complex products. The same pattern can be observed for the transportation and logistical aspects, where "just-in-time" requirements are relatively relaxed. Deliveries to Torslandaverken are normally conducted on a less than daily basis.

One general conclusion from the 1996/97 data is that the changes described above have not generated any "geographical reaction" in the form of relocation of production closer to the Volvo plant. The only exception is Hydro-Raufoss who established a warehouse in 1993 at the location of what today is the Arendal supplier-park.

The absence of spatial restructuring up until 1996/97 can be assigned to two major factors. Regarding supplier-relationships related to product and development, the need for close contact was solved through a model where suppliers posted engineers inside Volvo. The part of the development process especially designed for Volvo could be handled by one or two people.

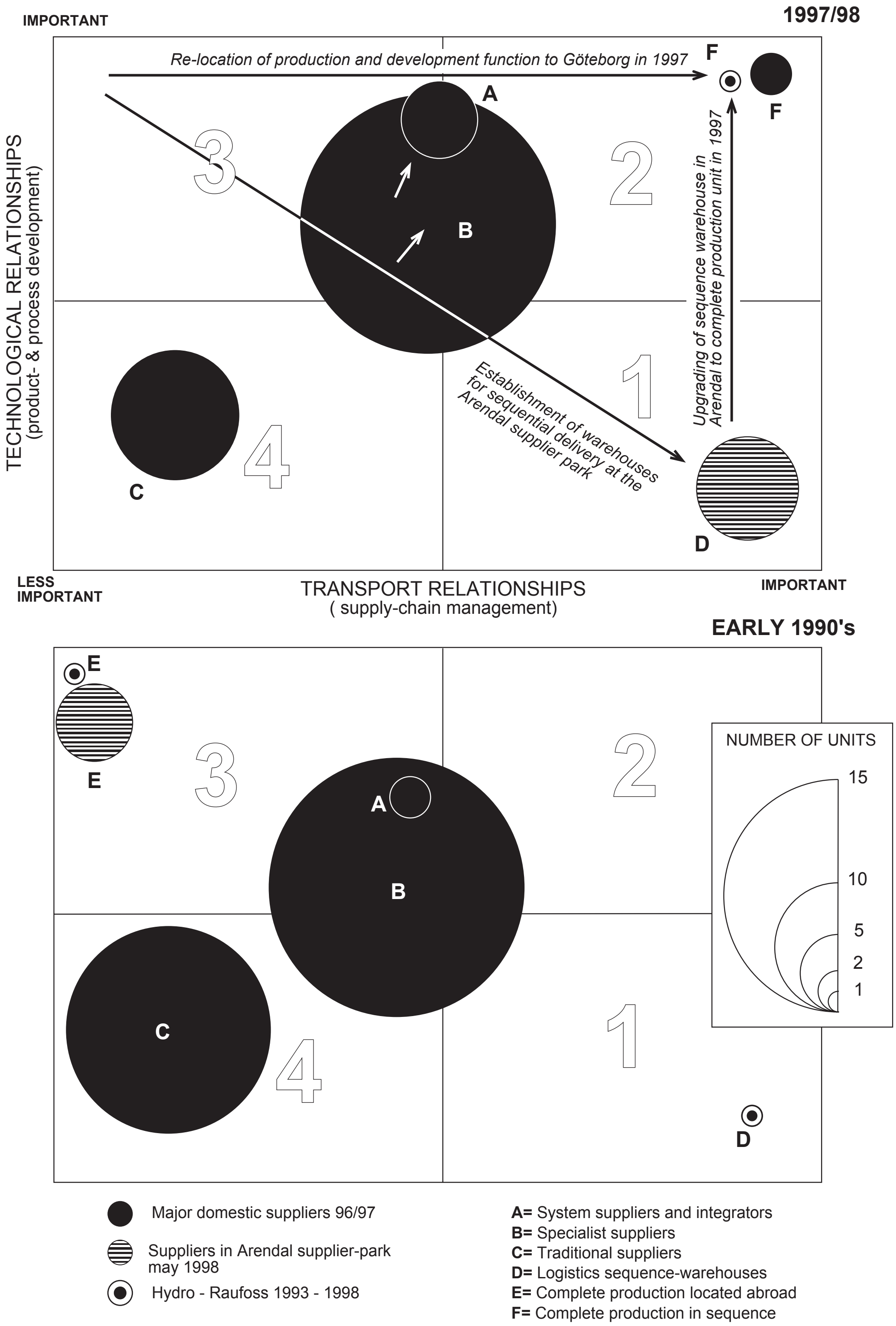

Figure 14.1: Position and direction of change for supplier-categories between early 1990's (bottom figure) and 1997/98 (top,) depending on importance of technological- and transport relationships with Volvo Torslanda. *Source:* Author's survey.

Delivery requirements have developed from weekly, to daily JIT-deliveries during the last decade. This was solved through more efficient transportation and planning. Volvo operates a system of time-table controlled pick-up routes for the accurate timing of deliveries.

The major problem in transports is when deliveries are made in sequence, which involves small and frequent deliveries several times per day. These units are marked **[F]** in the 1998 figure. In one case, the transport distance of 2 hours did raise questions about delivery-reliability. This particular arrangement was facilitated by the fact that the component in question was assembled into the car during the final stage of the process, and therefore allowed for a maximum time-window from final-order to the delivery. It has to be suggested that the infrastructural and traffic conditions in Sweden are favourable in a European context, and even more so in relation to the situation in Japan. Direct comparisons of the locational patterns have to take take this into consideration.

In contrast to the development until 1996/97, the purpose of the establishment of the supplier-park in Arendal was geographical proximity. The most significant factor behind this was the introduction of the S80-model in 1998. Within the development process of the new model, Volvo used geographical proximity as a strategic tool in supplier selection for the first time. In order to be considered as a supplier for the selected components to be manufactured in sequence, location in the vicinity of Volvo Torslandaverken was mandatory.

This gave a direct spatial reaction, although not identical for all of the selected suppliers. Figure 14.1 illustrates this with the figure for the starting-point where all of the future Arendal-companies were classified in the **[E]** -catergory. This means that production and development were built on a relatively high degree of co-ordination. Some of the suppliers in the 1997/98- figure were not suppliers to Volvo in the early 1990's, this is shown by the smaller circle in the bottom matrix. For 1997/98 we can see how the need for proximity was met by the establishment of warehouses intended for the sorting and preparation of sequential deliveries to Torslandaverken. The suppliers conducted final assembly operations within the main logistics function. None of the units could be classified as having a complete production in a traditional sense. Hydro-Raufoss Automotive Plastics is the only exception to this as they upgraded their warehouse into a complete production unit in 1997.

The need for *sequential JIT-deliveries* was the driving force behind the geographical clustering of suppliers at the Arendal site. This will furthermore facilitate personal contacts when information is of a more complex nature. Since the distance to the Volvo Torslanda plant is only 5 minutes by car, the conditions for frequent contacts and close co-operation in product development questions are favourable. This has not been of central importance for the creation of the supplier-park. In the future we may see a growing number of product-development functions related to the operations of the Arendal suppliers.

One example of such a development is Hydro-Raufoss Automotive Plastics. The company established a warehouse on the Arendal site in 1993. This was associated with a stategy to become a supplier of complete bumper modules. The product became increasingly complex with every new model, and since Volvo was the only customer the route via dedicated facilities was selected.

In the starting-point matrix, we can observe how Hydro-Raufoss had two units for deliveries to Volvo. Product development, management and the strategic moulding and painting of the plastic covers for bumpers were made in Norway. This arrangement was not reliable enough to perform sequential deliveries. With the same strategy as the Arendal suppliers used five years later, the components were transported to Göteborg by truck. At the sequence-warehouse, the bumpers were completed with additional components and sorted in the right model- and colour- sequence for delivery to Volvo every hour.

Unlike the other units in the park, Hydro-Raufoss has developed from a warehouse into an integrated production plant. Since 1997, the management of all Volvo-related product development is located in Göteborg, hence the movement from supplier-type **[D]** to type- **[F]**. The rationale behind the movement of the development function to Göteborg has not been studied directly, but the proximity to the product development department of the only customer, Volvo most likely influenced the decision to a large extent.

In the discussion above, the restructuring process of the domestic supplier-system of Volvo Torslanda assembly plant was analysed. By focusing on the type of relationship with Volvo, a number of supplier-types were distinguished. They were positioned in the matrix in figure 14.1 depending on the importance of their technological- and transport-relationships to Volvo Torslanda. In this section the geographical characteristics of the supplier-types is discussed.

Depending on the position in the matrix, four different locational strategies are defined. Each of the numbered fields in the matrix have their special locational characteristics. It is important to see these groups as general types, put forward in order to generalise the complexity of supplier geography in a simplified model.

The first supplier-type comprise production units with a high level of importance regarding transport-relationships, but a lesser importance as regards technological relationships. Sequential JIT-deliveries and very limited manufacturing-functions are typical features of these suppliers. The production units are found in close proximity to the Torslanda assembly plant. Their location is a direct result of the function as warehouses for sequential deliveries, aimed at organising and securing reliability for the frequent deliveries to one customer.

As shown in figure 14.1, the units in the Arendal supplier-park all fall inside the first locational field. These units can be termed *logistics point-localisers,* highlighting the importance of proximity due to delivery requirements. These are a new group of suppliers in Sweden, mainly associated with the introduction of sequential production. One alternative to re-location due to high delivery-demands is used in relation to the SAAB assembly plant in Trollhättan, where the most important suppliers deliver to a logistics-firm who does the sequentiation and final delivery. This means that the suppliers can remain at their traditional location and still be able to follow tight delivery demands from many customers at the same time.

For production units in the first field, we can conclude that proximity really matters. It is, at least in the case of the suppliers in the Arendal-park, the basis for their existence. The most important factor of explanation is the use of *sequential just-in-time deliveries.* Hourly deliveries with minimum inventory-levels are not possible without temporal proximity, which in the case of the transport of physical goods, is equivalent to geographical proximity.

In the second field, the delivery requirements in the previous field are combined with the importance of technological relationships. This means that the local unit functions both as a sequence-supplier and a product development partner. In this case, proximity becomes important in terms of deliveries and can furthermore facilitate frequent personal contacts. As the matrix shows, very few of the suppliers can be found in this category. One explanation of this is the size of the Swedish automotive industry which is not big enough to attract large suppliers from their original locations. Two reasons for the establishment of complete production in proximity to Volvo can be seen in the study:

- Volvo is the dominating customer, as in the case of Hydro-Raufoss. The concentration to one customer makes it logical to put new investments into locations close to the Volvo assembly plant and development centre in Göteborg.
- The supplier is large enough in terms of financial capacity to establish or acquire a local production unit. If a local supplier is bought, it can be relocated to fit the general strategy of the corporation, as in the case of Lear Corporation.

None of the suppliers in this group reported that proximity was caused by demand related to product development relationships. Delivery requirements, especially sequential production, is the single most important factor behind locational decisions by the Volvo supplier in the study.

Since delivery requirements seem to be the important factor behind proximity to the Volvo Torslanda plant, the locational motives for suppliers in fields 3 and 4 are not related to proximity. The characteristics of suppliers in the third field are linked to their importance as product development partners. Many of the domestic systems- and specialist suppliers can be found in this group. They have complete production located in Sweden. Since they are not involved in sequential deliveries, the position will be in-between important and less important on the transport axis. In the matrix depicting the situation in the early 1990's, we can observe a number of Arendal-suppliers in the top left corner of field number three. In these cases, transport requirements were of very limited importance, since all of the suppliers were located abroad.

When these suppliers needed to adapt to the new delivery requirements for the S80-model, the solution was the establishment of local units with primarily logistical functions. This made it possible to keep strategic functions at the original location and still be able to adhere to very tight delivery restrictions. One alternative strategy would have been to move production to Göteborg. Such a strategy is shown in the figure by the horisontal arrow when Hydro-Raufoss decided to invest in Göteborg instead of their traditional Norwegian plant.

The first strategy leads to a situation where the supplier acts in two fields simultaneously. Product development and manufacturing abroad and final assembly and sequentiation in proximity to the customer. In terms of regional development, this will create relatively unqualified jobs. In order to act as a magnet for the knowledge-intensive part of the automotive industry, there needs to be more investments in complete production combined with product development-functions, what could be termed a "Hydro-Raufoss effect". In such a scenario, proximity induced by transport-demands could act as an attractor and a "spatial glue" until more network-like relations evolved.

In field number four we find suppliers with a traditional function as suppliers of components or single details, not subject to either joint product-development or tight JIT-deliveries. Production units at this end of the matrix have no incentive to relocate or to consider spatial aspects of their relationship towards Volvo Torslanda. This does not mean that they are necessarily unprofitable. Studies in Sweden have shown that profit margins are higher among second-tier supplier compared to first-tier suppliers or final assembly (Tunälv 1997).

So, does proximity really matter? The answer in the case of Volvo has to be yes, and no. Spatial proximity is important in the cases where the suppliers are involved in *sequential just-in-time production.* The temporal restrictions associated with sequential production, frequent deliveries and minimum inventory-levels, can not be overcome unless the time-distance between suppliers and the assembler is very short. Judging from the case of the Volvo-suppliers, delivery requirements have been the sole driving-force behind the agglomeration of suppliers in the Arendal-park.

The geographical change among the Swedish suppliers to Volvo Torslanda assembly plant is also restricted to the recent S80-model. In the study covering 1996/97, there were no indications of movement of production units.

One conclusion to be drawn is that although suppliers have experienced significant changes related to technological issues such as more complex products and more joint product-development, this has not resulted in any re-location of suppliers. It appears as if information and knowledge can be transferred without direct proximity between the suppliers production units and Volvo.

This leads to a concluding comment on the concept of proximity. In the cases of sequential JIT-production, it is clear that time is the crucial measure of proximity. Volvo demands a certain delivery frequency and sequence and then it is up to the respective supplier to comply with this, independently of the physical distance to Volvo Torslanda.

Physical proximity is closely associated with time-related demands since physical distance and time-distance are correlated. Information and knowledge on the other hand, do not show the same time-space relationship. With modern information technology, it is possible to have very frequent and sequential "deliveries" of information without physical restrictions. The importance of geography comes into consideration when the easily distributed information and knowledge shall be put into use. Are all locations and regions equally well prepared to take advantage of new technological conditions? Or is geographical proximity a competitive advantage when it comes to the use of information and the exchange of knowledge between buyer and supplier? It is suggested by authors in the recent debate in economic geography that certain places are better qualified to succeed in the new knowledge-based economy.

These set of questions has not been adressed explicitly in this work and will therefore be discussed in the next section about the future of the automotive industry in the light of the Volvo Torslanda suppliers.

14.5 The future of automotive supplier relationships: what can we learn from the Volvo case?

In this last section, the findings from the Volvo-case will be put in a broader perspective. To what extent can we draw any conclusions from the supplier-system of one single company? This is, of course, a highly relevant question to pose in the concluding chapter of a doctoral dissertation that focuses on Volvo in order to trace general explanations of the geography of supplier restructuring.

The methodology guiding this work has focused on finding and analysing how important concepts in automotive supplier restructuring such as subcontracting, time and proximity have been manifested in the domestic supplier-system of the Volvo Torslanda assembly plant.

In the following, these concepts will be discussed and compared to the development of both theoretically- and empirically grounded explanations of the automotive industry and its development.

Outsourcing and the shifting of responsibility upstream in the supply-chain is one major model of explanation of technological relationships in buyer-supplier relations, especially in the automotive industry. This is only partly possible to trace in the domestic supply-system of Volvo Torslanda. The study shows that there is a clear break in supplier-strategy associated with the introduction of the S80-model in 1998. Before that, outsourcing of production and development was made but to a limited extent.

This relatively late adaption of outsourcing and hierarchisation of the supply-system can partly be explained by the historical trajectory of Volvo. When the company started manufacturing motor vehicles in the late 1920's, they did not have enough resources to produce components in-house. The strategy (or adaption to reality) was to concentrate on the final assembly and use independent outside firms as suppliers. Even strategic parts such as engine and drive-train were made outside Volvo.

Consequently, Volvo used outsourcing as a principle as early as seventy years ago. Since then the company has incorporated strategic suppliers and become more vertically integrated. The long tradition of using independent domestic engineering-firms has built long-lasting trusting relationships within certain sectors. These were capable of providing both technological development and product quality using what today is called network-like relationships.

Following the development of supplier-strategies at Volvo, it is possible to see that today we are back at the starting point in terms of outsourcing. One experience from the Volvo-case is that strategies change over time and what is viewed as "best practice" today may be less interesting ten years from now. If the outsourcing trend continues, one important question will be where to set the limit between the car-manufacturer and the global supplier. Will suppliers in the future be able to put together the final product themselves, leaving Volvo with only product-development and marketing-functions? This is even more complex given the association between manufacturing and development. Is it really possible to develop new cars without the practical experience of manufacturing?

One major experience from the study is *the significance of model-shifts for structural changes in the supply-system.* The most pronounced change in this study was the introduction of sequential deliveries with the S80-model in 1998. This gave an immediate response in the form of the establishment of a supplier-hierarchy with some of the most important suppliers moving to the adjacent Arendal supplier-park.

The process om limiting the number of suppliers delivering directly to the final-assembly has been associated with models-shifts during the last decade, even though the tendency is most marjed in the latese change assiciated with the S80-model.

One further aspect, outside the scope of the thesis, is the Ford purchase of the Volvo Car operations in spring 1999. In the light of the discussion on the importance of model-change on the supplier-system, Ford will most certainly have an impact on the Swedish suppliers. New jointly-developed platforms will introduce new supplier-practices and the traditional Swedish suppliers will be measured on a global "Ford-scale". This will probably mean that smaller companies have to either join forces with large international suppliers or take a step down in the hierarchy and become second- or third tier suppliers. As discussed above, this does not necessarily have to be a negative change in terms of profit-margins. However, the direct contact with Volvo will disappear and this may in the longer perspective give less opportunities for technological development.

One of the most striking observations from the Volvo-study is the fact that *the most powerful factor behind the spatial restructuring of the supply-system is the use of sequential production*. The sequentiation of production means that every component supplied to Volvo is targeted to one specific car on the assembly-line. With the current JIT-practices, involving minimum inventories and frequent deliveries, this is not possible to co-ordinate without extreme reliability in deliveries. This has been attained through the establishment of "delivery-warehouses" in close proximity to Volvo Torslanda assembly plant. The function of these warehouses is to act as sorting-stations in order to meet the demand from the customer.

The geographical clustering of sequence-suppliers in the Arendal supplier-park is a new feature to the Swedish automotive industry. Industrial agglomeration is an old phenomenon, but the concentration of suppliers related to one single customer and one production-philosophy is not very common.

One major conclusion is that the "spatial glue" that holds the suppliers together in the initial phase is associated with delivery demands and Volvo-specific relationships. The supplier-park concept did not involve any ideas of learning and co-operation between suppliers. It is important to notice that the function of the Arendal-facility is in its initial stages and co-operative arrangements may evolve over time.

The use of supplier-parks with primarily logistics functions are used within a number of places in Europe. These supplier-parks or logistics-centers may develop into centers of knowledge and development if suppliers establish co-operative relationships.

If these parks attract more suppliers and build up a place-specific knowledge-base, they may start to work as attractors of automotive assembly. A supplier-park with a high performance, fine-tuned supplier-base could be the deciding factor in a future locational decision by an assembly-firm.

We will end this work by concluding that the Volvo-case has shown that proximity can matter, and that the driving force was such a basic factor as the deliveries of physical products. It has also been shown that this is not a simple one-sided process.

Even in a relatively small system such as the domestic suppliers to Volvo Torslanda, a number of parallel geographies exist. And the most long-lasting and successful ones may not necessarily be the ones fashionable today.

Summary

PROXIMITY MATTERS? Geographical aspects of changing strategies in automotive subcontracting relationships: the case of domestic suppliers to Volvo Torslanda assembly plant

This study aims at analysing *the significance of geographical proximity in the restructuring process of a domestic supply-system in the Swedish automotive industry, using the case of Volvo Torslanda assembly plant.* The following research questions forms the basis of the work:

i) What constitutes the organisation of buyer-supplier relationships at Volvo Torslanda assembly plant over time?
ii) To what extent have time-related delivery strategies been adopted by Volvo, and what has been the content of these strategies?
iii) What has been the significance of geographical proximity in the restructuring process of the domestic Volvo Torslanda-suppliers?
iv) In what areas can the Volvo case study contribute to the general understanding of the geography of buyer-supplier relationships in the automotive industry?

The thesis can be divided into five main parts. The *first part* includes a discussion of the research problem where a basic model, combining the importance of technological and transport aspects of supplier-relationships is presented. The theoretical frame of reference is discussed in the second chapter and focuses on the growing complexity of inter-firm relationships. Of special interest is the network-approach, which is used as a conceptual point of departure for the following analysis of buyer-supplier relationships. There is, furthermore, a presentation of different definitions and concepts regarding subcontracting as a phenomenon. Ending the first part is a methodological discussion and a positioning of the automotive industry in a wider context.This part is intended to act as a conceptual base for the rest of the work and to provide a ground for a further discussion of the Volvo case.

The aim of the *second part* is to discuss concepts and processes central to the restructuring of buyer-supplier relationships. It is divided into questions associated with technological and organisational aspects of supplier-relationships, while chapters five and six have their focus on questions connected to the transport relationships between buyers and suppliers. This part of the work contains a discussion of major concepts within the restructuring of the automotive supplier industry. Firstly the development towards a buyer-supplier model built on co-operation instead of

competition is identified. This is followed by a comparison of the three major automotive regions in the world as regards supplier relations and their respective geographies. Underlined is the importance of historical, political and social factors on the development of the automotive supplier relationships.

Transport-relationships and their importance are discussed in the following chapter. The significance of time in the supplier restructuring process is highlighted and the concept of "just-in-time" (JIT) is penetrated. A basic distinction is made between "relaxed" and sequential JIT, where the later requires extremely frequent and reliable deliveries. Reliability is put forward as a basic prerequisite for transportation in order to respond to JIT-production requirements in general, and sequential arrangements in particular.

The *third part* is an introduction to subcontracting in Swedish industry in general, and the automotive industry in particular. This is completed with a presentation of Volvo and the context of the empirical investigations. In this part the historical development of supplier-strategies at Volvo is discussed and related to the recent development in the automotive business. The relatively small Swedish economy has forced the major manufacturing companies to rely heavily on foreign suppliers. This is shown in the automotive industry where the majority of front-end suppliers are located abroad. The locational pattern of the domestic automotive supply-sector is geographically concentrated to the south-west, where the main assembly plants are located. One important feature of the restructuring of the Swedish automotive-supply system is growing share of foreign involvement, global actors have acquired many of the former domestic suppliers and changes the structure in the direction of a hierarchical model.

Volvo has since the start relied heavily on independent firms as suppliers of components. During the expansion period in the 1950' and 60's many strategic suppliers were acquired by Volvo. Today the trend is towards more out-sourcing, a situation with many similarities to the original strategy. The share of foreign suppliers have grown along with new factories in Belgium and Holland, at the same time as Swedish suppliers have been able to follow Volvo into the European market.

The empirical investigation is presented in *part four* of the work, and subdivided into three parts. The first part is based on an investigation of the most important domestic first-tier suppliers to Volvo's Torslanda assembly plant in Göteborg in 1996/97. This is complemented by a case-study of a recently established supplier-park adjacent to the assembly plant, and finally a company case-study of the supplier Hydro-Raufoss Automotive.

Regarding the domestic suppliers in 1996/97 it can be concluded that they are larger than previous studies have estimated for the total automotive supply industry in Sweden. The suppliers in the sample are best characterised as medium-sized firms, rather that small firms. The absolute majority exports were made to other Volvo production sites, mainly Ghent. Two-thirds of the suppliers are active within traditional, relatively low-value product segments such as metals, rubber and plastics and have the automotive industry as their main customer

The suppliers in the study constitute a heterogeneous group of companies with very different types of technological relationships towards the Volvo Torslanda assembly plant. It is not possible to find any clear indications of a hierarchical organisation, although a few international automotive suppliers have acquired domestic suppliers within strategic product-segments. This might be the beginning of a development towards a multi-tiered system. Since the 1996/97-study we have witnessed a major development towards a supplier-hierarchy in connection to the production start of the S80-model in April 1998 . On the basis of the importance of co-operation in relationships connected to production and product development, four categories of suppliers have been identified: integrators, systems-suppliers, specialists and traditionals. There is a limited connection between geographical proximity and the supplier categories. Suppliers with more co-ordination-dependent activities are located closer to Volvo, compared to the others.

Questions regarding transports and logistics in the Swedish supply system of Volvo Torslanda is characterised by its diversity of supplier-types. The fact that sequential JIT-suppliers, with hourly deliveries, are to be found together with firms delivering once per week, can be taken as an indication of the transitory phase that the Volvo supply-system is going through in the late 1990's.

The general development is an increase from weekly to daily deliveries. Only a handful of suppliers delivered more than daily according to sequential JIT-practices. There are only a few cases where proximity is of major concern with reference to transport arrangements, these are directly associated with the use of sequential deliveries. Road transport is the only means of transport for deliveries to Volvo Torslanda. It has to be put forward that the infrastructural and traffic conditions in Sweden are favourable in a European context.

Spatial proximity of suppliers became a strategic factor when Volvo established a supplier-park in close proximity to their Torslanda plant. The rationale behind the project was the growing numbers of systems and modules to be manufactured and supplied in sequence, where each delivery from the supplier is matched against a specific car on the assembly line.

The suppliers in the park can be characterised as small or medium-sized. All of the production units were foreign-owned, belonging to major international automotive supplier groups. The function of these local units is to make final assembly and then sort the products for sequential deliveries to Volvo. Except for one company, there were no investment in product development capacity.

The case of Hydro-Raufoss Automotive Plastics is an example of the spatial and organisational development of an automotive supplier in order to meet the increasing demand for product quality and complexity together with extreme delivery requirements.

The physical delivery dimension demonstrates a clear connection to the importance of geographical proximity towards the customer. The two production units that perform sequential JIT-deliveries are located only minutes away from the respective Volvo-plant, Recently, the product development function has been relocated to Göteborg, which indicate that technological relationships may benefit from proximity, especially since Volvo is the only customer for the product.

So, does proximity really matter? The answer in the case of Volvo has to be yes, and no. Spatial proximity is important in the cases where the suppliers are involved in *sequential just-in-time production.* The temporal restrictions associated with sequential production, frequent deliveries and minimum inventory-levels can not be overcome unless the time-distance between suppliers and the assembler is very short.

Technological relationships on the other hand does not seem to be able to create the need for spatial proximity by themselves. It is a future question if the delivery-induced supplier-agglomerations will disappear with the current management fashion, or be the start of the development of network-based places of continuous learning and regional competitive advantage in the automotive-supplier business.

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Appendix 1

Questionnaire/Interview guide sent to the 40 largest Swedish suppliers in 1996/97

Original version in Swedish and English translation

Handelshögskolan
VID GÖTEBORGS UNIVERSITET

Göteborg 961017

ENKÄT TILL VOLVOS STÖRSTA LEVERANTÖRER I SVERIGE

Mitt namn är Anders Larsson, jag är forskarstuderande på Handelshögskolan i Göteborg.

På uppdrag av Kommunikationsforskningsberedningen (KFB) arbetar jag ned en studie kring förändrade lokaliserings- och transportbetingelser för underleverantörer. Som ett exempel på förändringsprocesser har jag valt att studera Bilindustrins, och speciellt Volvos, underleverantörer i Sverige.

Genom Volvo Personvagnar har jag fått tillgång till namnen på de 40 största inhemska underleverantörerna till Volvo Torslandaverken, vilka får tillsänt sig denna enkät.

Det är självklart helt frivilligt att svara på enkäten men jag är väldigt tacksam om någon lämplig person på ert företag kunde göra ett försök.

För att underlätta svarsprocessen är det följt möjligt att avge svaren per telefon där det ges möjlighet att precisera eventuellt svårförståeliga frågor.

Resultatet av undersökningen kommer att presenteras i en doktorsavhandling där inga enskilda företag kommer att kunna utläsas. Arbetet är således ett fristående avhandlingsarbete även om Volvo Personvagnar och Svenska Fordonskomponent Gruppen har varit behjälpliga med kommentarer.

Om ni har några frågor så hör gärna av er till mig på telefon 031-7731417 (dagtid) alternativt 031-517678 (hem), eller på fax 031-7731398.

Med vänliga hälsningar:

Anders Larsson
Kulturgeografiska institutionen
Handelshögskolan vid Göteborgs universitet
Box 630
405 30 GÖTEBORG

ENKÄT TILL VOLVOS SVENSKA UNDERLEVERANTÖRER

LÄS DETTA FÖRST!

1 **Enkäten gäller ert arbetsställe**. Om företaget har flera anläggningar skall svaren i möjligaste mån gälla förhållandena på er anläggning.

2. I de fall inget annat anges gäller svaren **ert förhållande till Volvo Torslandaverken**. Jag är tacksam om ni försöker skilja detta från övriga Volvo-kunder.

3. Om ni tillverkar flera produkter för Volvo Torslandaverken skall svaren i förekommande fall gälla **den viktigaste produkten** (värdemässigt).

4. Jag är medveten om att flera av frågorna kan innebära tidsödande efterforskningar. För att undvika detta hänvisa gärna mig till någon annan i företaget, eller försök uppskatta i grova drag. **Hellre en välgrundad uppskattning än inget svar alls!**

TACK FÖR HJÄLPEN!

ENKÄT TILL VOLVOS TORSLANDAVERKENS STÖRSTA UNDERLEVERANTÖRER I SVERIGE

.... **ID-nr**

Företag: . . . .

Adress: . . . .

Ägare: . . . .

Antal anställda: . . . .

Produkt(er): . . . .

Antal produkter: . . . .

I. ALLMÄNT

Hur stor var er *totala* försäljning i miljoner kronor för år 1996 alt. 97? .... MKr

Hur fördelas er totala försäljning på föjande grupper?

→ Produkter tillverkade vid er enhet .... %
→ Produkter från moderbolag/dotterbolag .... %
→ Produkter för vilka ni är återförsäljare / agent .... %
→ Annat, nämligen: .... %

Hur stor andel av er tillverkning är avsedd för kunder i bilindustrin? .... %

Hur stor andel av tillverkningen till bilindustrin utgjordes av export? .... %

Hur stor andel av er tillverkning är avsedd för Volvo? .... %

Hur stor andel av er tillverkning är avsedd för Volvo Torslandaverken? .... %

Hur fördelas er försäljning till Volvo Torslandaverken? (andel av tot. förs.)

→ *Underleveranser* dvs produkter specificerade **av kunden** .... %
→ Produkter ur ert företags standardsortiment .... %
→ Produkter för vilka ni är återförsäljare / agent .... %
→ Annat, nämligen: .... %

Hur länge har ni varit leverantör till Volvo Torslanda? .... år

Kommer ni att vara leverantör till nästa bilmodell som skall tillverkas på Volvo Torslanda?

❐ Ja
❐ Ja ---> men vi kommer att fungera som sekundärleverantör till: ....
❐ Nej
❐ Vet ej
❐ Annat: ....

Är ni underleverantör till andra företag? Ange de tre största kunderna vilken produkt samt ungefärlig andel av försäljning:

FÖRETAG & PRODUKT ANDEL AV FÖRS.

.... %
.... %
.... %

II. PRODUKT

Vilket eller vilka påståenden beskriver bäst de produkter ni levererar till Volvo Torslanda? Sätt kryss i en av de två alternativen i varje motsatspar.

❐ högvärdig
❐ lågvärdig
❐ bulkig
❐ kompakt
❐ många varianter
❐ få varianter

Har era Volvo Torslanda relaterade produkt/er förändrats sedan ni startade era leveranser?

❐ Ja, mer komplicerad
❐ Ja, fler produkt-varianter
❐ Ja, fler färg-varianter
❐ Ja, nytt material (t.ex plast, gummi)
❐ Ja, betydligt fler elektroniska komponenter
❐ Nej
❐ Annat: ....

Vilket alternativ passar bäst för den/de produkt/er ni levererar till Volvo Torslanda?

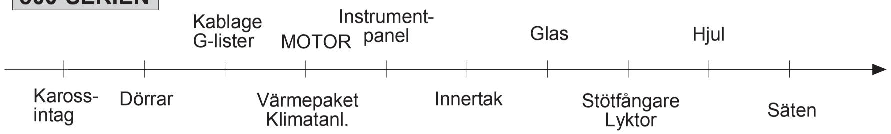
❐ 1. en av oss framtagen produkt av ***standardkaraktär***. (t.ex skruv, mutter)
❐ 2. ***en enskild detalj*** som ingår som en "byggsten" i monteringen på Volvo Torslanda
❐ 3. ett flertal enskilda detaljer som bildar ***en komponent*** som ingår som en "byggsten" i monteringen på Volvo Torslanda.
❐ 4. ett flertal komponenter som bildar ***en systemlösning***
❐ 5. en helhetslösning/koncept i form av en ***modul*** som levereras färdig för inmontering på Volvo Torslanda (t.ex lackerade stötfångare med spoilers, färdiga säten).

→ **Har det skett någon förändring mellan kategorierna ovan under de senaste 10 åren?**

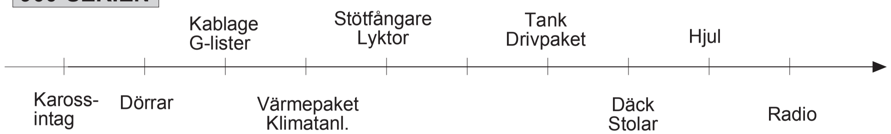
❐ Ja, huvudsakligen från alternativ: .... till alternativ ....
❐ Nej
❐ Annat: ....

Var i produktionsprocessen på Volvo Torslanda monteras er produkt in i bilen? (markera ungefärligt läge med ett kryss) Om era leveranser huvudsakligen är avsedda för annat än monteringsfabriken, skriv detta under figuren.

800-SERIEN



900-SERIEN



III. ARBETSDELNING / ANSVARSFÖRDELNING

Vem ansvarar för följande delar av produktionsprocessen? Sätt kryss i de rutor som bäst överensstämmer med er situation. Endast ett kryss per funktion.

	FUNKTION		
ANSVARIG	produkt-utveckling	specifikation av produkten	inköp av råvaror
Volvo			
Ert företag			
Ert företag i sam-arbete med Volvo			
Ert moderbolag, motsvarande			
Annat			

På vilket sätt specificerar Volvo sina krav på produkter?

❐ Genom att ange förutsättningar redan vid produktutvecklingsstadiet och sedan ge er ansvar att ta fram och tillverka produkten.
❐ Genom att ange specifikationer vilka Volvo själva har utarbetat.
❐ Genom att köpa era egenutvecklade produkter utan att specificera.
❐ Annat: ....

Vem har huvudansvaret för *produktutveckling* på ert företag?

❐ Vår enhet
❐ Huvudkontoret i Sverige
❐ Huvudkontoret utomlands i ....
❐ Annat: ....

Vem har huvudansvaret för *produktionsprocessen* vid ert företag?

❐ Vår enhet
❐ Huvudkontoret i Sverige
❐ Huvudkontoret utomlands i ....
❐ Annat ....

Vem har huvudansvaret för *strategiska beslut* vad gäller leverantörer och marknadsföring vid ert företag?

→ **marknadföring**

❒ Vår enhet
❒ Huvudkontoret i Sverige
❒ Huvudkontoret utomlands i ....
❒ Annat: ....

→ **leverantörer**

❒ Vår enhet
❒ Huvudkontoret i Sverige
❒ Huvudkontoret utomlands i ....
❒ Annat: ....

Har er tillverkningsenhet under de senaste 10 åren genomgått betydande förändringar vad gäller ägande och/eller arbetsdelning?

❒ Ja, helt eller delvis ***uppköpts*** av svenskt företag.
❒ Ja, helt eller delvis ***uppköpts*** av utländsk företag.
❒ Ja, företaget har ***expanderat*** genom införlivande av andra svenska företag
❒ Ja, företaget har ***expanderat*** genom införlivande av andra utländska företag
❒ Ja, företaget ***samarbetar*** med andra svenska företag.
❒ Ja, företaget ***samarbetar*** med andra utländska företag.
❒ Ja, annat: ....
❒ Nej

→ **Om ni svarade ja på frågan ovan, ange företag och år för aktuell förändring / ar:**

FÖRETAG	ÅR
....	....
....	....
....	....

→ **Har huvuddelen av förändringarna i frågorna ovan skett med företag inom bilindistrin?**

❒ Ja
❒ Nej
❒ Annat: ....

IV. PRODUKTUTVECKLING

Hur många anställda arbetar *huvudsakligen* med produktutveckling? .... st

Hur stor andel av era kostnader för produkter till Volvo Torslanda utgörs av utvecklingskostnader ?

❒ mindre än 10%
❒ 10-24%
❒ 25-49%
❒ 50-74%
❒ 75% eller mer

I vilken omfattning samarbetar ni med Volvo vad gäller *produktutveckling?*

❒ Ofta (1 gång per vecka)
❒ Ibland (1 gång per månad)
❒ Sällan (mindre än en gång per månad)
❒ Aldrig
❒ Annat: ....

I vilken omfattning samarbetar ni med Volvo vad gäller *processutveckling?*

❒ Ofta (1 gång per vecka)
❒ Ibland (1 gång per månad)
❒ Sällan (mindre än en gång per månad)
❒ Aldrig
❒ Annat: ....

V. TIDSKOMPRIMERING / LEVERANSKRAV

Hur många gånger per vecka levererar ni till Volvo Torslanda? ....

Levererar ni i sekvens till Volvo Torslanda?
- ❐ Ja
- ❐ Nej
- ❐ Planerar att göra detta

Vilka krav på ledtider ställer Volvo? Hur lång tid får det maximalt ta från beställning eller ändring i order tills dess att komponenten är färdig för montering på Volvo Torslanda? .... timmar

I vilken omfattning har leveransfrekvensen gentemot Volvo Torslanda förändrats under den senaste 10-årsperioden?
- ❐ ökat mycket
- ❐ ökat
- ❐ oförändrad
- ❐ minskat
- ❐ minskat mycket

Hur stort lager av råmaterial respektive färdigvaror har ni för era leveranser till Volvo Torslanda?
- → Råvaror ....dagars produktion
- → Komponenter ....dagars produktion
- → Färdiga komponenter .... dagars leveranser
- → Färdiga kompletta produkter .... dagars leveranser

I vilken omfattning har lagernivåerna förändrats under den senaste 10-årsperioden?

→ **Råvaror/komponenter:**
- ❐ ökat mycket
- ❐ ökat
- ❐ oförändrad
- ❐ minskat
- ❐ minskat mycket

→ **Färdigvaror:**
- ❐ ökat mycket
- ❐ ökat
- ❐ oförändrad
- ❐ minskat
- ❐ minskat mycket

VI. TRANSPORTER

Uppskatta fördelningen av era ut- och intransporter under 1996/97 per transportslag och volym . (om flera transportslag ingå i en kedja, ange det som används längst sträcka)

→ Inleveranser: Lastbil ....% Tåg ....% Båt ....% Flyg ....%
→ Utleveranser: Lastbil ....% Tåg ....% Båt ....% Flyg ....%

Har förhållandena i frågan ovan förändrats under den senaste 10-års perioden? Markera med (+) för ökning, (-) för minskning eller (o) för oförändrat vid aktuella transportslag.

.... Lastbil
.... Tåg
.... Båt
.... Flyg

Vem *ansvarar* för transporten mellan er och Volvo Torslanda?

❐ Ert företag
❐ Volvo
❐ Speditör / Transportförmedlare
❐ Annat: ....

Vem *utför* transporten mellan er och Volvo Torslanda?

❐ Ert företag
❐ Volvo
❐ Speditör / Transportförmedlare
❐ Annat: ....

Vad upplever ni som viktigast i er relation tillVolvo Torslanda vad gäller transporter? Rangordna de tre viltigaste (1= viktigast, 2= näst viktigast, osv)

.... Billiga transporter
.... Snabba transporter
.... Säkra transporter (med avseende på godskvalitet)
.... Tillförlitliga transporter
.... Flexibla transporter
.... Annat: ....

Hur stor vikt läggs vid transportaspekter vid produktutveckling och i produktionsprocessen?

❐ Stor vikt
❐ Mindre viktigt
❐ Ingen vikt
❐ Annat: ....

Vilka är de viktigaste formerna för kommunikation med Volvo Torslanda med avseende på leveranser/logistik? Rangordna *de tre viktigaste* (1= viktigast)

.... Post
.... Telefon
.... Fax
.... Dator
.... Personkontakter (möten)
.... Annat: ....

VII. KOMMUNIKATION

I vilken omfattning använder ni datorkommunikation i kontakterna med Volvo Torslanda?

❐ Ofta
❐ Ibland
❐ Sällan
❐ Inte alls
❐ Annat: ....

Om ni använder datorkommunikation mot Volvo Torslanda, inom vilka två områden används detta mest? (rangordna 1=viktigast, 2= näst viktigast)

.... inköp
.... produktion
.... produktionsplanering
.... produktutveckling
.... transporter
.... ekonomisk styrning/uppföljning
.... Annat: ....

Vilken typ av datorkommunikation använder ni i förhållande till Volvo Torslanda? Rangordna *de två viktigaste* (1=viktigast)

.... Standardiserad kommunikation (t.ex SDI, ODETTE)
.... Speciallösningar gentemot Volvo Torslanda (t.ex filöverföring)
.... Elektonisk post (t.ex MEMO)
.... Internet (t.ex www)
.... Annat, nämligen: ....

VIII. SEKUNDÄRLEVERANTÖRER

Hur många leverantörer har ni till er produktion för Volvo Torslanda? .... antal

→ **Ange hur många av dessa som levererar:**
a) av er specificerade produkter/komponenter/legoarbeten .... antal
b) sitt eget standardsortiment .... antal
c) annat: .... antal

Var är era fem största leverantörer avseende Volvo Torslanda lokaliserade? Ange företag, ort, produkt och ungefärlig andel av den totala inköpen för Volvo Torslanda leveranser. (Om ni inte vill ange företagets namn är jag tacksam om ni ändå fyller i så mycket som möjligt, helst orten)

Företag	Produkt	Ort	Andel av inköp
1.	....	....	....
2.	....	....	....
3.	....	....	....
4.	....	....	....
5.	....	....	....

Vilken leveransfrekvens har era viktigaste leverantörer? .... ggr/vecka

→ **Hur har leveransfrekvensen från era viktigaste leverantörer förändrats under den senaste 10-års perioden?**
❐ ökat mycket
❐ ökat
❐ oförändrad
❐ minskat
❐ minskat mycket

Vem *ansvarar* för organiseringen av transporten från era viktigaste leverantörer till er?
❐ Ert företag
❐ Leverantörerna
❐ Volvo
❐ Speditör / Transportförmedlare
❐ Annat: ....

Vem *utför* transporten från era viktigaste leverantörer till ert företag?
❐ Ert företag
❐ Leverantörerna
❐ Volvo
❐ Speditör / Transportförmedlare
❐ Annat: ....

I vilken omfattning samarbetar ni med era leverantörer beträffande produktutveckling av produkter till Volvo Torslanda?
❐ Ofta
❐ Ibland
❐ Sällan
❐ Inte alls
❐ Annat

Vilka är de viktigaste formerna för kommunikation med era viktigaste leverantörer med avseende på produktutveckling respektive leveranser/logistik. Rangordna *de två viktigaste* i respektive funktion (1= viktigast).

Produktutveckling	Leveranser/logistik
.... Brev	.... Brev
.... Telefon	.... Telefon
.... Fax	.... Fax
.... Dator	.... Dator
.... Personkontakter (möten)	.... Personkontakter (möten)
.... Annat:	.... Annat: ....

Vad upplever ni som viktigast i er relation till era leverantörer med avseende på transporter?
Rangordna *de två viktigaste* (1= viktigast, 2= näst viktigast)

.... Billiga transporter
.... Snabba transporter
.... Säkra transporter (med avseende på godskvalitet)
.... Tillförlitliga transporter
.... Flexibla transporter
.... Annat:...

Kommentarer:

ETT HJÄRTLIGT TACK FÖR ER MEDVERKAN!

❐ Jag vill gärna ta del av slutresultatet

Uppgiftslämnare: .... Telefon: ....

QUESTIONNAIRE TO THE LARGEST SWEDISH SUPPLIERS TO VOLVO TORSLANDAVERKEN

.... ID#

Company name: . . . .

Address: . . . .

Owner: . . . .

Number of employees: . . . .

Product(s): . . . .

Number of products: . . . .

I. GENERAL

***Total* sales for the year 1996 alt. 97?** .... MKr

How are total sales distributed among the following alternatives?

→ Products manufactured at your unit .... %
→ Products from mother/daughter company .... %
→ Products from wholesaler/agent .... %
→ Other: .... %

The share of your production aimed for customers in the automotive industry .... %

The share of your automotive production that was exported .... %

The share of your production aimed for Volvo? .... %

The share of your production aimed for Volvo Torslandaverken? .... %

The distribution of sales to Volvo Torslandaverken? (share of total sales)

→ *Subcontracting*- products specified by the customer .... %
→ Products from your standard range .... %
→ Products for which you are a wholesaler/agent .... %
→ Other: .... %

For how long has your production unit delivered to Volvo Torslanda? .... years

Will you be delivering to the next model to be manufactured at Volvo Torslanda?

❒ Yes
❒ Yes ---> but we will be sub-suppliers suppliers to: ....
❒ No
❒ Do not know
❒ Other:..

Is your production unit a subcontractor to other companies? Please specify the three most important customers and their share of total sales:

COMPANY & PRODUCT	SHARE OF SALES
....	.... %
....	.... %
....	.... %

II. PRODUCT

What of the following statements is most appropriate for your products to Volvo Torslanda? Mark with an X for one of the alternatives in the three contrasting pairs.

❒ high-value
❒ low-value
❒ bulky
❒ compact
❒ many variants
❒ few variants

Have your Volvo Torslanda-related product(s) changed since the start of your deliveries?

❐ Yes, more complex
❐ Yes, more product-variants
❐ Yes, more colour-variants
❐ Yes, new materials (plastics, rubber)
❐ Yes, significantly more electronic components
❐ No
❐ Other: ....

What of the following alternatives best describes your product(s) aimed for Volvo Torslanda?

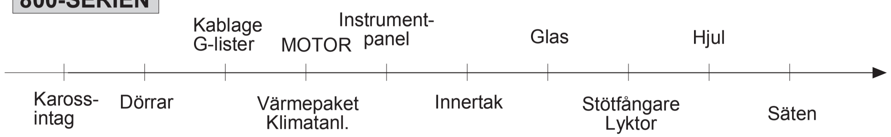
❐ 1. a product of ***standard-type*** developed by our company. (e.g. screw, nut)
❐ 2. ***one single detail*** included as a "building-block" in the assembly at Volvo Torslanda
❐ 3. a number of details forming ***a component*** included as a "building-block" in the assembly at Volvo Torslanda.
❐ 4. a number of details/components which form ***a functional system*** ready to assemble
❐ 5. a complete concept that forms a ***module*** ready to assemble at Volvo Torslanda (e.g. painted bumpers including spoilers, complete seats).

→ **Has there been any change between the categories during the last 10-year period?**

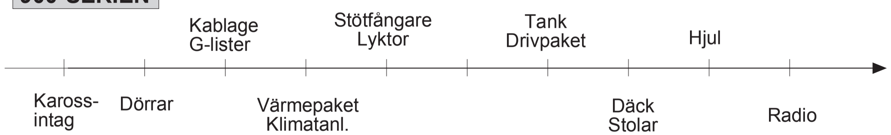
❐ Yes, mainly from alternative: .... to alternative: ....
❐ No
❐ Other: ....

Where in the manufacturing process is your product(s) assembled? (mark with an X) If your deliveries not aimed for final assembly, please write the destination below.

800-SERIEN



900-SERIEN



III. RESPONSIBILITY/DIVISION OF LABOUR

Who is responsible for the following parts of the production process? Mark with a X in the alternative that best describes your situation. Only one X per function.

	FUNCTION		
RESPONSIBLE	product-development	product-specification	purchasing
Volvo			
Your unit			
Your unit together with Volvo			
Your mother company or similar			
Other			

How is Volvo specifying their products?

❐ By giving the prerequisites at the product development stage and then give your company responsibility to develop and manufacture the product.
❐ By giving specifications developed by Volvo
❐ By purchasing your standard products without specification
❐ Other: ....

Who is primarily responsible for *product development* at your unit?

❐ Our unit
❐ Headquarters in Sweden
❐ Headquarters abroad, in: ....
❐ Other: ....

Who is primarily responsible for the *manufacturing process* at your unit?

❐ Our unit
❐ Headquarters in Sweden
❐ Headquarters abroad, in: ....
❐ Other: ....

Who is primarily responsible for the *strategic decisions* regarding marketing and supplier selection at your unit?

→ **marketing**

- ❐ Our unit
- ❐ Headquarters in Sweden
- ❐ Headquarters abroad, in: ....
- ❐ Other: ....

→ **supplier selection**

- ❐ Our unit
- ❐ Headquarters in Sweden
- ❐ Headquarters abroad, in: ....
- ❐ Other: ....

Has your production unit experienced any major changes in the last 10-years period regarding ownership and/or division of labour?

- ❐ Yes, entirely or partly ***acquired*** by a Swedish company.
- ❐ Yes, entirely or partly ***acquired*** by a foreign company.
- ❐ Yes , the ***expanded*** through the acquisition of other Swedish companies
- ❐ Yes , the ***expanded*** through the acquisition of other foreign companies
- ❐ Yes, through ***co-operation*** with other Swedish companies.
- ❐ Yes, through ***co-operation*** with other foreign companies.
- ❐ Yes, other: ....
- ❐ No

→ **If you answered Yes, please state company and year of major change**

COMPANY	YEAR
....	....
....	....
....	....

→ **Is the major part of the changes above associated with automotive-companies?**

- ❐ Yes
- ❐ No
- ❐ Other: ....

IV. PRODUCT DEVELOPMENT

How many of your employees have *product development* as their main task? ....

The share of your total costs for Volvo Torslanda-product that can be related to product development?

- ❐ less than 10%
- ❐ 10-24%
- ❐ 25-49%
- ❐ 50-74%
- ❐ 75% or more

To what extent do you co-operate with Volvo regarding *product development?*

- ❐ Often (weekly)
- ❐ Sometimes (monthly)
- ❐ Occasionally (less than once per month)
- ❐ Never:
- ❐ Other: ....

To what extent do you co-operate with Volvo regarding *process development?*

- ❐ Often (weekly)
- ❐ Sometimes (monthly)
- ❐ Occasionally (less than once per month)
- ❐ Never:
- ❐ Other: ....

V. TIME-COMPRESSION/DELIVERY

How many times per week do you deliver to Volvo Torslanda? ....

Are you involved in sequential deliveries to Volvo Torslanda?

❒ Yes
❒ No
❒ Considering the possibility

What is the lead-time demands put forward by Volvo? How long is the maximum time from final delivery-instruction until the component has to be ready to assemble at Volvo Torslanda? .... hours

---

How has the delivery frequency towards Volvo Torslanda changed in the last 10-year period?

❒ large increase
❒ increase
❒ no change
❒ decrease
❒ large decrease

How extensive is your inventory of raw-materials and finished goods for deliveries to Volvo Torslanda?

→ Raw-materials .... days of production
→ Components .... days of production
→ Finished components .... days of deliveries
→ Finished complete products .... days of deliveries

---

To what extent have inventory-levels changed in the last 10-year period

→ **Raw-material/components:**
❒ large increase
❒ increase
❒ no change
❒ decrease
❒ large decrease

→ **Finished products:**
❒ large increase
❒ increase
❒ no change
❒ decrease
❒ large decrease

VI. TRANSPORTATION

Estimate the distribution of in-bound and out-bound transport for 1996/97 by transport mode and volume . (if more than one means of transport is used, indicate the most important in terms of distance)

→ In-bound: Road ....% Rail ....% Ship ....% Air ....%
→ Out-bound: Road ....% Rail ....% Ship ....% Air ....%

Has the distribution above changed in the last 10-year period? Indicate (+) for increase, (-) decrease and (o) no change.

.... Road
.... Rail
.... Ship
.... Air

Who is *responsible* for the organisation of transport to Volvo Torslanda?

❐ Your company
❐ Volvo
❐ Transport company
❐ Other: ....

Who *performs* the transport to Volvo Torslanda?

❐ Your company
❐ Volvo
❐ Transport company
❐ Other: ....

What do you experience to be the most important factors in relation to Volvo Torslanda regarding transport? Rank the three most important (1= most important, 2= second, etc.)

.... Price
.... Speed
.... Goods safety
.... Reliability
.... Flexibility (ability to react to changes)
.... Other ....

How important are transport-related aspects in the product development and manufacturing processes?

❐ Very important
❐ Of little importance
❐ Not important
❐ Other:..

What are the most important forms of communication with Volvo Torslanda as regards deliveries and logistics? Rank the three most important (1=most important)

.... Mail
.... Telephone
.... Fax
.... Computer
.... Personal contacts (meetings)
.... Other ....

VII. COMMUNICATION

To what extent do you use computer-communication in your contacts with Volvo Torslanda?

❐ Often
❐ Occasionally
❐ Rarely
❐ Never
❐ Other ....

If you use computer-communication with Volvo Torslanda, within what areas is this used most frequently? Rank the two most important (1= most important)

.... Purchasing
.... Manufacturing
.... Production-planning
.... Product-development
.... Transportation
.... Economic control / management
.... Other: ....

What type of computer-communication do you use towards Volvo Torslanda? Rank the two most important (1=most important)

.... Standardised communication (e.g. EDI, ODETTE)
.... Special arrangements with Volvo Torslanda (e.g file-transfer)
.... E-mail (e.g. MEMO)
.... Internet
.... Other: ....

VII. SUB-SUPPLIERS

How many suppliers do you have for the production to Volvo Torslanda? .... number

→ **How many of these deliver:**
a) products/components specified by you .... number
b) products from their standard range .... number
c) other: .... number

Where are the five most important suppliers of Volvo Torslanda-related products located? Indicates company name, product, location and share of total purchases related to Volvo Torslanda. (If you can not reveal the name of the company, please indicate as much as possible. Location is of special interest)

Company	Product	Location (city)	Share of purchases
1.	....	....	....
2.	....	....	....
3.	....	....	....
4.	....	....	....
5.	....	....	....

What is the delivery frequency from your most important suppliers? .... deliveries/week

→ **How has the delivery frequency towards Volvo Torslanda changed in the last 10-year period?**
❐ large increase
❐ increase
❐ no change
❐ decrease
❐ large decrease

Who is responsible for the organisation of transports from the most important suppliers ?
❐ Your company
❐ Suppliers
❐ Volvo
❐ Transport company
❐ Other: ....

Who performs the transport from your most important suppliers to your unit?
❐ Your company
❐ Suppliers
❐ Volvo
❐ Transport company
❐ Other: ....

To what extent do you co-operate with your supplier regarding product-development of products to Volvo Torslanda
❐ Often
❐ Occasionally
❐ Rarely
❐ Never
❐ Other ....

What are the most important means of communication with your suppliers regarding product development and delivery/logistics? Rank the two most important in each category. (1=most important)

Product development	Deliveries/logistics
.... Mail	.... Mail
.... Telephone	.... Telephone
.... Fax	.... Fax
.... Computer	.... Computer
.... Personal meetings	.... Personal meetings
.... Other:	.... Other ....

What do you experience to be the most important factors in relation to your suppliers regarding transport? Rank the two most important (1= most important)

.... Price
.... Speed
.... Goods safety
.... Reliability
.... Flexibility (ability to react to changes)
.... Other ....

Comments:

THANK YOU VERY MUCH FOR YOUR CO-OPERATION

❒ Yes, I want to receive a copy of the finished dissertation

Informant: .... Telephone: ....

Appendix 2

Interview guide sent to suppliers in the Arendal supplier park May/June 1998

FRÅGEFORMULÄR SEKVENSLEVERANTÖRER - ARENDAL

Företag:

Produkt:

Antal anställda: ....

Moderboalgets hemland: ....

Typ av verksamhet:
- ❏ egen produktion + sekvensleverans
- ❏ betydande förmontering + sekvensleverans
- ❏ viss förmontering + sekvensleverans
- ❏ sortering + sekvensleverans
- ❏ annat: ....

Geografisk fördelning av inköp, i procent av totalt inköpsvärde:

.........%. lokalt (Göteborgsregionen)
..........% nationellt (Sverige förutom Göteborgsregionen)
..........% europa (Europa förutom Sverige)
..........% internationellt (Övriga världen)

Antal leveranser per dag: ....

Ansvarig för intransporter:
- ❏ vår enhet
- ❏ moderbolag eller motsvarande
- ❏ Volvo
- ❏ Annat: ....

TACK FÖR ER MEDVERKAN!

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