Global Sourcing: The transfer of development and production activities to Asian suppliers in the semiconductor industry

by
Wouter Heetman

Student identity number 0621701

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Company supervisors:
H. Dijkhuis, MBA, ASML
V.D. van Nieulande, MSc, ASML

Supervisors:
Dr.ir. W. van der Valk, TU/e, ITEM
Prof. dr. A.J. van Weele, TU/e, ITEM
Prof. dr. G.M. Duijsters, TU/e, ITEM
TUE. Department Industrial Engineering and Innovation Sciences.
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Abstract

Recent literature suggests that global sourcing can contribute significantly to the competitiveness of companies. However, many companies face difficulties in benefitting from the strategy. This paper examines the relocation process of production and development activities from European to Asian suppliers to understand the causes of these difficulties. A framework and model are developed to assess the transfer process at a high-tech company in the semiconductor industry. An embedded single case study design was applied to examine the problems and causes of ineffectiveness and inefficiency in these processes. In order to improve the performance of the projects transfer preparation and assessment tool is proposed to identify risks in the process in advance initiate mitigating actions.
Summary

This research entails the analysis of why companies face difficulties in benefitting from global sourcing as a strategy to obtain competitive advantage and a solution design to counter some of these problems. This problem was pointed out by Trent and Monczka (2003), who consider global sourcing to be a promising strategy for competitive advantage. The objective of this study was thus to explore the rationales behind global sourcing and identify the causes of these difficulties and to propose a solution, following the regulative cycle as described by Van Aken et al., (2006). This chapter summarizes this research starting with the problem description, followed by the research design and data description. Then the analysis is addressed, which leads to a diagnosis for which a solution is designed. The research is then reflected upon and recommendations and contributions to the theory are provided.

The study was conducted within the context of ASML, an Original Equipment Manufacturer in the semiconductor industry which produces lithographical systems for the production of computer chips since 1984. ASML is based in Veldhoven, where the systems are designed, assembled and shipped. Since 90% of the value of this machine is procured from a network of suppliers the procurement department is of crucial importance for the success of ASML.

The procurement department at ASML consists of several sub-departments: mechatronics, mechanics and frames, optical, immersion and vacuum systems and electronics and software. These departments all follow the ‘Value sourcing’ strategy as described by Dijkhuis (2004) which implies that suppliers are continuously capable of adding value for the customers of ASML through the parts they produce. Value is defined by using the QLTC-method, which stands for Quality, Logistics, Technology and Total Costs. A supplier has to meet requirements in each of these four categories. The Value Sourcing strategy also entails cross-functional sourcing teams which mainly consist of procurement, supply chain engineering, development and engineering and logistics representatives. In Strategic Product Family Teams they define a sourcing strategy per commodity group.

Recently, ASML has decided that it wants to achieve worldwide competitiveness through attaining a worldwide competitive supply base. For this purpose the company initiated the establishment of an Asian supply base, where it hopes to capture the benefits of Asia’s comparative advantage in production (e.g. lower product costs, lead-time reduction). Furthermore, an increasing number of customers of ASML is located in Asia and ASML hopes to support these better through their presence. To support sourcing from this supply market the ASML Centre of Excellence (ACE) was established in Taiwan.

Several initiatives to develop the supply base in Asia have been undertaken; the production of some parts was transferred from Europe to Taiwan. Despite this, only a very small percentage of the sourced volume is procured from there. In preliminary interviews this problem was investigated, but the exact reasons have remained unclear. Long durations of the projects, ineffectiveness of the
projects and a lack of insight in potential roadblocks were however indicated which has led to the problem:

*The current relocation process for development activities and production processes for components from current to Asian suppliers is not effective and efficient.*

Effectiveness in this respect is whether predefined goals have been attained, while efficiency is defined as the delay on the planned schedule.

The accompanying research question that was formulated to research this problem is:

*How can the efficiency and effectiveness of the relocation process for development activities and production processes for components from European to Asian suppliers be improved?*

Several sub-questions support the research of this initial question:
- Why are relocation processes initiated?
- What does the current relocation process look like?
- Which problems lead to inefficiency and ineffectiveness of the process?
- How can these problems be solved through a solution design?

The research to answer these questions has thus followed the regulative cycle by Van Strien (1997) as described by Van Aken et al. (2006) which leads from a problem definition to an analysis and diagnosis, a plan of action or solution, intervention and evaluation. These latter two steps were only executed theoretically by designing an implementation plan and evaluating the impact of the design. The actual implementation and evaluation should be conducted by ASML.

The research is a qualitative research aimed at the exploration of the causes of ineffectiveness and inefficiency of the transfer process. In order to find these causes a single embedded case study (Yin, 2003) after the transfer process at ASML was conducted, since the ASML process represents a unique circumstance. The research design was aimed at securing construct, internal and external validity and reliability, as listed by Yin (2003). Through consulting multiple sources of evidence and the creation of a chain of evidence construct validity was enhanced. Furthermore, internal validity was secured by the establishment of a framework (Figure 8) and a model (Figure 9) from a literature review to predefine the topics that were addressed and used to match the data during the coding process. External validity was attained by using the theoretical domains of outsourcing and global sourcing as a theoretical perspective. Finally, reliability was secured through the formulation of a research proposal, a protocol for the data collection and a theoretical framework and documentation in this report.

Within the single embedded case study design three units of analysis were selected by predefined criteria from a list of transfers that had been conducted. These projects had to involve a transfer covering the strategic and transition phase as defined by Momme and Hvolby (2002) in their model from European to Asian suppliers and have sufficient data sources accessible. The transfer of the Custom Made cable Set was the only project complying to all these criteria since it had been finished
completely. However, to prevent researching problems that would be specific for this project alone two other transfer projects were also investigated superficially.

The collection of data was carried out through the consultation of several sources of data. Semi-structured interviews with people involved in these projects have been the main source of data collection. These people were selected from different functional backgrounds, different functional departments, different levels of hierarchy, and different office locations (i.e. ACE and Veldhoven). The interviews followed a pre-defined set of questions covering all aspects defined in the developed framework and model. Furthermore, reports, time plans and internal communication were consulted for triangulation of data.

Prior of the data collection a literature review was conducted after outsourcing and global sourcing. In first instance the global sourcing literature was searched for a framework addressing the steps that have to be followed for a transfer. Global sourcing has been the topic of research for many studies from the early 1980’s. Despite this, the field still has many gaps according to Quintens et al. (2006). They define global sourcing as:

‘The activity of searching and obtaining goods and services and other resources on a possible worldwide scale, to comply with the needs of the company and with a view to continuing and enhancing the current competitive position.’

This definition entails that the strategy consists of a global search which leads to the best supplier worldwide available and may not lead to global purchases. Furthermore it refers to the strategic considerations that form the basis of the transfer and the fulfillment of company needs.

According to several scholars (e.g. Kotabe & Murray, 1990; Monczka & Trent, 1992; Bozarth et al., 1998) global sourcing is initiated as a result of competitive pressures from customers, worldwide opportunities, competition and the supply base location. It leads to competitive advantage through for instance cost advantages, higher quality, better delivery performance, government regulations, technology access and access to new markets.

Following the practice however brings along several requirements and challenges of which Birou and Fawcett (1993) provide a comprehensive overview which include for instance establishment of long-term relationships, developing global sourcing skills, understanding global opportunities, knowledge of business practices, planning, foreign buying offices, finding qualified sources, overcoming cultural differences and logistics support. Especially in the context of a transfer from Europe to Asia geographic distance, time-zone differences, multiple organizations, different interpretations of quality, cultural differences, transferring technological capabilities and the complexity of the industrial context (Karandikar & Nidamarthi, 2006; Nassimbeni & Sator, 2006) form huge challenges for companies.

Despite the complexity of the process and its many challenges, a framework for steps in global sourcing transfers was not found, and since this field is conceptually similar to outsourcing the outsourcing literature was reviewed. Several frameworks were found, most of them only address the identification of activities to outsource (e.g. McIvor, 2003; Sislian & Satir, 2000). Momme and Hvolby
(2002) (Figure 2) however propose a six-step framework starting with a competence analysis and ending with the termination of an outsourcing contract. According to Van Weele (2008) this process consists of three phases: a strategic phase for decision making and supplier selection, a transition phase for the transfer of knowledge and assets and negotiation of a contract and an operational phase in which the relationship is managed and terminated.

For each of these phases the literature was reviewed for recent insights and activities that should be conducted in these phases. The strategic phase starts with the identification of a product or activity for outsourcing by evaluating the core competencies, the costs of different production options, supply risks and supplier availability. The requirements from a supplier are then specified after which the supply market is researched for suppliers. A long-list of these of these is through selection by selection criteria and strategic and business fit reduced to a short list. A process and product audit is then conducted to check the compliance to selection criteria of a supplier. In the operational phase a long-term contract is then negotiated with the selected supplier after which the transfer is started. This relocation consists mainly of the transfer of knowledge and assets. The complexity of technology transfer was emphasized by several researchers (e.g. Ivarsson & Alvstam, 2004; North, 1997; De Bruijn & Jia, 1993; Grant & Gregory, 1997). According to them it mainly involves the transfer of product and process knowledge which can be explicit or tacit of nature. Tacit knowledge is very hard to transfer and is more-or-less a matter of learning by doing. However, through reverse engineering, technical documentation, technical assistance and observation the transfer of embodied product and process knowledge can be enhanced.

From this review a framework covering these steps and assuming that execution of these steps will lead to a good transfer was developed. Furthermore it was hypothesized that the execution of this transfer and its success would be moderated by characteristics of global sourcing resulting from the geographically dispersed locations. These two results have guided the data collection and the subsequent analysis.

The first case of which data was collected was the Custom specific made cable set (CMS) and involved the transfer to the Taiwanese supplier Supplier 1 from the local supplier LOCAL SUPPLIER 1. The project started in early 2007 and was initiated by the product family team “cables and bundles” in the electrical procurement department. The product consists of 50 to 60 cables which are produced at a specific length for each customer since it depends on the floor plan of the factory, which determines the lead-time of ten days. Each cable has connectors at its ends. The cable was previously shipped to the customers in Asia, where it was installed to connect the sub-factory and the machine.

The transfer was executed by people from supply chain management, procurement and development and engineering from Veldhoven and ACE. The project was initiated by the PFT, who identified a product and formulated the QLTC requirements. The main drivers behind this initiation were the establishment of a worldwide competitive supply base. The cable set was selected since it was a mature and developed product of for which availability of technical documentation was assumed. Furthermore the high labor content allowed for substantial savings and transportation
costs and lead-time could be reduced by directly delivering to the customers. The select and qualify process was led by ACE. The PFT was however involved in supplier selection. The qualification tests were conducted in Veldhoven by supply chain engineering and development and engineering. Formally the transfer was not organized as a project with a project group. A plan for the first steps of the transfer was made by the PFT. ACE made a second and more detailed time plan for the “select and qualify” process, since it was executed under their supervision.

Based on the PFT requirements a supplier search was conducted, which resulted in a long-list of suppliers who were able to produce cables. This was reduced to a short-list based on RFI information. The three suppliers on this short-list were audited. One scored too low in this and was excluded. The others were asked to produce a sample for product qualification. During a site visit the business fit with ASML was discussed and one supplier, who was performing best, decided to withdraw as a result of non matching business types. Supplier 1 was then finally left as the selected supplier, although Supplier 1 had no experience with ASML-like products and scored low on several categories in the audit.

During the preparation of these samples many problems showed up. The technical documentation showed incomplete or wrong. Furthermore, the supplier required much iteration in this sample production to meet the required quality. Especially these loops of producing, checking and improving delayed the project substantially. In the final production of the cable set a lot of other problems showed up which is ascribed to an over emphasis on quality during the check and supplier capability. Finally, since it was believed that after several iterations the supplier was able to produce the set the product was released under pressure of the director electrical procurement in Veldhoven and the supply chain engineer at ACE.

Through coding the data according to the predefined framework the collected data was analyzed. A list of problems found in the transfer was established and these causes were grouped by their nature. This process resulted in an Ishikawa diagram (Figure 14) consisting of four branches of related problems. First, some problems were related to unawareness of the Asian supply market, its opportunities and local ways of working. This mainly led to non-matching types of business and resistance to transfer and an overemphasis on quality. Secondly, supplier selection issues resulted in an unclear selection process to the people in Veldhoven, which as a result of non-matching business types, led to the selection of a supplier who had no proven capability in producing ASML products. Thirdly, specification issues such as incomplete technical documentation hindered the transfer of product and process knowledge. Tacit process knowledge was found difficult to transfer. In this way unclear requirements led to the need for additional iterations. Fourth, the lack of project alignment resulted in an unclear supply base fit since these goals had not been included in the selection process. To gain further insight in the causality of the problems a cause-and-effect diagram was constructed (Figure 15) showing that delay and additional costs of the project resulting from iterations led to inefficiency, and unclear supply base fit as a result of bad alignment of the offices led to ineffectiveness.
Based on these four problem categories the literature was reviewed for solutions. Several building blocks were found to form an outline design which was then translated in a solution design specific for the situation of ASML. The final solution design consists of a three-step cycle addressing the preparation, execution and evaluation of a transfer. It is aimed at identification of risks for efficiency and effectiveness, inclusion of strategic objectives throughout the remaining transfer and alignment of activities by ACE and Veldhoven. The emphasis in the design is on this preparation phase. This consists of six steps (Appendix 10). The sourcing strategy developed by the SPFT, measurable strategic goals (e.g. supply base fit) and a selected commodity group serve as input for this phase. The commodity group can be selected by First, a cross-functional team with all relevant disciplines from both offices should be composed and commitment from their functional managers should be secured. Second, from the commodity group a product should be selected and assessed by its characteristics. Thirdly, the objectives of the transfer should be defined in measureable terms. The team should agree on these. Fourthly, the goals should be assessed on their feasibility and criteria for termination if goals of the project are not feasible any more have to be defined. Important in this step is the use of total acquisition costs which also includes indirect costs in the assessment of cost reductions. Fifth, a time plan and work breakdown structure has to be established. Based on this the required resources should be defined and secured in consultation with the management and project team. The team members should be aware of what is expected of them and others in each phase. Finally, in the sixth step the total acquisition costs scheme has to be updated and the feasibility of the goals requires a final check. The success of the transfer can now be determined from the qualitative assessment resulting from these steps. A decision can be taken whether to continue the transfer or whether termination is better, without having made any investments yet.

After this the execution phase can thus commence which should be carefully monitored and controlled by the project leader. Any new information that comes available should be assessed and included in the time plan. Finally, a global sourcing expert in the team is responsible for the evaluation of the process. This should lead to improvement of the solution and a better estimation of risks. Furthermore, he should make sure that knowledge is shared between the departments.

The implementation of this solution requires a change organization for which the existing SPRC department at ASML is most suited. They are already responsible for implementation and maintenance of procurement processes and should also appoint a global sourcing expert. The implementation does not require large organizational changes; the role of the functional representatives does not change. Rather, the project team fosters a more structured and aligned approach to transfers. The main difficulty is to convince team members who do not perceive the problem of ineffectiveness and inefficiency resulting from their hierarchical perspective of the need to adopt the solution. This report with analysis and emphasis on the need of their knowledge can be helpful in this.

Several conclusions and recommendations have resulted from this research. First, the rationales behind transfers were listed. The reasons for transfer mainly depend on the characteristics of the existing supply base and the external forces on the company. Second, the transfer followed more or less the steps defined in the literature framework. The supplier selection steps were however found
to be dividable into pre-selection and final selection. The audit is conducted in between and used for selection. Furthermore, knowledge is also transferred during the product and process audit. Thirdly, the causes of ineffectiveness and inefficiency were identified. It was found that awareness of the Asian supply market mainly impacts the transfer in the strategic phase. Supplier selection issues impact in the supplier selection and specifications issues mainly impact the knowledge transfer. Considerations such as the selection of a product and supplier and their associated risks then accumulate during the final knowledge transfer in which the supplier is tested to be qualified. Knowledge of such risks helps to improve these considerations and minimize inefficiency.

The solution to benefitting optimally from global sourcing through a successful transfer lies thus mainly in a thorough preparation of the process and anticipation on and mitigation of risks. With respect to the existing theory of global sourcing several contributions have been made. First, the framework by Momme and Hvolby (2002) has been further operationalized in the respect of international transfers for which no stepwise framework existed. The framework should be revised for global sourcing by adding a tactical preparation phase between the strategic and transition phase. This phase should translate strategic considerations into operational actions which attain these objectives. Secondly, a tool was developed for assessing risks in a transfer based on product characteristics, which did not exist for identification of products in global sourcing. Thirdly, some of the difficulties in the strategic and transition phase of global sourcing were identified as indicated by Trent and Monczka (2003). Fourthly, the study has combined recent insights from outsourcing and global sourcing into the global sourcing literature.

The outcomes and implementation of this research have also led to several recommendations. First, the design should be implemented and tested for its impact by a global sourcing expert at ASML. In this respect it should also be tested in different departments than the electrical only. Secondly, since the solution focuses on preparation, several problems in the execution or transition phase have remained unaddressed. Further detailing of this phase should include these findings as well. Thirdly, the research has only focused in difficulties in the strategic and transition phase as defined by Momme and Hvolby (2002). Issues in the operational phase have remained unaddressed and should be topic of future research. Finally, the solution was developed for a specific context. Future research can examine whether the four problem areas are also present in other industries and if the proposed design solves these. This summarizes the research elaborated in this report.
1. Introduction

This research addresses the topic of global sourcing in the context of a systems integrating company. Global sourcing has been the topic of research for many other studies since the early 1980’s and according to Trent and Monczka (2003) it still offers potential breakthroughs in performance of companies.

Increased competition resulting from today’s globalizing economy challenges many companies to review the way they make use of their business’ resources. Manufacturing companies have outsourced many of their production activities to their suppliers to free up resources and benefit from the suppliers’ capabilities. Even development activities are thereby increasingly undertaken by or in cooperation with suppliers resulting in a shift from arms length transactions to collaboration. This has created a shift towards dynamic virtual organizational networks (Kotabe & Murray, 2004) in which companies have to manage strategic partnerships with suppliers.

The performance of the supply base is thus a necessity for competitiveness of these companies. The potential benefits of sourcing from suppliers all over the world have led to increased attention for global sourcing. This strategy is according to Monczka and Trent (1992) a means for companies to achieve worldwide competitiveness in their supply base. Through global sourcing the companies can benefit from the best suppliers available in terms of technical capabilities, cost efficiency and other advantages. This implies that companies have to reconsider their sourcing strategies, transfer activities globally, and in some cases relocate production from local to global suppliers. Many companies engaged in this new practice to remain competitive and increasingly sourced components from low-cost regions like Asia. Due to their low wages and increasing technological sophistication, countries such as China, India, Malaysia, Singapore and Thailand are popular countries for sourcing activities in the high-tech industry (Nassimbeni & Sator, 2006).

A decade later however, Trent and Monczka (2003) emphasize the difficulties of capturing the benefits and avoiding risks of these international sourcing activities. Cultural differences and geographical distances between European sourcing firms and their Asian suppliers along with logistics and quality issues form impediments to capturing the real benefits of global sourcing. These issues have resulted in lower savings for many firms as a result of increased total costs (Song et al., 2007). Furthermore, the management and technical capabilities of these suppliers in Asia were in some studies indicated to be a challenge for buyers.

This study is aimed at exploring these challenges of a global sourcing process in a business context. The root causes of the performance were identified and a redesign of a part of the process was proposed to help a business get a better grip on the global sourcing process and in this way capture more benefits.

The study was conducted in the specific context of ASML, a high-tech manufacturing company of lithography systems in the Netherlands which sources the majority of their components from a network of suppliers. Recently, the company has moved towards global sourcing as a strategy for ensuring worldwide competitiveness and in this respect reconsiders the location and competitiveness of their suppliers. Similar to the finding by Monczka and Trent (2003) also ASML faces difficulties in outsourcing their manufacturing activities on a global level.
The report first addresses the assignment, problem statement and research design. In the following chapter a review of the literature regarding global outsourcing of manufacturing activities is presented. It has resulted in a framework which includes the activities and context of the transfer process which will be addressed in this research. After that the analysis of the business process will be described and the main causes for poor performance will be presented. The redesign of the process to increase performance is the topic of the next chapter. Finally, the research will be concluded and findings will be discussed.
2. Assignment and problem formulation

This research will, as stated in the introduction, address the topic of global sourcing. Global sourcing is a complex practice but, as Trent and Monczka (2003) state still is a substantial source of competitive advantage. The complexity of the strategy has been the reason behind this research and will be further elaborated upon below. Next, the problem and its context are addressed. Finally, the research design that was used throughout the study is described.

2.1. Objective of the study

According to Trent and Monczka (2003) global sourcing offers companies a potential competitive advantage through the comparative advantages of different countries. Companies which are already outsourcing parts of their production may want to reconsider their local sourcing strategies and relocate development and production activities to global suppliers. In the same study Trent and Monczka (2003) emphasize the difficulties businesses face in capturing these benefits. Despite these challenges there is to the knowledge of the author currently no tool available to help companies to get a grip on this process and benefit from the potential advantages. The objective of this research is to explore the rationales behind global sourcing and identify the causes of difficulties in benefiting from the strategy. The study will then propose solution to improve this.

2.2. Problem formulation

The problem definition is according to Van Aken, Berends and Van der Bij (2006) a crucial part of the business problem solving project. The problem statement should be related to unsatisfactory business performance or an undesirable state-of-affairs which leads to lower performance. As stated above, this research addresses the difficulties businesses face in benefitting from global sourcing. This topic has been researched within the context of ASML, a high-tech company in the semiconductor industry. This company and its activities will be described first, after which the problem statement will be presented.

2.2.1. Problem context

ASML is a company which operates in the semiconductor industry and was established in 1984 as a joint venture between Philips and ASMI. Since 1994 it operates as an independent company. ASML develops, produces and sells lithographic systems for the production of integrated circuits (IC) or chips. ASML is currently world market leader in these lithographical systems. The company maintains this position in the market through its mission statement: “To provide leading-edge imaging solutions to continuously improve our customers’ global competitiveness.” Embedded in this mission is the creation of value for their customers through development, production and support activities.

2.2.2. Procurement at ASML

ASML systems are designed around platforms which consist of many modules and components. Most of these parts are sourced from the supplier network; about 90% of the value of a system is created by suppliers (ASML Value Sourcing presentation, 2006). This fact emphasizes the importance of procurement for ASML.

The organization of procurement at ASML has been described in the ‘Supply Base Manual ASML’.
The role of the procurement department is stated in its mission: “Create, maintain and qualify a global supplier network that enables the execution of the ASML development, production and customer support plans and operates according to the principles of Value Sourcing”. Procurement is thus a supporting business function (Porter, 1985) for development, production and customer support and operations. For the purpose of the research it is important to distinguish between product related and non-product related procurement. This research focuses on the former.

The mission stresses that ASML manages its suppliers using the Value Sourcing methodology (Dijkhuis, 2004). This implies that suppliers are continuously capable of adding value for the customers of ASML through the parts that they produce. Value is assessed using the QLTC-method which consists of four categories: Quality, Logistics, Technology and total Cost. Each of these is a source of value for the ASML customers in integral quality, reliability of delivery, advanced technology and lowering total cost respectively.

Within the category of product related procurement five disciplines can be distinguished:

- Mechatronics
- Mechanics and frames
- Optical
- Immersion & Vacuum Systems
- Electronics and software

For each of these disciplines cross-functional Strategic Product Family Teams (SPFT’s) determine sourcing strategies which guarantee supply chain availability. Furthermore, they determine the QLTC requirements that suppliers have to comply with based on technology roadmaps and customer needs.

Supplier Account teams are on a tactical level responsible for the supplier relationships.

ASML currently sources mainly from suppliers in Europe and the US. Many of the suppliers are located close to ASML in the Veldhoven region. The company sources little from Asia, however in order to have a worldwide competitive supply base they feel they have to.

2.2.3. Problem definition

In preliminary interviews with several people involved in the transfer projects the problem was explored. These were structured in a problem diagram and discussed with the initiators of the research. The resulting problem definition is described below.

Since ASML operates in a global market with worldwide competitors and customers it needs a worldwide competitive supply base. Through sourcing in Asia ASML hopes to capture the perceived benefits in efficiency (e.g. lower costs, lead-time reduction) that sourcing of certain parts from Asia can bring.

The gradual shift of sales from Europe and the US to Asia is another reason for the establishment of an ASML Center of Excellence (ACE) in Taiwan. About 80% of the ASML systems are currently sold to Asian semiconductor manufacturers. One of the targets of ACE is to source selected service parts from Asia. In order to achieve this ACE currently has well-educated employees in for example engineering and procurement. For the sourcing of parts from Asia it is the task of the ACE procurement department to have a supply base complying with ASML standards from which products can be sourced.
Several initiatives to start development with Asian suppliers have recently been undertaken; the production of some parts was transferred from Europe to Taiwan. This transfer concerns volume production. ASML thus already has some experience with transferring production to Asia. The number of successful transfers however still does not meet the expectations. The reasons why expectations are not met have remained unclear after the orientation phase of this research.

Instead of relocating volume production to Asia, it was decided to start with transferring production and redevelopment of service parts to Asia. Service parts are compared to the volume products of a much lower volume. Moreover, these products have been proven to function, hence the design has been qualified. Furthermore they can be re-developed and produced independently from the rest of the system and thus remain free from system integration issues.

The aim of the relocation projects is to prepare for development and production in Asia in the long term by establishing a supply base. The projects are collectively undertaken by different ASML Veldhoven departments and ACE. Also these projects are developing unsatisfactory; after two years only one product has been identified that is potentially suited for transfer to Asia based on a business-case.

Despite the potential savings that sourcing from Asia can generate it has thus been very difficult to capture these through an actual transfer. It seems that problems exist regarding the selection of products to transfer. Furthermore there is a lack of insight in what potential roadblocks may arise in the transfer. These are however first insights and the problems have not been validated. What the main issues are has remained unclear during the orientation on the business problem.

The lack of successful transfer projects and the long duration of the transfer projects indicate a lack of effectiveness and efficiency. Effectiveness is in this respect defined as the extent to which the process has achieved the initial goals, whereas efficiency was defined as the schedule performance of the projects. Despite that the actual root causes have not become clear from the interviews, the initiators agreed that the following general problem exists and that its actual causes should be researched:

The current relocation process for development activities and production processes for components from current to Asian suppliers is not effective and efficient.

This problem was focused upon during the research. In order to further examine this problem several research questions have been formulated which will be addressed next.

2.3. Research questions

During this research several research questions have been answered. The main question that has been addressed is: “How can the efficiency and effectiveness of the relocation process for development activities and production processes for components from European to Asian suppliers be improved?”

Several sub-questions have been formulated to substantiate the answer to the main-question:

- Why are relocation processes initiated?
- What does the current relocation process look like?
- Which problems lead to inefficiency and ineffectiveness of the process?
- How can these problems be solved through a solution design?
These questions also outline the design of the research which will be addressed in the next section.

2.4. Research design and methods
This research involved a business problem solving project as described by Van Aken, Berends and Van der Bij (2006). Design oriented business problem solving projects are initiated to improve the performance of a business process. This chapter will present the process followed and the design that was used to conduct the research.

2.4.1. The regulative cycle
This project in this respect followed the regulative cycle by Van Strien (1997) for problem solving (Figure 1) which is often used in these types of research. This process is particularly applicable for doing business problem solving since it consists of an analysis to determine the need the design should meet followed by an implementation and reflection of the design.

The first two steps of the cycle are aimed at the identification of the business problem which should be put in the context of several related problems.
In the analysis and diagnosis phase the business process is researched and the causes of ineffectiveness and inefficiency of the transfer process were identified through systematical analysis of the data and comparison with a predefined framework (Figure 8) and model (Figure 9). These results from the literature review that was conducted during the research have functioned as propositions in the analysis. These propositions were that if a transfer process is executed following the framework the transfer is likely to be successful and that this success is in a global context influenced by several factors. According to Yin (2003) such propositions guide the research and "direct the attention to something that should be examined within the scope of the study". Furthermore, in the analysis step the initial problem statement should be validated to assure that the problem is real and not based on perceptions (Van Aken et al., 2006).
The resulting diagnosis and structure of the problem then led to a plan of action or redesign of the process to solve the problem. In the intervention step a change plan was created to estimate the impact of the change in the organization and determine the actions to be taken. Furthermore, the
effect of the implementation was theoretically evaluated to assure that the business problem will be solved by the design. The implementation itself has not been part of this project but has to be carried out by ASML.

Finally, the research process was reflected upon in the last chapter. This part of the study addresses the implications for theory that were derived from this particular case study.

2.4.2. Research strategy

In the analysis and diagnosis step a qualitative empirical and theoretical analysis were made of the current relocation process of development and production activities and a diagnosis of the main problems resulting in reduced efficiency and effectiveness was presented. Qualitative analyses are according to Van Aken et al. (2006) appropriate when the research is oriented at the discovery of qualities of things which are in this research the occurrence and causes of situations and events. The analysis consists of an empirical exploration and validation of these qualities: the business problem and the causes that have led to the occurrence of the problem.

The problems in the business process were explored by conducting a single embedded case study with multiple units of analysis (Yin, 2003). This is according to Eisenhardt (1989) “a strategy which focuses on understanding the dynamics present within single settings.”

A number of criteria for the use of case studies have been listed by Yin (2003). He states that it is most appropriate as a research strategy if: “a “how” or “why” question is being asked about a contemporary set of events, over which the investigator has little or no control.” Furthermore he states that the context and phenomenon are not distinguishable as in the situation of ASML in which the business context and business problem are indistinguishable.

A single case design was chosen since there is only one relocation process from European to Asian suppliers available within the context of ASML. Despite that only one such process is present in the company, several project have been initiated within this process. A single case study is thus justified since Yin (2003) states that it is appropriate if the case represents a unique circumstance.

Besides the rationale for conducting a case study and the number of cases, Yin (2003) also refers to several aspects that should be considered in the research design. These are four kinds of validity, namely: construct, internal and external validity and reliability.

Construct validity was attained by using multiple sources of evidence, as will be explained in the data collection section of this chapter. Furthermore, a chain of evidence was created by formulating the interview questions and data collection plan from the research questions and references to the data sources were made in the report. Finally, the case study report has been reviewed by two key informants.

In order to secure the internal validity of the research a framework (Figure 8) and model (Figure 9) were developed from the literature review. These define the topics that were addressed in the research and were during the analysis used to match the data to by coding of the data.

External validity according to Yin (2003) refers to the extent to which findings can be generalized to a broader theoretical domain. By using the theory of outsourcing and global sourcing practices to analyze this case the findings are placed in a broader theoretical perspective.

The reliability of the study finally is, according to Yin (2003) to secure that the study can be repeated and the same findings can be obtained. This was taken into account by formulating a research proposal and case study protocol. For this protocol the purpose of the study, the selection of cases,
sources of data and a theoretical framework were defined in advance of the research and finally documented in this report. The following section will address these topics in further detail.

2.4.3. Case description and selection
This research involves a single embedded case study (three units of analysis in one company) as stated above. This is the process followed at ASML to transfer production activities from European to Asian suppliers ranging from the identification of a product to transfer and the qualification of the production process for this transfer. Several projects have already passed through this process. Each of these steps and activities taken in these projects and the considerations behind them were examined and analyzed.

2.4.4. Case selection
Three units of analysis have been analyzed to determine the dynamics and properties of the events in a relocation process. They have been selected out of a list of transfer projects (Table 1) that has been developed from a list of transfers that was provided by the international purchasing office of ASML in Taiwan and through snowball sampling during the interviews. The international purchasing office has been asked to list 5 to 10 recent projects. Furthermore, during the interviews that were conducted several interviewees have suggested to contact other people in different projects. Three projects were thus selected of which one was analyzed in depth, the others only served for validation of the problems to assure that the problem is representative for the case and not just a symptom in a single unit.

For the selection of the main unit several criteria were pre-defined:

- The project should involve a transfer of production activities from European suppliers to Asian suppliers. Within the context of ASML this excludes transfers from the United States to Asia. This criterion was chosen to control for differences across units resulting from different geographical locations. Furthermore, it eases the collection of data since the most important people involved in these projects are then located at ASML in Veldhoven.

- The historical data of the project should cover the strategic and transition phase as defined in the model by Momme and Hvolby (2002). This criterion secures that the selected projects range from the identification of a product for transfer to the approval of the supplier for the start of production.

- The project should have sufficient information richness to derive problems from. This criterion was formulated to ensure the availability of data. Cases for which important people or sources of information were unavailable have been excluded.

This selection has resulted in one case which complies with these criteria: the Customer specific Made cable Sets (CMS). This case was thus researched in depth and data were collected and analyzed to understand the dynamics of this transfer case.

Next to this case, the Carrier Handler and XCDA Valve Assy cases were investigated less in depth to increase the robustness of the study to changes in the company environment as well as differences resulting from the type of products and the responsible departments. These have been selected on recommendation of ASML since they had specific characteristics such as
Table 1: List of recently initiated transfer projects

<table>
<thead>
<tr>
<th>Project name</th>
<th>Start</th>
<th>Finish</th>
<th>Status</th>
<th>New vendor</th>
<th>Local vendor</th>
<th>Departm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cust. specific Made cable Sets</td>
<td>03-2007</td>
<td>11-2008</td>
<td>R4V</td>
<td>Supplier 1</td>
<td>Local Supplier 1</td>
<td>Electrical</td>
</tr>
<tr>
<td>Beam Delivery Kits</td>
<td>12-2007</td>
<td>07-2008</td>
<td>R4V</td>
<td>Supplier 5</td>
<td>Local Supplier 3</td>
<td>Mechanical</td>
</tr>
<tr>
<td>PCBA</td>
<td>07-2008</td>
<td>09-2008</td>
<td>Closed</td>
<td></td>
<td>Local Supplier 4</td>
<td>Electrical</td>
</tr>
<tr>
<td>Pod Cover Lifters</td>
<td>01-2008</td>
<td>08-2008</td>
<td>R4V</td>
<td>Supplier 4-7</td>
<td>Supplier 5</td>
<td>Mechanical</td>
</tr>
<tr>
<td>Integrated Reticle Library</td>
<td>02-2008</td>
<td>05-2009</td>
<td>FA to R4V</td>
<td>Supplier 4-7</td>
<td>Local Supplier 5</td>
<td>Mechanical</td>
</tr>
<tr>
<td>Carrier Handler</td>
<td>07-2008</td>
<td>05-2009</td>
<td>Qualification</td>
<td>Supplier 4-7</td>
<td>Local Supplier 6</td>
<td>Mechanical</td>
</tr>
<tr>
<td>XCDA Valve Assy</td>
<td>01-2008</td>
<td>01-2009</td>
<td>R4V</td>
<td>Supplier 4</td>
<td>Local Supplier 2</td>
<td>IVS</td>
</tr>
</tbody>
</table>

2.4.5. Data collection

Yin (2003) lists several sources of data that may serve as evidence of the dynamics of the process. As suggested by Eisenhardt (1989) and Yin (2003) multiple sources of evidence were used for triangulation of the data and to enhance the internal validity of the data.

First, semi-structured interviews have been conducted. According to Yin (2003) interviews have several strengths: they are targeted at the study topic and are insightful and provide perceived causal inferences. They however also have some weaknesses since the method may be biased by poorly constructed questions, response bias, inaccuracies due to poor recall and reflexivity. These biases were attempted to counter through predefining the questionnaire, consulting multiple interviewees, making literal transcriptions of the interviews and data triangulation using other sources.

The interviews thus consisted of pre-defined questions (Appendix 1) and addressed some general characteristics of the process such as duration, the people involved and the product. Then the process was addressed to identify the actions that had been taken, the reasons behind them and the problems that had been faced. Finally, the interviewees were asked how they would evaluate the process in terms of effectiveness and efficiency.

Ten interviewees were identified through preliminary talks and during the first interviews. Eisenhardt (1989) also refers to this method of sampling for “individuals whose importance became clear during data collection” and states that it is justified for the purpose of understanding the case in depth. A list of the interviewees is shown in Table 2 below. Since he was responsible for the initiation of the transfer and had a thorough insight in the process, the chairman of the PFT and account manager was interviewed first, the others in order of availability.

With respect to the functional areas members from the disciplines Procurement, Supply Chain Engineering and Design & Engineering were selected since these are the most important disciplines involved. To further enhance objectivity and reliability of the data the interviewees are from both the offices in Veldhoven and in Taiwan. Both offices have different concerns and perspectives towards the processes which may influence their perception of the development and performance of the transfers. Furthermore, the level of involvement varied between them. Some were involved on a strategic level, others on a tactical and a few on an operational level in the transfer process. An overview of the interviewees is show below in Table 2, showing their roles, the project in which they were involved, the site at which they are located, their functional departments, level during the project and their task.
Secondly, several internal documents such as time plans, presentations, reports and e-mails about the transfer projects were analyzed and used to support and further clarify the data from the interviews (Table 3). These documents were collected during the interviews by asking the interviewees for archived documentation, mainly when indistinctness of the facts for the problem analysis existed.

### Table 3: Consulted archival data sources

<table>
<thead>
<tr>
<th>Source</th>
<th>Date</th>
<th>Type of source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier Development plan Supplier 1</td>
<td>07-2008</td>
<td>Time plan for monitoring progress of S&amp;Q process</td>
</tr>
<tr>
<td>Cable suppliers Taiwan</td>
<td></td>
<td>Long-list of cable suppliers in Taiwan</td>
</tr>
<tr>
<td>Activity plan rev13</td>
<td></td>
<td>Activity plan for transfers of electrical parts to ACE</td>
</tr>
<tr>
<td>PFT Strategic file revised</td>
<td>10-2007</td>
<td>PFT strategy document Cables and Bundles</td>
</tr>
<tr>
<td>Summary Cable audits</td>
<td>07-2007</td>
<td>Summary of audits of Supplier 2, Supplier 1 and Supplier 3</td>
</tr>
<tr>
<td>Supplier 1 1900i CMS QLTC project presentation</td>
<td>06-2009</td>
<td>Project status presentation for CMS 1900i</td>
</tr>
<tr>
<td>Sourcing process ACE</td>
<td>07-2007</td>
<td>Presentation of the standard sourcing process at ACE</td>
</tr>
<tr>
<td>ACE sourcing for CoG XT IV indentified projects</td>
<td></td>
<td>Overview of cost of goods reductions for XT IV parts</td>
</tr>
<tr>
<td>Supplier pre-survey final</td>
<td></td>
<td>RFI document as sent to suppliers by ACE</td>
</tr>
<tr>
<td>Monitoring o/t learning mechanism</td>
<td></td>
<td>Overview of issues found during qualification of CMS</td>
</tr>
<tr>
<td>Supply Base Manual</td>
<td>03-2009</td>
<td>Description of procurement organization and processes at ASML</td>
</tr>
</tbody>
</table>

In summary, the regulative cycle by Van Strien (1997) was followed, starting with an examination of the problem and its diagnosis. The problem was defined as: “The current relocation process for development activities and production processes for components from current to Asian suppliers is not effective and efficient.” From this diagnosis a plan of action or solution design was developed. Finally, a plan for implementation and evaluation of the solution was made. The research design above was used to guide the data collection and analysis. It describes a single embedded case study with three units of analysis to be conducted using multiple sources of evidence. In order to focus this data collection and to enhance the construct validity a framework and model were developed from a literature review. These include the topics and propositions for the data collection and analysis. Multiple sources of evidence were consulted. As a start interviews were used which were supported by archival data. The review which resulted in the development of a framework and model will be addressed in the following chapter.
3. Literature

To gain insight in the topic of this research and to construct a theoretical framework for analysis of the problem the literature was searched for models of outsourcing processes and global sourcing strategies. The elements found to be of importance in this were examined in the perspective of global buyer-supplier relationships. The broadness of this approach implies that not all topics have been investigated in depth, but that a selection was made of the most insightful studies.

Furthermore, to delimit the review several assumptions were made. First of all the decision whether or not to outsource activities is not in the scope of this review. Rather, some aspects for consideration of the appropriate activities to outsource globally in a successful manner are given. Secondly, the perspective of a manufacturing firm requiring high-tech custom products was taken. Thirdly, only this outsourcing evaluation and the subsequent transfer and implementation of production and development activities will be addressed, implying that supplier relationship management practices and evaluation of suppliers is out scope. Finally, the transfer is limited to the implementation of production and development activities and will not include ramp-up for volume production and the consecutive logistic aspects.

This chapter will subsequently address the global sourcing literature, the outsourcing literature and based on these the construction of a theoretical framework for global outsourcing.

3.1. Global sourcing

Global sourcing has been the topic of research for many studies from the early 1980’s and according to Trent and Monczka (2003) it still offers potential breakthroughs in performance of companies. The strategy has however not been researched very extensively. According to Quintens et al. (2006) many gaps still exist in the literature. This is partly due to the variety of terms used by the researchers. Quintens et al. (2006) for provide a comprehensive overview of these in their review of articles between 1990 and 2005 published in supply chain management, international marketing management and international business journals. Global sourcing, international purchasing, worldwide sourcing, import sourcing, offshore sourcing and international procurement are according to them used interchangeably. This variety leaves the question what kinds of activities global sourcing concerns.

3.1.1. Definitions

The definitions that are used to define global sourcing provide a good starting point to gain insight in the activities and goals of the strategy. Several definitions have been found in the literature (e.g. Monczka & Trent, 2003; Kotabe & Murray, 2004).

Quintens et al. (2006) use a definition in line with Bozarth et al. (1998) and Van Weele (2005). They define global purchasing as:

‘The activity of searching and obtaining goods and services and other resources on a possible worldwide scale, to comply with the needs of the company and with a view to continuing and enhancing the current competitive position.’

Quintens et al. (2006) refer to three elements in this definition. First, it covers not only the operational activities but also the more strategic ones such as supplier development. Secondly, not all search activities may lead to worldwide purchases. In fact, a company may conclude that sourcing
locally is the best option for competitiveness. Thirdly, the strategy is applied since it may provide the firm with a sustainable competitive advantage. The inclusion of the purpose of global sourcing as need of the company and the broadness of activities makes this the most suitable definition that will be used in this review.

3.1.2. Drivers of Global Sourcing

The factors that influence the success of global sourcing have been investigated in many studies. The potential competitive advantage of sourcing from countries all over the world in addition to their domestic supply base is by many authors mentioned as one of the drivers behind global sourcing (Kotabe & Murray, 1990; Monczka & Trent, 1992; Bozarth et al., 1998). A comprehensive overview is presented in Table 4.

Monczka and Trent (1992) name various external forces as main drivers for the need for companies to have a worldwide competitive supply base. Competitive forces, customer requirements, worldwide market opportunities, the nature of competition and the supply base location for purchased items can all necessitate a worldwide competitive supply base and impact a company’s global sourcing strategy. Intense competition requires these companies to seek suppliers who can help them keep up with their competitors. When they compete on worldwide levels the response in sourcing strategy may also be to source globally. Besides competition the increasing requirements from customers can also challenge them to seek for world class suppliers. Customers may for example demand higher performance or lower costs. Furthermore sourcing from suppliers globally can facilitate access to foreign markets and capture worldwide market opportunities. Furthermore it may be a prerequisite for sales in a foreign market due to government requirements such as countertrade or local content.

The review by Quintens et al. (2006) includes a comprehensive overview of a wide variety of influencing factors resulting from product, management, network, industry or competition, or environment. They roughly divide them into three categories: the drivers that lead to global sourcing, facilitators and barriers. The distinction between these is not clear for all factors; some may in one situation be drivers and in another form barriers.

Cost reductions are frequently mentioned as main drivers (Monczka & Trent, 2003; Bozart et al., 1998; Song et al., 2007; Quintens et al., 2006). Product quality however, may in some cases be a driving force to source globally but in others hinder it. Like logistic issues such as on-time delivery and lead-times it is likely to be dependent on the sophistication of the suppliers’ processes and control. Furthermore access to technologies that are not available locally is mentioned often.

The categorization by Bozarth et al. (1998) summarizes these drivers in the way they bring competitive advantage to a business. According to them global sourcing may result in competitiveness through increased quality, price reductions, technology access, cycle time reductions and product availability according to scheduled requirements.

The main motivation for firms to source globally is thus the world wide competitiveness of their supply base which is necessitated by external forces as put forward by Monczka and Trent (1992). Furthermore, government regulations can force companies to source globally. This competitiveness is provided to them through the factors listed by Quintens et al. (2006) and Bozarth et al. (1998) and can be categorized into a decrease in costs, improved quality, access to other technologies and markets and lead-time reductions.
### Table 4: Drivers of global sourcing

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive forces</td>
<td>Cost advantages</td>
<td>Offset requirement</td>
</tr>
<tr>
<td>Customer requirements</td>
<td>Better delivery performance</td>
<td>Currency restrictions</td>
</tr>
<tr>
<td>Worldwide market opportunities</td>
<td>Higher quality products</td>
<td>Local content</td>
</tr>
<tr>
<td>Nature of the competition</td>
<td>Unique or differential products</td>
<td>Counter-trade</td>
</tr>
<tr>
<td>Supply base location</td>
<td>Obtain better technology</td>
<td>Lower prices</td>
</tr>
<tr>
<td></td>
<td>Flexibility</td>
<td>Quality</td>
</tr>
<tr>
<td></td>
<td>Global attitude</td>
<td>Technology access</td>
</tr>
<tr>
<td></td>
<td>Centralized decision making</td>
<td>Access to new markets</td>
</tr>
<tr>
<td></td>
<td>Integration of worldwide activities</td>
<td>Shorter lead-time</td>
</tr>
<tr>
<td></td>
<td>Advantage of existing logistic systems</td>
<td>Comparative advantage</td>
</tr>
<tr>
<td></td>
<td>Diversification of the supply base</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Competitive positioning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protect proprietary technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Access to new markets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Market size</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Countertrade requirements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Guard against currency fluctuations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stimulating foreign government policies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advantageous legal and economic environment</td>
<td></td>
</tr>
</tbody>
</table>

### 3.1.3. Success factors of Global Sourcing

The drivers and opportunities of global sourcing give good reasons for business turning to the strategy. According to Monczka and Trent (2003) however, many companies face difficulties in capturing these benefits and managing the international character of the buyer-supplier relationships. Given this problem it may be valuable to search for success factors of global sourcing which managers should take into account to capture these benefits.

One of the reasons behind failing to benefit from the global potential is the focus on short-term gains in component prices (Monczka & Trent, 2003). This benefit however seems to be hard to capture without establishing a long-term relationship with global suppliers. These long-term relationships can, according to Kotabe and Murray (2004), provide companies a more sustainable competitive advantage. Moreover, the short-term gains are often counterbalanced by the total costs of sourcing globally (Monczka & Trent, 2003; Song et al., 2007).

Birou and Fawcett (1993) also recognized the need to understand the requirements and challenges for companies to capture these benefits. They studied international purchasing and present an overview of these (Table 5). To be successful in global sourcing companies should take these factors into account when executing the sourcing process.

### Table 5: Requirements and challenges of Global Sourcing (Birou & Fawcett, 1993)

<table>
<thead>
<tr>
<th>Requirements of Global sourcing</th>
<th>Challenges of Global sourcing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top management support</td>
<td>JIT sourcing requirements</td>
</tr>
<tr>
<td>Developing communication skills</td>
<td>Finding qualified sources</td>
</tr>
<tr>
<td>Establishing long-term relationships</td>
<td>Logistics support for longer supply lines</td>
</tr>
<tr>
<td>Developing global sourcing skills</td>
<td>Culture/language differences</td>
</tr>
<tr>
<td>Understanding global opportunities</td>
<td>Duty/customs regulations</td>
</tr>
<tr>
<td>Knowledge of foreign business practices</td>
<td>Fluctuations in currency exchange rates</td>
</tr>
<tr>
<td>Foreign supplier certification/qualification</td>
<td>Knowledge of business practices</td>
</tr>
<tr>
<td>Planning for global sourcing</td>
<td>Nationalistic attitudes and behavior</td>
</tr>
</tbody>
</table>
The table provides a comprehensive overview and most of the factors have also been underlined by other researchers. A long-term relation with global suppliers is for instance also what other authors (Bozarth et al., 1998; Monczka & Trent, 2003; Kotabe & Murray, 2004) propose to prevent some of these total costs. Monczka and Trent (2003) distinguish international purchasing, which is limited to international buying and short-term relations only, versus global sourcing which requires the integration of different business functions and long-term agreements. Also Kotabe and Murray (2004) emphasize this coordination of functions. This distinction between international purchasing and global sourcing is an important one, since from a total cost perspective many costs may be associated with the coordination of functions and the establishment of long-term relationships.

Long-term relationships thus seem the best method to capture the benefits of international sourcing activities. Nassimbeni & Sator (2006) endorse this in their study collaborative direct sourcing strategies

3.1.4. Asian contextual factors

General challenges for global sourcing were listed by Birou and Fawcett (1993) and are shown in Table 5. The focus of this review is however on global outsourcing in Asia and its complexities. It should be noted that many countries in Asia are developing with a rapid pace and that results of past studies may be quickly outdated. Therefore only recent studies have been included in the review of this topic.

Karandikar and Nidamarthi (2006) acknowledge that geographical distance will make it hard to have frequent face-to-face meetings and establish trust between the partners. They list several challenges for international engineering activities of which an overview is provided in Table 6.

The research by Nassimbeni and Sartor (2006) focuses international sourcing and China in particular. They mention language, cultural and geographical distance, coordination of logistics, transfer of technical capabilities and managerial practices and quality monitoring at the source as challenges (see Table 6). Furthermore, they posit that the sourcing typology is dependent on article complexity, company size and the complexity of the industrial context.

Table 6: Contextual factors affecting global sourcing in Asia

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographical distance</td>
<td>Language differences</td>
</tr>
<tr>
<td>Time-zone differences</td>
<td>Cultural differences</td>
</tr>
<tr>
<td>Multiple organizations</td>
<td>Geographical distance</td>
</tr>
<tr>
<td>Varying labor costs</td>
<td>Coordination of international logistics</td>
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<td>Multiple cultures</td>
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<td>Long-term strategic perspective for members</td>
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<td>Different interpretations of quality and safety</td>
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Especially from the perspective of a Western buying company and an Asian supplier capturing benefits of global sourcing is very much affected by geographical and cultural distance. These barriers however are not impossible to overcome but require long-term relationships to get adapted
to each other and to obtain a thorough understanding of cultural differences. Frequent communication and making use of information technology for sharing business information is a necessity for building trust, personal relationships and overcoming communication problems. Most researchers in the field of global sourcing have focused on drivers and consequences of global sourcing. Although challenges and requirements have been identified, no framework or stepwise process has been found addressing how to put these into practice. Having such a framework would structure the strategy more and would likely help managers benefit more from global opportunities. Since global sourcing of manufacturing activities resembles outsourcing of manufacturing on a global scale, this field of research will be reviewed next for a guiding framework to use as a steppingstone.

3.2. Outsourcing of development and manufacturing activities

In essence, the process of sourcing development activities and production in a global perspective is an outsourcing process where the location of the supplier may be another country or continent than the buyer’s. Outsourcing business activities has been a trend in industry since the 1990’s (Berggren & Bengtsson, 2004). It was applied in many companies to free up resources, gain access to resources, increase flexibility and to leverage the core competences (Van Weele, 2008).

3.2.1. Definitions of outsourcing

Outsourcing is in literature described by many definitions and terms (e.g. Bengtsson, 2008; Arnold, 2000; Van Weele, 2008; Ellram & Billington, 2001). Axelsson and Wynstra (2002) define it as: “the decision and subsequent transfer process by which activities that constitute a function, that earlier have been carried out within the company, are instead purchased from an external supplier.” All authors thus agree on the aspect that outsourcing involves making use of external sources of supply, either national or global. The latter definition covers two interesting aspects of outsourcing: the decision and relocation process. It follows from this definition that these two phases should be covered in an outsourcing process. This distinction with respect to the other definitions also makes that this definition will be adhered to throughout the study.

3.2.2. Outsourcing as a process

Momme and Hvolby (2002) emphasize the need for a guiding framework since many outsourcing decisions are taken without sufficient consideration. Several scholars have published frameworks to guide managers through the outsourcing process. The most comprehensive one has resulted from the study by Momme and Hvolby (2002) (Figure 2). They distinguish six generic phases in outsourcing with key activities, performance measures and tactical considerations. This framework is very similar to the purchasing process by Van Weele (2008), which also consists of six phases: specification, selection, contracting, ordering, expediting and follow-up and evaluation.
The framework by Momme and Hvolby (2002) however does not explicitly mention the specification of the required relation and products. Since this is an important step in the selection process the specification should be included in the framework.

Based on Momme and Hvolby’s (2002) framework Van Weele (2008) distinguishes three phases: a strategic phase, a transition phase and an operational phase. In his view the strategic phase involves defining the rationales behind outsourcing, the selection of a product or activity and the selection of a supplier. The transition phase consists of the negotiation of a contract and the transfer of the activity. Relationship management and contract termination belong to the operational phase. He remains however vague on the overlap between the phases and the six steps of the purchasing process since the arrows overlap the steps, as shown in Figure 2.

Other authors who have provided frameworks for outsourcing largely focus on decision making for outsourcing (McIvor, 2003; Sislian & Satir, 2000) and management of supplier involvement (Van Echtelt et al., 2008). These frameworks however do not take the actual transfer of the activity to the supplier into account. This is not remarkable since according to Momme and Hvolby (2002) most research is aimed at this strategic phase. They however, in line with Van Weele (2008) consider in line with the definition by Axelsson and Wynstra (2002) the transition from an ‘externally managed equally difficult’. The organizational consequences of this can be severe since it may involve the transfer of employees and assets and processes, but also the establishment of a new interface for control.

The framework by Momme and Hvolby (2002) thus provides the most comprehensive overview and a good guidance through the process, although specification of the needs should be added to the activities. An outsourcing process would thereby consist of three phases: a strategic, a transition and an operational phase.

3.3. The strategic phase

The strategic phase is according to the framework by Momme and Hvolby (2002) the first step in an outsourcing process. Several authors have presented their views on which issues the strategic phase should address. Following the views by Momme and Hvolby (2002) this phase concerns the analysis of competencies in the company and identification of those qualifying for outsourcing. Next, potential suppliers will have to be searched, assessed, selected and audited according to the needs of the company. Although the selection of activities or parts to be outsourced and supplier selection seem two distinct phases, the outsourcing decision is very much dependent on the availability of capable suppliers and their associated risks.

A comparable distinction is presented by Monczka et al. (2000). Their process is more long-term oriented and aimed at partnerships and supplier integration. It consists of three major elements: determining current and future needs, developing a well-aligned world-class supply base and developing a bookshelf of viable technologies and suppliers. These first two are consistent with the view from Momme and Hvolby (2002). The third element is however different and involves the monitoring of the supply market for emerging technologies to rapidly implement these in new products. Furthermore, they specifically focus on development and manufacturing to be outsourced and state that the decision which commodity groups should be outsourced is a strategic decision. An organizational structure and a decision model for insourcing or outsourcing are proposed.
Also Van Echtelt et al. (2008) have addressed strategic activities in supplier relations. In their strategic management arena they propose to determine which technologies to outsource, to formulate guidelines for supplier involvement, monitor supplier markets, pre-select suppliers, exploit existing supplier knowledge and motivate them to develop new knowledge, and finally to periodically evaluate supplier performance. Compared with the definition the strategic phase would consist of all activities between identification of technologies and pre-selection of suppliers.

These views from various researchers provide a good indication of which elements should be present in the strategic phase. All authors stress the need of identification of a technology or activity to outsource. Furthermore, according to some the company should formulate its needs and according to these start monitoring the supply market for potential suppliers. A selection process should then follow to choose one supplier from the pool of potentials. These elements will thus be addressed in the next sections.

### 3.3.1. The outsourcing decision

The outsourcing decision mainly concerns which activities to outsource, or put differently: “what should a firm outsource and what should it keep in-house?” (Moses & Ahlström, 2008). This question resembles the make-or-buy decision which implies that firms could either choose to produce by themselves or in a partnership or buy with long- or short-term arrangements (Quinn & Hilmer, 1994). However, since the scope of the review assumes that the activities will be outsourced this part will discuss different considerations for identifying a component or technology to outsource.

According to Moses and Ahlström (2008) the make-or-buy decision has changed over time due to various dimensions such as cross-functionality and the fit of the process to the strategy. Furthermore they emphasize the criticality of the decision and stress the need to develop formal processes for it. Through formalization processes can improve and become more efficient. This again underlines the need for a structured approach.

Three important views regarding on which criteria this decision should be based exist in literature: a core competence based and a cost based view (Van Weele, 2008; McIvor, 2003; Arnold, 2000; Mantel et al., 2006). A third group of researchers focuses on risks associated with outsourcing. Quinn and Hilmer (1994) for instance state that although outsourcing can lead to competitive advantage, it will also increase a company’s strategic vulnerability. According to them managers should carefully consider market factors such as the number of suppliers, asset specificity, and the trade-off between flexibility of the firm and the required control over the supplier. They should thus weigh the benefits, which can be both monetary and strategic, and the risks, which they group in loss of critical skills, loss of cross-functional skills and loss of control over the supplier.

Most of the literature in this field is operationally oriented. Mantel et al. (2006) emphasize however that decisions are usually not taken by firms but by humans who use heuristics to process complex information for decision making like those in outsourcing. In an experimental research they included these three decision factors. Their conceptual framework suggests that managers take outsourcing decisions based on the degree of core competencies in a sourced part and the perceived strategic vulnerability of the company. This supply risk was operationalized as a combination of the number of available suppliers (i.e. the likelihood of opportunistic behavior and dependency), the cost implications and information sufficiency. The results show that managers tend to weigh vulnerability more than core competencies. The effects show that in actual decision making core competencies,
the number of available suppliers, cost insights and the amount of available information are all relevant.

The authors referred to above more or less list the same aspects on which an outsourcing decision should be based. Specifically, they distinguish four elements: core competencies analysis, cost analysis, risk analysis and supplier availability.

3.3.1.1. Core competencies

With respect to the first evaluation many scholars have argued that a company should concentrate on its core-competences and outsource the others. Core-competencies are those that provide a company its sustainable competitive advantage. Several authors have proposed criteria for the identification of core competencies (Prahalad & Hamel, 1990; Quinn & Hilmer, 1994; Monczka et al., 2000). They support the belief that companies should only undertake activities that consist of these core-competencies. This implies that where firms used to conduct most activities in-house and buy in a traditional way, an increasing amount of activities is executed by suppliers and less physical assets are owned by the buyer. In this continuum the ‘dematerialized company’ (Arnold, 2000) or the company as a ‘systems integrator’ (McIvor, 2003) are seen as the extremes of outsourcing. Since the focus in this research is on the transfer of already outsourced activities, the evaluation of core activities will not be elaborated further.

3.3.1.2. Cost evaluations for outsourcing

An important assumption of outsourcing is that a function can be carried out more effectively and efficiently by an outside party (Ellram & Maltz, 1995; McIvor, 2003). This implies that beside the selection of an activity an estimation of sufficient savings as a second evaluation should also be made. The cost associated with internally producing and developing a product has to be higher than when outsourcing it. Three interesting views on costs of outsourcing exist: the transaction cost theory, the total cost approach and that of the switching costs.

3.3.1.2.1. Transaction Cost Analysis

The differences in efficiency are also the basic assumptions of transaction cost theory which is another view on activity selection. The transaction cost perspective originates from the views of Williamson (1989). The premise is to minimize the costs associated with each transaction or contact with a party. These costs are influenced by the character of the transaction. Asset specificity, uncertainty of information and infrequency of transactions affect the height of the transaction costs. McIvor (2003) refers to asset specificity as the height of investments specific to the exchange relationship and lists four types: site specificity (i.e. resource immobility), physical asset specificity (i.e. technology advantages), human asset specificity (i.e. know-how advantages) and dedicated assets (i.e. specialized investments). Production should according to this theory take place where the total transaction costs are minimized. When highly specific investments are required to obtain products from an external party the buying company should rather produce in-house; the transaction costs would be too high. This view however is not very specific regarding partnerships and long-term agreements in which company boundaries are less clear, and risks and ownership of assets may be organized in a different way. Despite the attempts to operationalize the transaction cost theory there seems to be no good model available to support outsourcing decisions (Song et al., 2007).
A general model which integrates the core competence and transaction cost views was developed by Arnold (2000). In addition to only insourcing and outsourcing he leaves room for hybrid forms. According to him activities which have low specificity and strategic importance and provide no competitive advantage should be outsourced.

3.3.1.2.2. **Total Acquisition Cost**

Another group of researchers see the total cost of ownership as a better approach for cost estimation. Starting with the work by Ellram (1993) many authors have advocated the inclusion of other costs than only purchase price in outsourcing evaluations (Axelsson & Wynstra, 2002; Song et al., 2007; Ellram & Maltz, 1995; Mclvor, 2003; Wouters et al., 2005; Bengtsson, 2008). If only purchase price would be considered in outsourcing decisions the actual cost savings may be substantially lower than expected or even lead to an increase in costs. Insight in these additional costs should thus also be part of the decision making process. The model by McIvor (2000) emphasizes this explicitly by incorporating a total cost analysis.

A comprehensive overview of potential costs is shown in the ‘total cost wheel’ by Ellram and Maltz (1995) which includes six areas. According to this model activities related to management, delivery, service, communications, price and quality can all result in additional costs. They propose for the purpose of outsourcing to first construct a process flow for the in-house activities and analyze all costs associated with each step. The final assessment should then be based on the outsourcing situation including eliminated costs, additional costs and the change in current costs. The authors however also mention some difficulties in this total cost approach. Accurate cost information is often lacking.

Recently this was confirmed by the attempt by Song et al. (2007) to estimate the total acquisition costs for overseas outsourcing. Their discussion confirms the issue of shortage of data. Furthermore they emphasize that their study was based on historical costs and that for future cost estimations such as for outsourcing this issue will be even larger. Despite these problems the applicability of the approach is good, which is illustrated in the study by a manager who stresses a trade-off between accuracy of the model and occupation of resources and time. Based on a review of literature and interviews with practitioners about total cost they present a very comprehensive list (Appendix 2) of sources of additional costs, which they group in information collection, price, administration, logistics, quality issues, supplier management and other costs. The subsequent case study of manufacturing outsourcing to China provides more insight in the exhaustive list of costs. They conclude their analysis stating that the evaluation based on total costs shows substantially lower savings than if only the purchase price had been taken into account.

3.3.1.2.3. **Supplier switching costs**

A third view on the costs of outsourcing involves the incurred costs when switching from one supplier to another. As stated in the introduction, global sourcing may lead to potential benefits compared to local sourcing. In these cases companies may have to reconsider their outsourcing decisions and reallocate production. These switches between suppliers may result in additional costs which should also be taken into account in cost calculations in addition to the above mentioned ones.

Wagner and Friedl (2007) address this issue by modeling supplier switching decisions and their financial consequences. In their model they assume that firms can decide to reallocate either no, part
of, or the complete production. They may be hindered in this decision by the status quo effect, lack of information about the costs of the new situation and switching costs. The latter may result from prior commitments, supply market research, preparing requests for quotation, etc. Buyers will switch from supplier when the costs of the new supplier are below the sum of the switching costs and those of the current supplier. The buyer will, according to the authors, attempt to minimize the total costs consisting of the payment to the entrant supplier, the payment to the current supplier according to the remaining volume and the switching costs.

A switch between suppliers will also result in a competitive reaction by the current supplier, who will lower his price as a result of increased competition. On the other hand the buying firm will incur a negative effect due to the economies of scale. When the volume is split between suppliers the product price will increase.

The model implies that when supplier switching decisions are made, also other costs than purchase price should be taken into account and that switching can lead to economic reactions by suppliers.

Based on the transaction cost theory components having low specificity in terms of assets, human resources or knowledge can be outsourced. This approach does however not lead to a clear decision which products those are. The total cost analysis can provide managers a good insight in the actual savings generated by outsourcing production and development activities. The framework by Song et al. (2007) is very complete and useful for this. The eliminated costs should however also be taken into account in this evaluation just as supplier switching costs and competitive effects. A total cost analysis should thus consist of costs resulting from information collection, price, administration, logistics, quality issues, supplier management, eliminated costs, switching costs and competitive price effects. Accurate estimation of these costs will remain a challenge.

3.3.1.3. Risks in outsourcing of production and development

A third group of elements often addressed by researchers in the outsourcing evaluation are the potential risks to which a company can be exposed when no longer conducting activities in-house. Although many definitions for risk are employed most authors agree that it consists of the likelihood of an event occurring with a detrimental effect on the company.

The contingencies found in literature affect a firm in two ways. Some risks (e.g. loss of strategic knowledge) are not dependent on the choice of supplier. Other risks however can affect the supply chain of the company. Since the decision whether to outsource is outside the scope of this review only the supply risks will be addressed.

The study by Zsidisin (2003) on managerial perceptions of supply risk shows that supply risks can originate from three directions. First, the market which the suppliers are in has certain characteristics that will be of influence. The location of the supply market, the number of (qualified) suppliers in a market and price fluctuations in the market may all involve risks. Secondly, buying firms may encounter capacity constraints or managerial and quality issues. Thirdly, the effect of the risk and managerial perception are according to Zsidisin (2003) affected by the impact on profitability and the nature of the product application or newness.

In a later study Zsidisin et al. (2004) analyze supply management techniques and list several supply risks. After assessment of the financial impact they suggest a proactive approach for mitigation and supplier improvement.
Harland et al. (2003) also focus on the risk in supply networks and how these can be assessed. They argue that increased product complexity, changed supply networks and processes as a result of outsourcing and the globalization of these are the main sources of risk. Furthermore, detrimental events can result in losses. These can be financial, performance, physical, psychological, social and time losses. Companies should according to them assess the probability of occurring and the significance of the consequences and adapt their supply network risk strategies accordingly. New products generally have, according to them, higher perceived risk than existing products. Van Weele (2008) lists some of the downsides of outsourcing: dependency on suppliers, communication and organization issues, leakage of confidential information and the potential loss of strategic knowledge. He distinguishes four groups of risks: technical risks (i.e. whether a supplier will be able to supply leading-edge technology), commercial risks (i.e. cost fluctuations in production), contractual risks (i.e. whether the contract covers the relation sufficiently) and performance risks (i.e. the chance that a supplier is unable to supply).

The impact of supply risks on a firm justifies their thorough assessment when outsourcing production or manufacturing. Although some risks are affected by the selection of a supplier, many are also influenced by the type of product and the nature of its supply market. When selecting an activity to outsource these aspects should thus be taken into consideration. When aiming to minimize the risk outsourcing an existing product is a safer option than a new product.

### 3.3.1.4. Availability of a capable supplier

The decision whether to outsource an activity or conduct it in-house is according to McIvor (2003) also dependent on the availability of a capable supplier. When a supplier is less capable then the buying firm to produce a component, the buyer can according to him better produce it in-house. Furthermore firms should consider the number of available suppliers to prevent opportunism and becoming too dependent on a supplier. This in particular is difficult in this stage of the process, since the activity still has to be identified and specified. Moreover, the supplier market has officially not been monitored and it is thus hard to determine how many capable suppliers are available.

Although supplier capability will be largely addressed in the supplier selection part, it is interesting to look at the changing demand of activities conducted by suppliers and their responsibility. The success of outsourcing production processes is according to Bengtsson (2008) very much dependent on the integration of buyer and supplier activities. Integration of the supplier is in the literature often referred to as supplier involvement in product development. A considerable number of authors have conducted research on this topic (e.g. Petersen et al., 2005; Van Echtelt et al., 2008; Primo & Amundson, 2002; Mikkola, 2003, Ragatz et al., 1997) and they tend to focus on the effects of supplier involvement on new product development, the coordination of suppliers and the level of responsibility.

An interesting study in this light is conducted by Ragatz et al. (1997) who identify success factors for supplier involvement. They find co-location of the supplier, direct cross-functional communication, shared education, linked information systems, technology sharing, establishment of trust, sharing of customer information, shared assets, formalized reward sharing and agreement on performance measures significantly related to successful involvement. Especially in the context of international buyer-supplier relationships these may bring along challenges for the buyer.
3.3.2. Specification of requirements

The second step in the strategic phase involves the specification of the activity to be outsourced in terms of needs. Both Van Weele (2008) and Monczka et al. (2000) emphasize the importance of this since they form the basis of the selection criteria in the next step. This is underlined by Ellram et al. (2004) who state that procurement should start with the identification and specification of needs. Despite this emphasis very little literature was found on specification of requirements in an outsourcing context, especially not in the context of global sourcing or when supplier responsibilities are included. Some guidelines may be found in general procurement literature focussing on purchasing of components. However, since outsourcing of manufacturing activities involves the external execution of a business function other needs should be specified as well. Ellram et al. (2004) refer to the Service Level Agreement as a legal document which includes a statement of work. Although they address the procurement of services they do not go into details regarding what a statement of work should include and how needs are identified. Van Weele (2008) distinguishes a functional specification, a list of requirements and technical specification. Specific to the outsourcing process he states that also technical and organisational capacities, future needs, strategies and cultural aspects should be incorporated in the needs. In the seven steps by Monczka et al. (2000) the identification of future needs is even an individual step. Furthermore they emphasize the need to specify the required level of supplier integration, ranging from no involvement in development to black box integration. In the latter the supplier has full responsibility for the design based on performance specifications from the buyer. The specification of the buyers’ needs should thus involve more than only functional or technical specifications. Also organisational requirements and supplier responsibilities should be included. Ellram et al. (2004) thus unjustly state that the specification of manufacturing can be specified precisely, since it not only involves the product but also organizational and logistic aspects. Furthermore, since outsourcing relationships generally are long-term agreements also future needs should be covered.

3.3.3. Supplier selection/supply base

The third step in the strategic phase by Momme and Hvolby involves the preliminary assessment and creation of a list of potential suppliers and the subsequent selection. The importance of careful supplier selection was stressed by many researchers (Monczka et al., 2000; Axelsson & Wynstra, 2002; De Boer et al., 2001). Most models in the recent literature take the perspective of outsourcing supporting business activities such as Information Technology, cleaning services etc. These generally are less close to the core than activities like manufacturing and design. The strategic importance and criticality of these activities for production may cause that companies become dependent on suppliers. Assessment of suppliers on various aspects to reduce risks and total costs is thus very important to secure the supply of goods. Many authors have in this perspective addressed the issues in supplier selection. Three important aspects of supplier selection have been identified and will be addressed in this review. First, some authors focus on criteria to which suppliers should comply, others on the methods by which suppliers can be ranked and assessed (e.g. De Boer et al. 2001). Since selection methods can be generally applied in every supplier selection situation these will not be further elaborated upon. A second group of researchers has emphasized the importance of fit between buyer and supplier. Thirdly,
some researchers argue that the supplier’s perspective is very important for managing the relation, especially when the buyer has little power over the supplier.

3.3.3.1. Selection criteria

The first group of researchers has thus focused on ways to select the right supplier from all available suppliers. Throughout the years however, buyer-supplier relationships have changed according to Spekman (1988). He describes a transition from cost oriented approaches to long-term and partnership-like relationships. He states that the more strategic and collaborative partnerships with suppliers require different approaches towards supplier selection. In this perspective he proposes two stages: the first to establish a pool of potential partners complying with traditional criteria, the second to select strategic partners.

With respect to the first step traditional criteria should be taken into account following Spekman (1988), however since long-term relationships also aim at future performance he emphasizes to assess supplier practices and not only historical data. The second stage should according to him concern the selection of strategic partners from the supply base. He presents a list of questions which help to assess the strategic fit with the buyer with respect to the future and joint planning and problem solving.

This distinction is in line with the model by Momme and Hvolby (2002) which implies that companies generally establish a short-list of prequalified suppliers whose capabilities comply with basic specifications. This was also incorporated in the supplier selection framework by De Boer et al. (2001). According to McIvor (2000) establishment of a supply base has also been a method for businesses to reduce risks in outsourcing.

Other authors stress the importance of a broad range of selection criteria. Fawcett and Scully (1998) for instance show that a wider range of selection criteria results in more success in worldwide sourcing relations, emphasizing a broader scope than only quality, delivery and cost measures.

3.3.3.2. Buyer-supplier fit

Regarding the second element of supplier selection, Ellram (1990) reports four categories of criteria revealed in case studies. These are broader than only supplier capabilities and include financial issues, organizational culture and strategy issues, technology issues and other factors such as references. She also emphasizes that besides standard measures strategy and culture should be assessed.

McIvor (2005) lists more or less the same criteria in five categories: strategic commitment, ability to meet needs, capability, buyer-supplier fit and honesty and integrity. He also emphasizes the location of the supplier and his attitude towards audits.

In their study on the impact of supplier selection on business performance, Kannan and Tan (2002) show that although cost, quality, delivery performance, capability and culture are important to assess, soft factors are more important. More attention should according to them thus be given to strategic commitment and information sharing, since these have a greater impact on business performance.

Monczka et al. (2000) state that selection criteria should be established by cross-functional teams. Furthermore, additional criteria are according to them required for outsourcing as opposed to ordinary purchasing. This is especially the case for relations in which the supplier’s responsibility
involves design activities. Their criteria result from interviews with managers and include also the ability to develop future technologies and focus on requirements for alignment of design teams.

A wider range of prerequisites for a buyer-supplier relationship is listed by Axelsson and Wynstra (2002). According to them six aspects for a good fit are important:

- Functional complementarity - in terms of complementary resources
- Strategic fit - complementary future directions
- Organizational fit - organizational designs facilitate cooperation
- Business philosophy fit - shared values
- Timing fit – timing of cooperative activities
- Willingness – parties will find a way to cooperate if they want to

Hsu et al. (2006) attempt to conceptualize all the previous research into a framework distinguishing three constructs: supplier quality, supplier service and strategic/management fit. An interesting statement in this research addresses the management fit, stating that goals of the company in terms of volume and innovativeness should match. The operationalization of strategic fit does however not sufficiently do justice to the complexity and importance of the construct.

Selection by criteria like cost, quality, delivery performance and capability to reduce the long-list of suppliers and establish a supply base of preselected suppliers is thus a first step in selection where traditional supplier selection criteria are appropriate. The element of culture can better be assessed in the context of strategic fit. In a second step the fit between buyer and supplier will should addressed using different criteria.

Despite the amount of research that has been conducted on this topic most authors remain presenting lists of criteria resulting from case studies and emphasizing the wide range of criteria to assess. Most criteria differ only in terminology and touch upon the same supplier characteristics. Some authors thereby focus more on the strategic level through assessing alignment of strategies; others address the more tactical criteria like the alignment and fit of business practices. All this research has however not yet resulted in a comprehensive list of criteria for all relevant supplier characteristics.

Although most of the authors also underline the need to include strategic fit between buyer and supplier, none of them gives guidance on how this should be included in the selection; only alignment of current business practices is assessed. This is striking since the long-term character of the relationship implies that suppliers should also be able to meet future needs.

### 3.3.3.3. Customer value

The two previous sections describe a perspective in which the buyer selects a supplier from a pool of potential suppliers. A third group of researchers however argue that this is a too limited view on buyer-supplier relationships (e.g. Ellegaard et al., 2003; Ramsay & Wagner, 2009; Christiansen & Maltz, 2002; Steinle & Schiele, 2008). The basis of their views is that of becoming an interesting customer for the suppliers, making them want to work for you.

Ramsay and Wagner (2009) posit that suppliers thus also have a choice in the relationship and can reject an offering by a buyer. They do this if the supplier value gained from the relation is too little. Supplier value is according to them the difference between the perceived benefits and the perceived life-time costs. They list several sources of supplier value besides economic benefits: efficiency gains,
ethical behavior, technology gains, market linkages and corporate image. This idea of value is supported by Christiansen and Maltz (2002) who studied means to motivate a supplier for companies with limited buying power. Ellegaard et al. (2003) see becoming a preferential customer as a way to motivate suppliers and perform better and provide the buyer with competitive advantage. According to these authors it is thus the challenge for the buying company to gain a preferential buyer status or become the customer of choice. This can be done through offering the supplier sources of value and will result in suppliers performing better and helping their customers to increase their competitive advantage.

A list of sources of supplier value is shown in Table 4. Following Blonska et al. (2008) not all sources can be used to become an interesting customer before a relationship has been established. They show that although supplier development activities facilitate a preferential buyer status, this is mediated by supplier relational embeddedness or the extent to which trust, affective commitment and economic satisfaction are present. This implies that a buyer can have two statuses: when a relation has not been established he can be an ‘interesting customer’ and once relational embeddedness has been created he can obtain a ‘preferred buyer’ status.

Gaining the preferential buyer status or becoming an interesting customer becomes more difficult in the context of global sourcing as suggested by Steinle and Schiele (2008). Arguing from the cluster theory they state that suppliers in developing countries are unlikely to have developed without relying on a cluster of suppliers and customers. Gaining a preferential buyer status in such clusters is very hard. Through offering new technologies, testing early versions of products, sharing knowledge or helping by penetrating new markets buyers can attempt to become an interesting customer.

3.3.4. Audit and approval of supplier
The fourth step in the strategic phase in the outsourcing model by Momme and Hvolby (2002) involves the auditing and subsequent quality approval of the selected supplier. According to Van Weele (2008) auditing is an internal assessment of the quality level of a supplier. He distinguishes three different audit types than can be applied to verify the quality compliance. This definition and focus on quality and technical capability will be used as a limitation for auditing. A product audit thus assesses the quality performance on a product level through checking it for failures and identification of the root-cause. A process audit tests whether the supplier’s processes are capable of complying with the specifications. Finally, in a system audit an assessment of the quality system is carried out. This implies that the internal quality system is compared to an external standard, for example the ISO 9000 series or a company specific system.

Following Song et al. (2007) auditing costs should be taken into account in the cost evaluation of outsourcing decisions since it can be a lengthy and costly process.

3.4. The transition phase
Having decided which activities should be outsourced globally according to the core competencies, cost evaluations, risks and availability of a supplier the transition phase can commence. The next steps according to Momme and Hvolby (2002) are contract negotiations and the transfer of production technology, product and process knowledge. These steps will be addressed below.
3.4.1. Contracting

In the first step of the transition phase of the model by Momme and Hvolby (2002) a contract between buyer and supplier has to be negotiated after which the transfer of the activities can take place and an order can be issued. This section will address the elements of a contract in outsourcing of development and manufacturing.

The contract for outsourcing decisions involves many different elements. Despite the importance of this legal document very little literature addressing what such contracts should contain is available. Many aspects of what the supplier is expected to perform and under which conditions has already been covered in the specification of the service and the supplier selection. These specifications have however no legal validity and therefore require a contract.

Van Weele (2008) considers the contract essential for the success of the relation and he lists several basic elements which a contract may consist of, although they are aimed at buying business services. An important aspect of the contract is the Service Level Agreement. According to Van Weele (2008) it should reflect the overall business goals, include the objective of the relation, a clear description of expectations of the supplier, the resources that will be made available by the buyer, the organization of communication and the expenses that a supplier will receive. Furthermore, especially the protection of IP rights has been emphasized frequently in the context of Asia. Other aspects can be confidentiality of information, audit rights and for instance transfer of assets.

Halvey and Melby (2000) mention similar aspects in a business process outsourcing context. They stress that in international contexts the legal conditions of the supplier’s country should also be taken into account. Although general overviews of elements in contracts were found, very little was also found about how international contexts (e.g. cultural perception) influence the contracts and how different supplier responsibilities should be included. The review has however shown that it is important to define the responsibilities of both parties. Furthermore it has shown that long-term agreements are desirable in global outsourcing relations and that in this context the legal conditions in the suppliers’ country should be taken into account.

3.4.2. Inter-firm transfer of production and development

The definition of outsourcing includes that activities were formerly conducted in-house and will be transferred to an external supplier. The second part of the transition phase deals with this transfer. It implies that knowledge, assets, practices and possibly human resources will have to be allocated at the partner’s factory (Grant & Gregory, 1997; Van Weele, 2008). Especially the statement by Ivarsson and Alvstam (2004) that developing countries (e.g. low-cost countries) ‘possess a limited capacity to generate new technology by themselves’ underlines the need of transferring technology. This may even be enhanced by a high level of technology in some industries. The establishment of sourcing activities is thus likely to involve more than only the transportation of production equipment.

This paragraph will address what has to be transferred in order to start up production at an Asian supplier, which steps should be taken for this transfer, and by which means knowledge can be transferred.

3.4.2.1. Technology transfer

Despite the complexity that relocation is likely to involve, very little research was found in the outsourcing literature addressing the types of knowledge to be transferred in a global context. The
little relevant literature in this field was found under the concept of ‘technology transfer’, where many studies were published (Steenhuis & De Bruijn, 2002) addressing this topic in the context of economic development and technology management. These are mainly explorative resulting in findings how transfers have taken place in practice.

Ivarsson and Alvstam (2004) have studied the transfer of technology to local suppliers in the automotive industry by multi-nationals. They state that: “The literature shows that the process of learning and technical change in successful industrial enterprises is not an easy task, and may involve considerable risks, costs, and requiring conscious decisions by firms rather than the mere accumulation of enterprises with enhanced experiences of production”. They also emphasize that the transfer of advanced technology should be complemented by locally developed tacit knowledge. In order to lower production costs at these global suppliers they suggest localized purchasing. The closeness of such international purchasing offices can reduce transaction costs, facilitate close monitoring and ease adjustment of specifications. Furthermore, face-to-face contact will foster building trust, which is especially valuable when specifications are tight and quality levels are high. A challenge to the buying company is to localize the supply of components which will further reduce production costs.

In the continuation of their research they report survey data from a case study about localized production to India as a consequence of lowering production costs, local content requirements and having component suppliers close to the assembly location. Having the suppliers meet the required standards demands buying firms to provide technical specifications and assistance. They distinguish product technology and process technology assistance. Besides technological knowledge they also recognize managerial practices to be transferred.

North (1997) also addresses the transfer of technology for manufacturing purposes in an international perspective. He uses a framework (Figure 3) for the transfer of knowledge in which he distinguishes a transfer process consisting of creation, diffusion, acquisition and adoption. Actors each have a role as suppliers, brokers or recipients of knowledge. Furthermore he describes a supply-side and receiving-side environment.

The mechanism to transfer technology depends according to him on the provision and absorptive capacities. Five mechanisms are addressed: the acquisition of equity, establishment of a license agreement, purchase of equipment, know-how and flow of human resources.

North (1997) acknowledges that technological knowledge should be transferred in stages. His research reveals that many companies start with transferring service activities or the production of spare parts. They then establish assembly activities and subsequently train suppliers to deliver simple parts, later followed by sophisticated components and next by development responsibilities.

Another interesting study was conducted by Kim (1999) on technological learning in of companies Korea. He describes that mature technology is transferred to developing countries and follows a three-stage process. First, foreign technology is acquired in the form of assembly processes, product specifications, production know-how, technical personnel, components and parts. Next, technology is assimilated and improved.
De Bruijn and Jia (1993) have identified five key problems associated with technology transfer, in this case in a Chinese context.

1) Selection of the right product to transfer is often problematic. This selection should be based on the market objectives and the technology should be as advanced as possible given the capability of the supplier.

2) Identification of the product technology data. The basis for this problem is the difference in standards between foreign buyer’s technology and that of local suppliers.

3) Localization of production, in which components from the product are replaced by locally produced parts, was often found to be an issue.

4) Restructuring the factory both in terms of facilities and management practices was found to be very difficult as a consequence of poor communication between departments.

5) Matching of management skills to the technology level. Since in China many modern concepts such as quality control, planning and control and performance measurement were relatively new at the time, the suppliers were not able to master these.

A successful transfer according to them consists of selection of the appropriate technology, establishment of the right infrastructure for training, rapid localization and the development of a dynamic technology transfer process.

In a later study Steenhuis and De Bruijn (2002) describe the concept of learning curve in the installation of new technology at suppliers. The learning phase is considered the next step after the transfer of knowledge. The concept reflects the reduction in production time for a part through an increase in volume. It was found that the time required for suppliers in developing countries to assimilate a technology is longer than estimated by the buying company. This is due to basing the learning curve calculation on the buyer’s circumstances. Scheduling the adoption of new technology is thus very difficult.

In the aircraft industry, according to Steenhuis & De Bruijn (2004), technology transfer has been practiced in the last decade due to economical reasons. They describe a pattern of licensed production of aircrafts at the end of their life cycle in developing counties towards increased development activities and R&D investments. The low production rate in this industry impedes steep learning curves and lowering of operating costs. Furthermore, they emphasize that the development of design skills is a time-consuming process.

Specifically for China, Duanmu and Fai (2007) propose a framework for relationship development and transfer of knowledge to suppliers (Figure 4) which allows for stable (S) development or failure.
(F). It starts with suppliers meeting the quality standards and continues with efficiency in mass production (e.g. quality, stability and cost control). In the final phase, supplier responsibility may increase as a result of increased trust, easier communication and experience and product development activities can be sourced from the supplier.

In summary, technology transfer was often found to be a complex and lengthy process with many potential problems (e.g. De Bruijn & Jia, 1993). Two processes can be distinguished for which steps have to be identified: a supplier development process and a knowledge transfer process. The first shows a pattern of increasing supplier responsibility starting with licensed production of simple parts or service parts and gradually developing engineering skills for design by the supplier. Localization of production is a difficult issue in the transfer but necessary for successful production. Furthermore, the adoption speed in this process is hard to predict and largely depends on the production volume. For the second process for transfer of knowledge the model by North (1997) provides a good basis. First, knowledge for transfer has to be identified, then diffused and acquired by means as technical documents, reverse engineering, technical assistance by the buyer and observation by the supplier. Finally the knowledge has to be adopted by the supplier to bring it into practice.

Besides these technological skills, managerial skills are equally important for a supplier to possess. This was emphasized in the study by Ivarsson and Alvstam (2004), who provide a clear and useful distinction between product related, process related and managerial knowledge. Although the studies mentioned above are very much subject to quickly improving industries in developing countries, the level of managerial practices requires improvement through assistance of the buyer.

### 3.4.2.2. Transferring knowledge

Grant and Gregory (1997) recognize that the transfer of manufacturing processes mainly involves the transfer of knowledge. The question remains how knowledge can then best be transferred and what kind of knowledge this is. They posit that although as a product life cycle matures knowledge accumulates, becomes more structured and transferability is fostered, more experiential knowledge is created impeding the transferability. Furthermore, they state that production process knowledge consists largely of routines which contain tacit knowledge. The body of knowledge thus consists of
transferable and ‘hard-to-transfer’ knowledge (Figure 5). The latter should according to them be conveyed through face-to-face training and practice.

Figure 5: The experience curve showing transferability (adapted from Grant & Gregory, 1997)

The extent to which production processes are transferable thus depends on the concept of transferability. This consists of two dimensions: the embodiedness in physical objects and the degree of contextuality. The transferability of various entities in production and development processes is illustrated in Figure 6.

The authors conclude that knowledge should be transferred through the “movement of physical equipment, reproduction of documentation, face-to-face training and practice.

Figure 6: Embodiedness and standardization of knowledge-bound entities (adapted from Grant & Gregory, 1997)

The before mentioned study by Kim (1999) states that technology is acquired through technological learning. This requires absorptive capacity from a supplier. Technological knowledge can according to him be transferred through machinery, imitation or reverse engineering, trade journals and other technological information. Furthermore, technical assistance from the buyer can help to transfer knowledge.

Like Grant and Gregory (1997), Duanmu and Fai (2007) also present a typology for production process and development knowledge (Figure 7). Within this typology they identify a pattern of sharing technical information to sharing managerial information and as the relationship matures more sophisticated and tacit knowledge is shared. Only very late in the relationship they find that ideologies are conveyed to the supplier although this brings the real benefits and professionalization into the partnership.

The master thesis by Eling (2007) includes an extensive review of knowledge sharing literature in a new product development context. He found eight categories of variables affecting inter-organizational knowledge sharing. Many of these elements of knowledge sharing are more
The research on global sourcing was reviewed and this has led to some valuable insights on global sourcing and how companies can benefit from it. Global sourcing was by Quintens et al. (2006) defined as the activity searching and obtaining goods and services and other resources on a possible worldwide scale, to comply with the needs of the company and with a view to continuing and enhancing the current competitive position.

The review of the literature about processes for global sourcing has resulted in three main findings. First, global sourcing processes are undertaken for a number of reasons. The company and customer needs and enhancing the competitive position lead companies to source globally through the main drivers decrease in costs, improved quality, access to other technologies and markets, lead-time reductions and government regulations. Many companies however experience difficulties in capturing these benefits. It is therefore that a structured approach for global outsourcing of development and production activities is required. Despite this, such a process has not been found in the literature. From the review of the outsourcing literature a new framework for global outsourcing of production and development activities has been constructed (Figure 8). A larger version of this framework is shown in Appendix 3. In the review the elements have been identified which such a process should consist of according to the scholars in this field. Three phases have been identified: a strategic, a transition and an operational phase. The focus in this review has been on the first two as

### Table: Dynamic knowledge transfer typology (adapted from Duanmu and Fai, 2007)

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Technological</th>
<th>Managerial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explicit</td>
<td>1. Product blueprints;</td>
<td>5. Quality system maintenance;</td>
</tr>
<tr>
<td></td>
<td>2. Product assessment reports;</td>
<td>6. Product cost portfolio analysis;</td>
</tr>
<tr>
<td></td>
<td>3. Product analysis reports,</td>
<td>7. Environment protection</td>
</tr>
<tr>
<td></td>
<td>etc</td>
<td>requirements</td>
</tr>
<tr>
<td></td>
<td>4. New facilities/equipment</td>
<td>8. Material sourcing information</td>
</tr>
<tr>
<td></td>
<td>use</td>
<td>9. Market information</td>
</tr>
<tr>
<td></td>
<td>skills</td>
<td>11. Supplier management;</td>
</tr>
<tr>
<td></td>
<td>15. Operation techniques (material processing skills; machine maintenance tips, etc)</td>
<td>12. Customer management;</td>
</tr>
<tr>
<td></td>
<td>16. Product design knowledge</td>
<td>13. Ideology</td>
</tr>
<tr>
<td></td>
<td>17. New product test knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18. R&amp;D management</td>
<td></td>
</tr>
</tbody>
</table>

Key: normal font = identified in initiating stage
      Italic font = identified in the developing stage
      Bold font = identified in the intensifying stage

Summarizing, knowledge can be categorized in product, process and management related knowledge. Process and managerial skills are due to their high degree of tacit knowledge very difficult to transfer. This transfer is hindered by a number of factors stemming from both the product and the distance between buyer and supplier as well as the documentation and availability of the knowledge and the presence of incentives for sharing of this knowledge. It will require a long time, building of trust and frequent interaction to overcome these interferences and convey this knowledge. The buying company will thereby have to help the supplier through advising, training and providing technical documentation.

### 3.5. Framework for global outsourcing

The research on global sourcing was reviewed and this has led to some valuable insights on global sourcing and how companies can benefit from it. Global sourcing was by Quintens et al. (2006) defined as the activity searching and obtaining goods and services and other resources on a possible worldwide scale, to comply with the needs of the company and with a view to continuing and enhancing the current competitive position.

The review of the literature about processes for global sourcing has resulted in three main findings.

First, global sourcing processes are undertaken for a number of reasons. The company and customer needs and enhancing the competitive position lead companies to source globally through the main drivers decrease in costs, improved quality, access to other technologies and markets, lead-time reductions and government regulations. Many companies however experience difficulties in capturing these benefits. It is therefore that a structured approach for global outsourcing of development and production activities is required. Despite this, such a process has not been found in the literature. From the review of the outsourcing literature a new framework for global outsourcing of production and development activities has been constructed (Figure 8). A larger version of this framework is shown in Appendix 3. In the review the elements have been identified which such a process should consist of according to the scholars in this field. Three phases have been identified: a strategic, a transition and an operational phase. The focus in this review has been on the first two as
the definition of outsourcing implies. Within each of these phases several sequential steps have to be executed.

Figure 8: Framework for global outsourcing

The strategic phase should consist of five steps: Identification, specification, monitoring, selection and audit and approval. The figure lists several elements on which identification should be based. This step is however paradoxical with regard to cost evaluations and the availability of a supplier: although the activity has not been identified the number of suppliers should already be known and the same goes for their quotations.

The specification of needs has been researched insufficiently, despite the emphasized importance of this element. This element requires more research on the changing responsibilities of suppliers and how this influences the specification, taking a broader perspective than technical specifications only.

An interesting idea in this respect is that specification may to a large extent be based on the existing (local) supply base and thereby limit potential Asian suppliers. This would also close the existing gap about how other needs than technical ones have to be specified.

The next step, monitoring of the supply market, has not been reviewed in depth. It was found to be an important activity during the review. This element requires further research on the availability of searching practices and the availability of technologies in offshore regions.

The final elements of the strategic phase are the selection of a supplier and its auditing and approval. The availability and accessibility of information for decision making remains a critical issue here, especially in a global context where buyers are unfamiliar with market characteristics and culture.

What strikes throughout the whole review of literature about the strategic phase is that researchers mainly answer which steps should be taken, risks should be assessed and criteria for supplier selection should be used. There exists a gap in how to operationalize these elements.

Furthermore, no literature was found addressing how the drivers or goals of global outsourcing should be incorporated in the process or specification. The absence of this fosters a process in which the company goals and the derived outsourcing goals are forgotten leading to failed processes.

The second phase of the framework starts with the formulation of a contract. As mentioned before this topic has insufficiently been covered in the literature. Very little researchers list elements which a contract should cover or how contracts should be negotiated in an international context.
In the transfer phase two main processes were found: the process of knowledge transfer and that of supplier development. The literature regarding the first mainly focuses on processes, facilitators and barriers of transfer and adoption. An interesting direction for research would here be how the buying company can facilitate this process through improving the transferability of tacit knowledge. The studies on technology transfer and the development of the supplier were found to be very explorative. This field of research requires the identification of best practices and a stepwise process for technology transfer to international suppliers.

The second finding is that the transition phase of the outsourcing process described above is moderated by the geographical dispersion of the buyer and the supplier. Specifically, the requirements and challenges moderate the success of the transfer of the activities. This is reflected in the model shown below (Figure 9).

These moderators can be countered through the establishment of a long-term relationship, trust, communication interfaces, an International Purchasing Office and personal relationships and through maintaining face and harmony between the parties. Furthermore, other requirements as listed by Birou and Fawcett (1993) can also help to overcome the effects of these moderators. They identified global sourcing skills, understanding of global opportunities, knowledge of foreign business practices, planning and expert assistance. Not listed in the studies was the contract, but this is a means of maintaining and managing the relationship.

The third finding is that the literature regarding the strategic phase not specifically addresses the global context or the transition phase ahead. It would be very interesting to study how this strategic phase should be adapted so that activities in the transition can be facilitated by anticipating on them (e.g. through supplier selection or product selection) in the strategic phase given that it has to deal with a global environment and development and production activities to be transferred to Asia. Moreover, it would likely increase the effectiveness of the outsourcing process.

The framework and model that has been developed in this chapter was be used to guide the data collection and analysis in the following chapters. The framework consists of several elements that were all studied in the case on how they have been executed. Furthermore, the moderating factors were examined for their presence and the extent to which they have influenced the performance of the transfer project.
4. Data collection

As a first step in the analysis of the case data was collected to identify the problems and its causes. This data has been collected as described in the Research Design section of the report. This chapter will subsequently address the CMS case and the validation of the representativeness of this case.

The case of the custom specific made cable set (CMS) involves the transfer of production activities to the Taiwanese supplier Supplier 1. The case was analyzed using interviews and archival data such as plans and internal presentations. An overview of the interviewees is shown in Table 2 in Section 2.4.5. An overview of the main documents that were studied is provided in Table 3.

The transfer was initiated in 2007 by the Product Family Team cables in the department of electrical procurement and ranges from this initiation to the release for volume at the end of 2008 after which the supplier is qualified for volume production. Although the transfer has by several interviewees been characterized as successful, the interviewees also state that it has been subject to many problems causing a substantial delay of half a year. The case description below will first briefly describe the cable set and then address the transfer process.

4.1. Description of the CMS

The CMS is an electrical component for XT step-and-scan lithography systems which is installed at the customer and leads from the sub-factory to the machine. It is characterized as a product with low technical complexity and high labor intensity. It consists of a set of 50 to 60 cables which have to be made according to the specifications in the technical product documentation (TPD) and at a variable length (an example of a cable is shown in Figure 10). This length is derived from measurements at the site of the customer and depends on the specific situation and routing. The availability of this information determines the lead-time of ten days. At both ends of the cable set are pin connectors that have to be fastened to the cables. About 50 to 100 of these cable sets are produced each year, which makes it a low-volume product.

Currently, four sets of cables for the XT 850, XT 1900, XT 1450 and the NXT 1950 have been transferred and released for volume production, which is about 60% of the total number of cable sets. The set was previously single sourced at the local supplier LOCAL SUPPLIER 1 Industrial Automation. During the transfer process this single sourcing was continued to ensure continuous supply chain stability. LOCAL SUPPLIER 1 currently delivers to the European and US markets and has lowered their price due to the threat of losing their business to Supplier 1. Supplier 1 now produces for ASML’s customers in Asia and delivers directly to the local warehouse.
4.2. Organization of the process

Several people were involved in the execution of the transfer project. They were located in Veldhoven and at the international purchasing office at ACE in Taiwan and had different disciplines. In Veldhoven the director electrical procurement, the chairman of the PFT and the procurement account manager were involved from the side of procurement. Furthermore, the supply chain engineer and an electrical development engineer were concerned with the qualification of the products. From ACE a supply chain engineer was responsible for the qualification, assisted by a development engineer, as well as the auditing process and implementation of the production process. The procurement account manager at ACE and in a later stage the procurement director were the most important people involved. All of them have several years experience in Asia, the director procurement is Taiwanese. According to the director electrical procurement the members were not formally organized as a project team but by their line-responsibility. He stated: “Of course the project was not organized in a project team. I am an advocate of the line. A project team is a matrix. If you don’t have a matrix organization in which the responsibilities have been determined you enter a situation in which nobody is responsible anymore.” This opinion was not shared by all, since the group had the character of a project team.

According to the PFT chairman there was no single person who held responsibility for the transfer process ranging from identification to release for volume as a whole. Responsibilities changed between departments depending on the activity that was executed. The procurement people in Veldhoven were however involved throughout the whole project. Within the team the PFT chairman and the procurement account manager were responsible for the initiation of the transfer; the supply chain engineers are responsible for qualification and implementation of the product and process. An external party was hired for the construction of a sample cable set and completion of the TPD.
It is important to note that ASML clearly distinguishes two phases in the transfer, which can be subdivided into four main steps (Appendix 3). The first phase consists of the identification of a product for transfer and searching of suppliers. The identification is as mentioned the role of the PFT and the procurement account manager, supplier search was carried out by the local procurement department in Taiwan. The second phase, also known as the ‘select and qualify’ process involves the selection process of a supplier and the subsequent qualification of the process and product. This phase was mainly the responsibility of the supply chain engineers and procurement people at ACE. Time-plans for the activities to be undertaken were made regularly in a Gantt format and followed with strict deadlines. No schedule covering the entire transfer process was however found. An activity plan only covered the first phase and supplier selection. In some cases deviations from this plan were made, the plan has however not been updated accordingly. The next steps were covered in the more elaborate and detailed qualification plan (Figure 11) which shows the planned activities and their finishing time. This latter plan was maintained more precisely, showing also the actual finishing times of activities. Several versions of this time-plan were however found, showing different information. According to the interviewees it was however clear which plan had to be used. Furthermore, some of the activities that were undertaken during the process such as the visit of procurement people from Veldhoven to the potential suppliers were not on the schedule. More importantly, the first manufacturing of a sample, checking and sending of the technical documents and the check of the sample are missing. In the overlapping part of the plans, e.g. the supplier selection process, the responsibilities of tasks did not correspond. Contrary to the initial plan, more iterations were required than planned to get the supplier on the required level. Some of the problems and number of iterations required were thus not foreseen by the procurement and supply chain people.

![Figure 11: Gantt-chart for Select and Qualify process](image-url)
Communication during the project was done by weekly conference calls between ACE and Veldhoven and the exchange of documentation by e-mail. The verbal communication between ACE and Veldhoven procurement and supply chain engineering project members was qualified by the interviewees as good. One interviewee however referred to the difficulties in understanding the English pronunciation of the Taiwanese, especially over telephone lines. The people involved in the qualification communicated with the supplier by e-mail and telephone, which according to them worked well. It was however indicated that due to time-zone differences issues can take more time to be solved. The procurement director at ACE emphasized the cultural differences and perception of Asia stating: “People have to recognize that Dutch is some unique culture as well. And most of course is the communication in English a problem. I mean the level of English is different in each region and for each individual. [...] Normally European people have the perception of Asian people that they are the same stereotype. They think that Asia is China, China is so and so, so Asian people should be something like that. However, the more you are engaged with the people in this region you realize how different they are.”

4.3. Process description
The transfer process of the CMS has been referred to as a top-down process meaning that it was initiated by the PFT and consists of some more or less formal processes of fixed steps which are graphically represented in Appendix 4. This flow-chart was constructed by reviewing the available schedules and interview data. It thus is not a formal process diagram but represents the activities as they have taken place. The data described below follow this process.

4.3.1. Identification phase
As mentioned the CMS has been identified as a potentially transferable component together with a couple of others by the department of electrical procurement through the PFT Cable assemblies and bundles. This PFT was chaired by a procurement account manager and consisted of people from Supply Chain Engineering and Development and Engineering.

Several reasons for the transfer of the CMS were named as listed in Table 1. First and most important, at the time of the transfer a support office in Asia was established. This office ACE had as one of the goals to support procurement activities and provide access to Asian suppliers and thereby secure worldwide competitiveness. At the time no qualified suppliers for cable sets as a part of the preferred supply base were available. Only according to the procurement people the main reason to transfer the CMS was the establishment of a supply base. The director electrical procurement stated: “My goal has been to have a supplier in Asia who could become a potential large volume supplier and who fits to my preferred supply base.” To reach this goal a non-complex, mature component was sought with substantial savings. According to the initial plans in which the price by the current supplier and the corresponding price from the new supplier were compared, these savings added up to 12% of the purchase price of the former supplier. Product maturity would ensure the availability of a complete TPD and proven functionality. The goal of establishing a supply base and the corporate pressure to do so was not named by the interviewees from ACE and the people involved in the qualification process.

Secondly, the cable sets were being produced locally, then shipped together with the machine to the customer and finally installed there. Sourcing the cables from Asia would eliminate this transportation time and the associated costs. A detailed cost analysis was made to determine this.
Thirdly, the labor intensiveness of the production process made it very likely that cost reductions would be obtained by sourcing in a low-cost country. It should however be noted that cost savings were initially not considered in the transfer. Only after a change in corporate policy during the transfer this aspect became of increasing importance.

Fourthly, the PFT had set a strategy of sourcing cables at US, European and Asian suppliers and thereby aimed to reduce the dependency on the current supplier LOCAL SUPPLIER 1. Based on these rationales the PFT has selected the CMS to be sourced from Asia.

Table 7: Rationales for transfer of the CMS

<table>
<thead>
<tr>
<th>Rationales for transfer of the CMS</th>
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<tbody>
<tr>
<td>Establish an Asian supply base</td>
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<tr>
<td>Worldwide competitiveness</td>
</tr>
<tr>
<td>Low-product complexity</td>
</tr>
<tr>
<td>Product maturity</td>
</tr>
<tr>
<td>Logistics costs savings</td>
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<tr>
<td>Product cost savings</td>
</tr>
<tr>
<td>Lead-time reduction</td>
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<tr>
<td>Reduction of supplier dependency risk</td>
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</tbody>
</table>

4.3.2. Supplier searching phase

As a next step suppliers were sought by the procurement people at ACE. They started their market research searching for cable suppliers and based on the pre-defined PFT strategy and a supplier wish profile by the PFT (Appendix 6). This is a standard ASML document which defines the requirements for a supplier in terms of QLTC. The wish profile for the CMS was a combination between that for special cable assemblies and standard cable assemblies. The wish profile is basically comparable to the status of the current supplier and forms the baseline of supplier performance. Furthermore, the competences which were required from the supplier have been identified and communicated clearly. The fit with the current supply base was not found to be included in the description of a potential supplier. This was despite the emphasis the director electrical procurement put on supply base development and supply base fit. He stated that if you qualify a supplier for a certain product category you would want to use this supplier also for the production of other products in the portfolio of electrical procurement.

The scouting at ACE has resulted in a long-list of 24 of suppliers who were capable of producing cables. They were derived from several sources such as the government supplying a list of companies, peer companies’ references and business-to-business databases like the Yellow Pages. The companies on the long-list have been sent a standard RFI or Supplier Pre-Survey in which they are asked to provide ASML with information regarding management structure, marketing, business information, strategy and policy, organization, education and training, quality assurance and EHS. The provided information served as input for creating a short-list. Three suppliers were put on the short-list: Supplier 1, Supplier 2 and Supplier 3. According to the PFT strategy selection criteria should be pre-defined and evaluated in a Pre Survey Benchmark Selection Matrix but they were not. Despite this, an evaluation has been made based on whether these cable manufacturers were able to construct a cable of the type required by ASML. The rationales behind the disqualification of the other 21 cable suppliers were not clear to the procurement people in Veldhoven.
4.3.3. Supplier selection phase

The three suppliers were then asked to sign a non-disclosure agreement to prevent the leaking of sensitive information. Next they were asked to quote for the manufacturing of a sample set consisting of 14 cables including non recurring expenses and the manufacturing of an “XT1900Gi Electrical Pre-installed Custom Made Set” cable set. Therefore they were sent the bill of materials for a sample set and the technical product documentation for the 14 cables together with the technical documents for the complete cable set. The TPD for the sample set had specially been created, the other was considered complete. Based on these documents the suppliers started preparing their quotations. ASML has calculated its own target-price or PP3 for the CMS based on local labor rates, prices of components and tooling costs. These quotes were compared to the current supplier’s price, the calculated PP3 price and the eliminated transportation costs.

In a next step the suppliers were asked to make a work preparation and order the necessary components for the construction of a sample set for auditing the product. This sample consisted of 14 cables covering all the required competences. The work preparations were checked by ASML. The time plans show conflicting responsibilities in this check: the plan covering the first phases assigns it to procurement in Veldhoven, the qualification plan assigns it to supply chain engineering in ACE. During the interviews it was indicated that making work preparations based on the technical documentation was problematic. These issues will be more specifically addressed later in this section.

In an extensive process audit the three suppliers were then checked according to a predefined auditing tool and the scores were summarized in an audit report. This tool consists of four categories: quality, logistics, technology and total cost. Each category consists of questions addressing the required capabilities. Quality assessed the presence of quality monitoring and quality levels. Logistics assessed the suppliers’ logistic capabilities, flexibility, availability of an ERP system and delivery reliability. In the Technology category the technological capabilities, knowledge, development process and competence development were assessed. Finally, in the Total Cost group the competitiveness, cost reduction efforts, payment terms and cost risks were evaluated. The scores in each category were added and compared to the required scores in the wish profile and added up for comparison with the other suppliers. An additional category was defined by ACE Supply chain engineering which reported ‘Business fundamentals’ and assesses the match between ASML and the alignment of the business and the presence of several business related requirements. This category is not standard for ASML but was added since these criteria are absent in the audit questionnaire.

In the audit reports Supplier 2 (Figure 12) scores highest. They score below threshold on complaint handling, flexibility, process-control and payment terms.

<table>
<thead>
<tr>
<th>Category</th>
<th>Supplier 2</th>
<th>Overall Vendor Rating</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>B</td>
<td>92%</td>
<td></td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistics</td>
<td>B</td>
<td>91%</td>
<td></td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>A</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Total Cost</td>
<td>B</td>
<td>82%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

Figure 12: QLTC scores Supplier 2
Supplier 1 (Figure 13) scored a C level. The complete audit report is shown in Appendix 6. The main gaps between required and actual scores regarding quality were found in material quality, version control, complaint handling, health and safety and customer focus. In the logistics category they scored low on flexibility, delivery reliability, cycle time reduction and process control. The technology part shows more gaps in technical knowledge, supplier involvement, continuous improvement and engineering change management. Furthermore, the report stated that Supplier 1 had no previous experience with cables like those of ASML and expected long learning-curves. With respect to costs they scored very low on market conformity, open costing and cost reduction programs.

<table>
<thead>
<tr>
<th>Overall Vendor Rating</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td>81%</td>
</tr>
<tr>
<td>Logistics</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td>83%</td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td>D</td>
<td>86%</td>
</tr>
<tr>
<td>Total Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>63%</td>
</tr>
</tbody>
</table>

Figure 13: QLTC scores Supplier 1

Supplier 3 finally scored worst of all with a D score before execution of the closing plan which was formulated to improve supplier performance, and was excluded from the selection plan.

Supplier 2 thus performed better overall, also in the business fundamentals category.

One of the interviewees stated that suppliers generally score below the required levels since ASML is a very demanding company requiring high performance on QLTC aspects, which results in a performance gap. In case a supplier scored below required in the QLTC audit they were asked to provide a plan covering how to close this gap. The plan covered how to bring the supplier to the required levels on the low-scoring items in an acceptable time-span. Supplier 1 presented a plan, but it was reported to be disappointing.

Besides the QLTC audit, the suppliers were checked on whether they had an history with IP issues by an external agency, since ASML sources products that are protected by intellectual property rights. The people involved in the auditing at ACE advised to continue with two suppliers, since Supplier 3 scored too low in the overall vendor rating.

The two remaining suppliers, Supplier 2 and Supplier 1, were asked to quote for the complete CMS. Both suppliers were also visited by the PFT chairman and director electrical procurement. During this visit the relationship between ASML and the supplier was discussed. Supplier 2 believed the cable set would generate insufficient business for them, and decided to withdraw from the quotation process.

The director electrical procurement emphasized the importance of this discussion on business fit and buyer-supplier relation stating: “The question is thus: how can you realize a certain customer position with Supplier 1. What kind of customer will you be? You have to think that over in advance, since it makes no sense to select a supplier that doesn’t fit to your business. That would result in a wonderful supplier in which you have invested a substantial amount of time, which does not fit your strategy and by itself becomes a crappy supplier.” He considered this fit more important than supplier performance in supplier selection. In this respect other interviewees involved in this process mentioned the contradiction between many suppliers in Asia producing large volumes of products who are not interested in the small series of high-mix products ASML needs. The supply chain engineer at ACE remarked that although many electrical suppliers are located in Asia the low value of
electrical ASML products does not interest them. This occurring left Supplier 1 as the only potential supplier. The people involved knew that Supplier 2 was with respect to performance the better option and that choosing Supplier 1 would imply more work. However, since the decision to transfer was taken under the pressure of establishing a supply base in Asia it was decided to continue.

Two other processes were also executed in parallel: the manufacturing of the sample product and the implementation of the above described gap-closing plan for supplier development. It was planned that the manufacturing would require two iterative steps to deliver the sample according to the specifications. Various problems showed up as reported by the interviewees and in the test reports. These errors have not been researched in depth in this study, but an overview of the main reported ones is given here.

The TPD was sometimes incomplete with missing or incorrect specifications. Also the bill of materials contained errors. Specifications were sometimes conflicting. The supply chain engineer at ACE stated: “Well, it took a very long time. There were many errors found. Far too many even. It was completely incorrect, to be honest and they had to reconstruct the TPD based on the analysis we did here. It has delayed the project by 3 or 4 months.”

Several reasons for this incompleteness were given by the interviewees. ASML often lacks resources to finish the TPD. Furthermore, the product was previously sourced at a supplier with whom ASML had a long-term relationship. The supplier knew what ASML wanted as indicated by the PFT chairman: “We have a specific way of working with our suppliers since they have been working with us for a very long time. You thus communicate orally or with scrap paper and scrap tables. That won’t work if your supplier is at a great distance. That is where the bottleneck partly is: we assume that a supplier knows something which is not the case with a new supplier. Then it fails.” This statement also illustrates the misinterpretation or misunderstanding of ASML’s technical information by the supplier, which led to construction errors.

In order to prevent incompleteness of the TPD it was first checked on consistency by a development engineer at ACE. According to the qualification schedule the TPD had indeed been checked, however the preparation and manufacturing had already begun when the review was finished. Besides this the use of standard components also caused many problems. The supplier had to use standard ASML components as prescribed in the Approved Vendor List of ASML. These components have been qualified at specific suppliers. The components for the CMS had to be ordered at a Dutch local supplier. The development engineer described the problem as: “We use products specifically adapted for ASML. The supplier orders according to the product code and they can’t see that it is a specific ASML product. They order for example from a supplier in Germany and get the wrong product, which we don’t see immediately. Later on we see something strange and the inner side of their tooling shows slightly different. We order locally and the supplier knows that it is specific for ASML.” This caused lead-time problems and also required investments from the supplier due to minimal order quantities. In first instance the supplier thus used components from one of their local suppliers, which was a reason to reject the samples since they were not compliant with the approved vendor list.

The report also shows several errors due to the use of the wrong tooling which leads to deviations in the product. These were mainly wrong crimping tools for fastening connectors to the cable.
During this process it was decided by electrical procurement to have the TPD finished with photos and a description of how to construct the cable with the help of the external model shop Local Supplier 7 and to send sample products to the supplier. The translation of requirements to English proved difficult, just as the translation of the different standards in technical drawings did. To make these explicit some employees from Supplier 1 visited ASML to see how the assembly of the cable was done there.

The manufacturing and its quality check in Veldhoven by the development representative and the supply chain engineer had to iterate three times in order to reduce the number of deviations. This is illustrated by Table 8, which shows the number of deviations in each sample. With respect to this check predefined quality measurement procedures were however missing. It was mentioned by all interviewees that during the check there was an emphasis on quality. They agreed that this was not a bad thing in itself, since the cable set would be delivered directly to the customer. However, the people in the qualification were perceived to be tending to overemphasize it and find faults with everything. The director electrical procurement stated: “And our people were out of their mind, because if the cable was twisted to the left it wasn’t good. I tried to end that. I didn’t succeed, because still our people here were right, the quality was miserable”. The overemphasis was ascribed by the ACE supply chain engineer to perception stating: “It has more to do with perception. It hinders us, yes. It is a ‘Dommel Valley’-syndrome; we can only get things from Veldhoven otherwise it is probably not good. My boss once said to me: China is cheap, but the quality is shitty.” According to the director procurement at ACE this perception caused delays: “Some people may have some perspective already on low-cost country suppliers. Which is true, but it sometimes depends on what you want; what kind of product we are talking about. If you apply the same perception to all the products there is a problem. The fear and resistance are more difficult to overcome.”

<table>
<thead>
<tr>
<th>Item</th>
<th>Number of cables</th>
<th>Number of Errors</th>
<th>New errors</th>
<th>Number fixed</th>
<th>Recurring errors</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st set</td>
<td>14</td>
<td>24</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>1. SUPPLIER 1 not clear with ASML criteria</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. Some wrong information in ASML TPD and needs to modify data from supplier site</td>
</tr>
<tr>
<td>2nd set</td>
<td>14</td>
<td>16</td>
<td>9</td>
<td>10</td>
<td>7</td>
<td>SUPPLIER 1 workmanship issue</td>
</tr>
<tr>
<td>3rd set</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Wrong tool from 2nd-tier</td>
</tr>
<tr>
<td>4th set</td>
<td>53</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>1. 1 issue: function will be impacted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. 6 issues: function won’t be impacted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2x SUPPLIER 1 workmanship issue;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2x Personal judgment issues at both side and ASML hasn’t written down criteria for Supplier 1 to follow. (during ACE SCE &amp; SUPPLIER 1 CQE final inspection, these issues not easy to be detected);</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1x Knowledge of supplier and wrong tool from 2nd-tier</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1x Suspect design issue or transportation issue</td>
</tr>
</tbody>
</table>

After each check of compliance of the sample products a report was made with deviations accompanied by photos and their root causes. This report was then fed back to the supplier to
improve the sample and propose corrective actions. After these three iterations it was decided to continue with the qualification of the final product since the process was delayed too much. The final conclusion of the third report stated: “Mainly the cables look very well, they were clean and well packed (not cleanroom-clean packed yet). Extra attention needs to be given to the root cause of the crimps from cable 81821. We expect Supplier 1 to come up with an 8D analysis report and presentation in ACE. After the root cause is found, explained and solved, ASML needs one cable and work instruction for qualification.” This conclusion shows that there were substantial improvements in the cable quality, but not yet a fully compliant product after three iterations.

Concurrently to these manufacturing and supplier development steps the long-term agreement (LTA) was discussed with the supplier and Supplier 1 and ASML signed the agreement after selection of the supplier. This happened despite that the director electrical procurement stated in the interview: “I don’t want a signed LTA, I want an LTA with them once we have decided to enter into a long term relationship with them. So I first want to see in the first phase of the selection process, in which we test whether they can be an ASML supplier and handle complex products, whether they would accept the LTA conditions and agree with what being an ASML supplier means.” The long-term agreement is thus finalized in a too early phase in the process according to the procurement view.

4.3.4. Supplier qualification phase
After having selected a supplier, the process was continued with a supplier qualification phase to ensure that the QLTC requirements are met. A purchase order was sent for the first article, which was a complete XT1900i cable set. Again, based on the corresponding technical product documentation, General Standards of ASML, Bill of Materials and IPC norms a work preparation had to be prepared by the supplier and tooling and components had to be ordered. The work preparation was checked by supply chain engineers at ACE.

The subsequent construction of a prototype consisting of 53 cables and its check in Veldhoven did not meet the expectations the first time. This was also reported in a feedback document. It was however decided to continue the process under pressure of the director electrical procurement, despite that by then the prototype had not reached its required quality level. The supply chain engineers at ACE who were in close contact with the supplier and procurement people in Veldhoven were convinced that the supplier was ready to produce volume products according to QLTC targets. The remaining issues were considered manageable under responsibility of the supply chain people at ACE. Finally the CMS was qualified. According to the director procurement of ACE he was confident that Supplier 1 would be able to produce according to requirements. This corresponds with the statement by the supply chain engineer from ACE saying: “At the end we said, and the director electrical procurement supported me in this: Stop droning on from development and engineering. John, can you guarantee the quality? And I whole-heartedly responded: Yes, because I was really convinced of it, and so it proved. Then we said: stop this nonsense, we’ll qualify it!”

In parallel to the qualification an FMEA of the production process was executed to assess the risks of failure in the process and prepare preventive actions. Furthermore a move-rate analysis was

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1 IPC is an international association for connecting electronics industries who have established norms
conducted to determine whether the supplier would be able to produce the required number of cables on time.

The project was finished by the second half of 2008 with a delay of half a year. With respect to the goals of the transfer the opinions are mixed. The direct cost savings were made, although no volume has yet been produced. The number of cables that has been qualified is according to the director electrical procurement somewhat disappointing. Regarding his goal of bringing business to Asia he qualifies the project as successful, just like the ACE supply chain engineer. He has however no actual view on the status. According to the director procurement at ACE it is progressing.

Now that the CMS was released for volume the supplier was able to produce orders. Although the CMS has a short lead-time, the absence of a phase-in and phase-out plan for the current and new supplier led to procurement placing orders at the former supplier. According to the supply chain engineer at ACE this has frustrated the suppliers. Furthermore, the suppliers lose their routines and skills which may result in lower quality and higher product costs.

The section above has described in detail which activities have been conducted in the transfer project starting with the identification of a product up to its final release in which assets and knowledge have been transferred. Since this case addresses only one product with its own characteristics and is transferred under the responsibility of the electrical procurement department, it is important to validate whether these data also hold for other product types and departments. Furthermore, the case is subject to organizational change and the context at the time the transfer took place may be different than the context at the time of the research. Therefore two other transfers were studied which are briefly addressed below.

### 4.4. Validation of representativeness of the case

Two other transfer projects were thus examined using interviews. These cases were not studied in depth but only to have an indication as to what extent the issues in the CMS transfer hold in different departments.

#### 4.4.1. Carrier Handler

The first transfer that was researched is that of the carrier handler which is a mechanical component and temporarily stores wafers during the production process of chips. Within the procurement department the mechanical department is responsible for sourcing the product. It has been dual sourced at suppliers since the volume exceeded the capacity of a single supplier.

The transfer process has mainly been carried out by the procurement and supply chain engineering departments at ACE. In negotiations with the current suppliers and the transfer the procurement account manager at Veldhoven was also involved, since he has been the responsible buyer.

A cost benchmark has been the reason for transferring the product to a Taiwanese supplier with whom ASML had done business before. This supplier was aware of the requirements of ASML and belonged to the preferred supply base. A request for quotation was initiated to benchmark the current suppliers with this new Taiwanese supplier based on the existing QLTC requirements. The statements from the procurement account manager and the supply chain engineer at ACE differ from each other regarding the reasons behind the transfer. The procurement account manager stated that
he had negotiated a quotation from the current suppliers which equaled the quotation from the Taiwanese supplier who quoted lowest in first instance. Having negotiated this cost of goods target he had attained his cost reduction objective. According to him, since he had attained this goal there was no need for a transfer anymore. It was however decided by higher management that the module would be transferred to Asia and that one of the suppliers would be left. The supply chain engineer on the other hand stated that since the quotation from Taiwan was lowest they had started preparing the transfer and were surprised by the indistinctness of where the module would be sourced. He favored a clear bidding procedure in which boundary conditions for the quotes were defined. The business case for assessment of the attractiveness of sourcing from Asia was established on non-recurring engineering, direct product costs

Contrary to the CMS transfer which had many issues with the specification, the construction of a sample module showed no large problems. The technical product documentation was available since the product had recently been transferred to a supplier in the United States. Furthermore, the Taiwanese supplier already had experience with ASML products and met the required QLTC levels. The supplier had not yet been released for volume, but was working on the production of five samples for qualification. According to the procurement account manager, who was frequently informed about the progression, there was no reason to believe that the module would not be finished shortly.

A more pinching problem was indicated by both interviewees. The former supplier had to be left, but had maintained levels of stock to meet ASML lead-times. Although the opinions on how to solve this problem differed, they both found that a plan should be defined during the transfer covering how to decrease production and what to do with stocks that had been maintained by the supplier. With respect to the evaluation of the project the project is mostly evaluated as effective. However, the procurement account manager found that the objectives were not complete, since his objective was only a cost of goods reduction. He furthermore emphasized the ambition of ASML to make suppliers responsible for parts of the development of a module, which was also not taken into account in the benchmark.

4.4.2. XCDA Valve Assembly

The transfer of the XCDA Valve Assembly was initiated as a result of quality problems in the module. An error in the design necessitated a redesign and the design of a spare part to maintain the machine. The product was sourced under the responsibility of the Immersion and Vacuum Systems PFT. People from supply chain engineering, procurement and development were involved in the “select and qualify” process, as well as supply chain engineering and procurement people from ACE. Furthermore someone from Veldhoven was in charge of the alignment of ACE and Veldhoven processes and inclusion of the transfer project in the PFT strategy.

Since the required volume of these components, which had been done by a local supplier, would exceed his capacity an extra source was searched. From this perspective a supplier search was also conducted in Taiwan for production of the module as a spare part. Since most of the spare parts would be needed at the customer base in Asia, transportation costs and lead-times could be eliminated by sourcing from Taiwan. Supplier searching was conducted by ACE, who proposed
Supplier 4-3 and three others as suppliers, after which a company visits were initiated. The finally selected supplier in Taiwan, Supplier 4-3, was already part of the preferred supply base of ASML since it was producing several other products as well. The supply chain engineer and development engineer were invited for this company audit. The selection of the company and the qualification has followed the standard “select and qualify” process in which the people from Veldhoven were closely involved. A check of the technical documentation was conducted by the Veldhoven office. With respect to this TPD the introduction talk was emphasized. Usually in case of local suppliers an introduction talk for the TPD takes place to explain the pitfalls and requirements. In case of Asian supplier this initiation needs more attention since it does not automatically follow. The supply chain engineer stated that such talks are essential to understand the documentation. Cultural differences and communication were in this respect not considered to be problems. She furthermore indicated that the design contains specified components which the suppliers have to use and which lead to additional costs and lead-times.

During the sample production ACE assisted Supplier 4 weekly in their production process to tackle problems. Frequent calls were initiated between ACE and Veldhoven to align the activities in Veldhoven and ACE and prevent communication problems.

The XCDA Valve Assembly was finally released with a delay of not more than a couple of weeks. Contrary to the CMS case these latter two cases were thus initiated from different approaches; a cost benchmark and a capacity and quality problem which required a new supplier. A procurement account manager from ACE confirmed that projects are not only initiated by PFT’s by stating that projects are initiated both by them as well as by the buyers in Veldhoven. He furthermore observes increased management support for global sourcing. The attention for global sourcing was underlined by the vice president procurement, who sees the role of ACE as a supporting office for sourcing from Asia. He requires a business case in which he assesses whether sourcing globally would create value through lowest integral costs on the short and long term. Positive business cases are often found in products with high labor content and transportation costs.

The select and qualify process seems to have changed from the situation of the CMS. A communication matrix was developed to enhance communication between ACE and the Asian supplier. In addition, the procurement account manager has frequent calls with the suppliers. Furthermore, for questions and issues regarding the development of a sample product and qualification product a new tool was introduced which enhanced communication on technical issues and documentation. The people at ACE see a development in the suppliers’ capabilities. They are increasingly capable of handling complex modules in production.

As stated before much emphasis was but by the supply chain engineer and procurement account manager from ACE on the importance of a phase-in and phase-out plan. The absence of such a plan has led to problems with suppliers who had finished the qualification, but saw no business coming from ASML. The risks of losing suppliers who terminate the relationship, or lose the developed production skills are realistic ones.

The problems regarding in the select and qualify process of the CMS are to some extent representative for the others. Specification was found to be a problem in the latter ones as well.
However, technical assistance at the suppliers by the supply chain engineers at ACE is likely to have taken away many construction issues. Furthermore, communication between ACE and Veldhoven seems to have improved, which was ascribed to the increased attention from PFT’s and higher management.

For all three cases data has thus been collected; for the CMS in depth, for the Carrier Handler and XCDA Valve Assembly only to look for similarities and differences. All products were transferred from a European supplier to a Taiwanese supplier. The main drivers behind this were supply base development, cost and lead-time reductions and a capacity problem. Evaluations regarding the performance of the projects differed on the effectiveness, whereas on efficiency they were more distinct. The CMS case seems to have had many more issues with the selection of a supplier and qualification. These mainly manifested themselves during the construction of a sample product and qualification set, which required many iterations to attain the required level of quality. Contrary to the other two cases this supplier was a new supplier for ASML who had not made comparable products before. The TPD was, unlike the CMS case, more complete since it had been recently redesigned or transferred. Furthermore, increased communication with and assistance to the supplier may have prevented many issues in the production of a sample product and qualification product.
5. Analysis
In the analysis the data was first structured and analyzed through open coding (Van Aken et al., 2006). The interviews and archival data were reviewed and small parts of data were coded based on their content. In a next step these codes were grouped according to their content on more general topics resulting in a tree structure of the data. Through this analysis the data was structured to facilitate finding the main problems and their causes.

The first step in the analysis of the data was the validation of the business problem. This should according to Van Aken et al. (2006) be done to ensure that the initial problem is not just a perceptual problem but a real problem. They propose the collection of factual information for this validation.

The initial problem in this thesis was that the current relocation process for production and development activities for components from European to Asian suppliers was not effective and efficient.

In the subsequent step the data was analyzed. In a theoretical analysis the data was systematically compared to the theory showing gaps between practice and literature. Further listing the problems and their causes resulted in a cause-and-effect diagram and a final diagnosis of the main root-causes of ineffectiveness and inefficiency.

5.1. Validation of the problem statement
During the interviews the opinions about the project’s effectiveness were mixed. Most interviewees found, as mentioned above that the project was effective. Effectiveness was defined as the extent to which the process has achieved the initial goals. With respect to these goals (Table 7) a product was transferred firstly to an Asian supplier firstly to establish a supply base, to ensure worldwide competitiveness, reduction of supplier dependency. Secondly, cost reductions resulting from elimination of transportation costs and from lower product costs were of subordinate importance.

The first goals have been attained since the production has been transferred to Supplier 1 and this supplier is producing the cable set for Asian customers. This also adds Supplier 1 to the ASML supply base. Whether the supplier strategically fits in the ASML supply base, as emphasized by the director electrical procurement is however unclear, since this depends on the requirements of the product family team. These have been specified in the wish profile and PFT strategy document, but this does not mention supply base fit. Furthermore, Supplier 1 has, after implementation of the gap-closing plan, proven to be globally capable or worldwide competitive. A worldwide competitive supplier is by Trent and Monczka (2003) defined as: “one that can competitively satisfy a buyer’s worldwide requirements at all sites in terms of design, cost, quality, cycle time and delivery.” This resembles the QLTC targets which were pre-defined before the qualification. Finally the dependency on the supplier LOCAL SUPPLIER 1 was reduced through dual sourcing and creating competition in the supply base.

With respect to the subordinate goals the direct cost reductions are likely to show based on the quoted price from Supplier 1. The project has however not been finished and factual prove for the achievement of these goals is not yet available. However, additional however costs have been incurred due to the number of iterations, the services from an external party, ordering standard ASML components and the delay of the complete project. These costs have been referred to by Song et al. (2007) as information collection, supplier selection and supplier management costs, which according to them decrease cost reductions. The total savings are thus likely to be lower than
expected, although indirect costs have not been considered or stated as a goal during the execution of the process.

The efficiency of the transfer process was defined as whether the project was finished as planned initially. According to the interviewees the project was planned to be finished in the first quarter of 2008, but was finished in the fourth quarter of 2008. The major causes of this delay are according to the interviewees the problems in the technical documentation and the many iterations of sample manufacturing required to attain the QLTC targets. This is also shown in the qualification plan showing delays of 18 weeks due to extra iterations. Whether delays had also occurred during the steps preceding the qualification and sample production is indistinct, as this plan does not show finishing times and planned finishing times. It could however be determined by examining reports from this first phase.

It can be concluded from the validation above that the effectiveness of the project was evaluated as good since a supplier was found and production activities were transferred and started up. It is however very likely, that the additional indirect costs due to extra activities and delay have lowered the effectiveness. The efficiency of the project was characterized by the interviewees as low. The problem is thus a real problem.

5.2. Analysis of the data
The next step according to Van Aken et al. (2006) is the exploration of the causes of the problem. The construction of a diagnosis should according to them be based on both a theoretical and an empirical analysis. Conceptualization of the empirical findings they state helps to sharpen the analysis. For this purpose the findings from the literature review will be used (Figure 8). In this review a framework was constructed based on the framework for outsourcing by Momme and Hvolby (2002). Within this framework several activities have been listed and the literature was researched for views on how these should be executed. Furthermore, a body of research about global sourcing was reviewed in which requirements and challenges were identified. These two findings were used to conceptualize and interpret the case data and systematically compare these to the literature. Based on the two types of analysis a cause and effect diagram was derived showing the main problems and their causes.

The coding of the data resulted in the main categories of project describing items containing information about the organization of the project, its performance and the rationales behind the transfer. Another category involves the strategic preparations of the process which corresponds to the framework by Momme and Hvolby (2002) which distinguishes a strategic and a transition phase. Further comparing the framework and its described steps to be taken provides other valuable insights. The transition phase was also found as a category and involved the implementation of the production process and the contracting. The comparison of these phases to the literature is first addressed, where after the organization of the project will be compared to the literature. The comparison between the framework from the literature and that derived from the data is shown in Appendix 3.
5.2.1. Identification phase

Regarding the identification phase, in which the product to transfer is identified the literature lists several considerations for transfer. The outsourcing literature suggests evaluating the core competencies of the business, the cost effectiveness gained by outsourcing, supply risks and supplier dependency, and the desired supplier relation. Global sourcing is according to several researchers undertaken to attain worldwide competitiveness through cost advantages resulting from comparative advantages, improved quality, access to other technologies and markets and lead-time reductions.

Several decision variables as used by the product family team can be recognized. The main reason to transfer the CMS was the establishment of a supply base in Asia to secure worldwide competitiveness. This is in line with the external forces identified by Monczka and Trent (1992) which compel businesses to source globally. Although cost advantages were not named as primary driver it may have been one of the considerations behind the establishment of an Asian supply base just as access to foreign markets. Lead-time reductions were in case of the CMS clearly one of the reasons why this product was considered for transfer.

Where the framework from the literature review assumes the availability of capable suppliers, the CMS case shows that suppliers have to be developed in some cases. Contrary to the findings in the literature, core competences were not evaluated since the product had already been outsourced before and therefore was not part of the competences of the business. Furthermore, unlike the suggestions by Ellram and Maltz (1995) and McIvor (2003) no cost evaluation was made at this stage, since cost reductions were no explicit driver in the transfer. Specificity as referred to by McIvor (2003) was included in the form of product complexity and the corresponding specificity of knowledge; a product was selected which had a low complexity. Furthermore, knowledge was expected to be easily transferable and low in specificity since the product was mature and technical documentation existed. Core competences did not play a role in the evaluation; the product had already been sourced from a supplier.

Supply risks were also considered since ASML aimed to reduce their dependency on the current supplier. Besides that an existing product was chosen to reduce the risk of failure. Supply risks resulting from sourcing in Asia were not mentioned but the team was aware of supply risks and decided to dual source supply for the Asian customers until the supplier had been qualified.

5.2.2. Specification

The search process for suppliers started with the derivation of requirements for the supplier. These had been defined by the PFT which is in line with the suggestions from the literature review to start with the identification of the needs (Van Weele, 2008; Monczka et al., 2000; Ellram et al., 2004). The QLTC wish profile is here used to pre-define the needs from ASML and is according to the characterization of specification by Van Weele (2008) a specification in terms of organizational and technical capacity. The cultural requirements and business alignment have been covered insufficiently in the profile if it is compared to the six aspects of fit by Axelsson and Wynstra (2002) since it does not specify what the strategic fit, business philosophy fit is, and how willingness to cooperate is fostered.
5.2.3. Supplier searching

Based on the PFT strategy and the required technical competences the monitoring of the supply market started which resulted in a long-list of cable suppliers. Contrary to the study by Spekman (1988) who suggests the use of threshold criteria for admission to the long-list and short-list, no formal criteria were however used in the search process, although business characteristics, competences, fit with the supply base and the potential of the supplier were mentioned as evaluations. A formal list of preliminary criteria to guide the search process would lead to a more focused long-list and potentially higher quality of short-list suppliers.

With respect to the reduction of the long-list to the short-list it is unclear to the procurement people in Veldhoven why and how the other 21 suppliers were deselected from the list. No standard tool as prescribed in the PFT strategy and by several scholars in the literature (e.g. De Boer et al., 2001) was used for this reduction, despite that it would have provided insight in the decisions. The non-standardized and unclear execution of the process indicates unaligned ways of working between ACE and Veldhoven procurement.

5.2.4. Supplier selection

As a first step in the supplier selection, the suppliers on the short-list were asked to quote for a sample product and a final product. Based on this a cost evaluation was made which included the quotations by the suppliers and the transportation costs and has resulted in the decision to continue with the process since it would result in sufficient savings. According to the procurement people in Veldhoven the business case was made based on total costs. The supply chain engineer in ACE however stated that no business case was made: “Business cases, I am unhappy about that in general within procurement. It is quite poor. It has however been two years ago that there should have been one. It was one of the first things we did: see what quote you can get, if it reaches 10% we do it. [...] There is no formal document within procurement. Everyone does it in his own way, it bothers me.” The PFT chairman stated that a business case had been created but that it was constructed to meet the required savings and that the real decision to transfer the product to Asia had already been taken. From the interviews it became clear that a thorough cost evaluation has been made, only in a later stage since the directions of the company’s management changed. This evaluation however only included direct costs based on the characterizations by Song et al. (2007) and Ellram and Maltz (1995). These are costs that are directly related to a product, as opposed to indirect costs such as supplier selection costs and supplier management costs which are not directly relatable to a product. The studies by Song et al. (2007) and Berggren and Bengtsson (2004) suggest that these costs are very likely to be substantial and lower the effectiveness of global sourcing.

5.2.5. Auditing

The suppliers on the short-list were then audited on their processes, and asked to prepare a work instruction for a product audit. Van Weele (2008) also mentions these two types of audits covering whether a supplier is able to meet the product and process requirements. The audit has assessed the suppliers and the gaps between required performance and actual performance were documented. The framework by Momme and Hvolby (2002) and Van Weele (2008) assumes that a supplier is on the required level. Practice deviates from this assumption since Supplier 1 and Supplier 2 could not yet meet the requirements, and a supplier development plan was set up which in the model takes place in the transfer phase. Conceptually, a gap-closing plan covers developing the product and
process knowledge as well as managerial practices such as logistics and quality management. This corresponds to the three categories distinguished by Ivarsson and Alvstam (2004). The implementation of this plan is, contrary to the assumptions by the framework, largely executed during the audit product audit process instead of after the contracting.

The supplier was then selected based on the process performance, technical performance and his quotation. Supplier selection in the CMS case was different than the literature assumes since only one supplier quoted and no choice between others was required. No other suppliers were available since they were either incapable or not interested. The insufficient amount of business compared to the effort producing for ASML requires closely corresponds to the finding by Ramsay and Wagner (2009) who state that suppliers evaluate the perceived benefits and life-time costs. The costs must in this case have exceeded the benefits leaving only Supplier 1 as a potential supplier. They suggest to balance the perceived benefits and costs and lower the required effort by a supplier as well as to increase the sources of supplier value which they list. The study by Blonska et al. (2008) shows however that it is important to become an interesting customer to a supplier, especially in the context of global sourcing (Steinle & Schiele, 2008) since it fosters the willingness to cooperate. The performance of Supplier 1 in the audits implied more work in the qualification phase. A total cost evaluation including indirect costs and a planning should then have been updated to show a more realistic view of the transfer as Berggren and Bengtsson (2004) suggest, since flatter learning curves will yield lower results. Having selected a supplier who had no previous experience with ASML products and significant deviations from the required performance has resulted in a complex implementation.

The implementation step or transition phase as Momme and Hvolby (2002) refer to it, has as mentioned above largely taken place during the construction of a sample product. The transfer of knowledge in the form of technical documents, samples for reverse engineering, technical assistance and observation was required since the supplier had to build a sample product. It was however first expected according to the planning that only the transfer of the technical documents would be sufficient to start production. This documentation was incomplete. The model by Grant and Gregory (1997) nicely explains this phenomenon. The product was previously sourced at a local supplier and in one of the later stages of the product lifecycle. Knowledge is then accumulated and structured, but also more experiential and tacit knowledge is created. The transferability of this process knowledge is dependent on the degree of embodiedness and contextuality. Tacit knowledge should thus be identified and transferred in other ways than through documentation only, which remains a matter of learning-by-doing. It is however a necessity to foster the transfer of tacit knowledge through the availability of technical documentation. The incompleteness of this was by the interviewees ascribed to the lack of resources for finishing technical documentation. It should be noted that adoption of knowledge and aligning practices requires time and effort from both sides. Finally, after the knowledge and assets were transferred a plan was made to further develop the supplier.

5.2.6. Transfer phase

Despite the emphasis on the transfer of knowledge transfer by Ivarsson and Alvstam (2004) this part of the transfer process has already largely been covered. The problems faced during the transfer of
knowledge have been listed above. This shows that, contrary to the framework by Momme and Hvolby (2002) most of the knowledge and assets are already transferred during the fabrication of a sample product.

5.2.7. Global sourcing factors

The literature review also showed several factors resulting from the global context of outsourcing (Figure 9) which were found back in the data. Birou and Fawcett (1993) have listed challenges and requirements of global sourcing (Table 5). Top management support was found back in the data in the form of pressure by higher management to establish a supply base. This has however also caused that suppliers were selected regardless of what their performance was. Confidence in global sourcing and the suppliers by the director of electrical procurement has however fostered the process and enforced decision making.

The development of communication skills to communicate effectively between different cultures and at great distances showed little problem, but direct communication with the suppliers was a matter of learning how to communicate. This effect was however, just as other cultural and global distance effects lessened by the existence of the IPO who functioned as a mediating office between geographic locations and cultures. Without doubt the existence of ACE has been crucial in the process.

The establishment of long-term relationships showed to be of great importance to align practices and communicate effectively. Many of the iterations in the sample production were due to misunderstandings and getting used to each other’s procedures.

The understanding global opportunities and risks have shown of crucial importance during the process in the form of anticipating on potential pitfalls. It was clear that ASML had little experience in transfer processes and that a lack of insight into requirements of global sourcing caused many delays. The insight in the potential opportunities of global sourcing was however also found back in the establishment of ACE to gain access to the global supply market.

Closely related to this was the knowledge of foreign business practices to know suppliers way-of-working and understand how to cooperate. This knowledge was available at ACE due to their cultural background and experience, but insufficiently shared with Veldhoven who were unaware of the consequences of this knowledge. The absence of expert knowledge or a knowledge base is in line with this finding.

Contrary to the challenge of logistics support for longer supply lines, supply lines actually became shorter since the customers were located near the global supplier and the product could be delivered to a local warehouse directly.

Cultural differences and language differences were, as mentioned above, largely decreased due to the mediating role of ACE. Nationalistic attitudes and behavior however have delayed the project since it resulted in lack of confidence in the supplier and resistance to global sourcing, also referred by one of the interviewees as the ‘Dommel Valley’ syndrome. These attitudes were not present in the minds of the expats at ACE, who were very confident of the capabilities of the suppliers due to their experiences.

Finally, De Bruijn and Jia (1993) refer to localization as a challenge, which has caused additional costs in the transfer and has also led to delays. The product largely consisted of standard components which had to be sourced locally, causing transportation costs and longer lead-times. The localization
of these components thus remains a challenge to take more costs out of the product and fully benefit from the opportunities of global sourcing.

5.3. Ishikawa diagram

Although the analysis above provided more insight in the structure of the problems, an additional method was used to structure the problem. Therefore the causes of the inefficiency and ineffectiveness of the relocation process were grouped in an Ishikawa or fishbone diagram (Ishikawa, 1990) according to their nature to structure the findings and gain more insight in the types of problems. Also Van Aken et al. (2006) refer to the Ishikawa diagram as a method for diagnosing causes and effects. The Ishikawa diagram was in here however used in a different way, since the branches show problem areas instead of the root-causes of the main problem. This analysis resulted in the diagram as shown below in Figure 14 and in a larger version in Appendix 8. Four main problem areas to the problem have been identified and they are described below.

Figure 14: Ishikawa diagram of the CMS transfer

5.3.1. Supplier selection

The supplier selection branch of the tree shows problems related to the selection of a capable supplier. As mentioned no formal pre-selection tool has been used for the reduction to a short-list of suppliers. According to Monczka et al. (2000), Axelsson and Wynstra (2002) and De Boer et al. (2001) supplier selection should be undertaken in a systematic and thorough way.

ASML being a not so interesting customer for suppliers, mainly due to different business types, has led to problems in the selection of a capable supplier. Only one supplier remained, which the project team was more or less forced to choose. The supplier capabilities branch shows problems resulting from insufficient supplier capability leading to more than planned iterations to reach the required
performance. Issues in supplier selection have thus to a large extent caused problems with the efficiency of the process.

5.3.2. Project management

Project management refers to the organization, preparation and planning of the project. Within this branch all problems related to the management of the project are grouped. With respect to planning, a lack of clarity of the complete transfer process and anticipation and identification of required steps specific for this project mainly caused delays.

On the other hand the problems related to the total cost evaluation largely affect the effectiveness of the process in terms of predicted savings. Savings can, according to Song et al. (2007), be substantially lower if all acquisition costs are included.

The organization root-cause shows resource problems as well as no central responsibility causing delays. In the strategic and transition phase different people were responsible for the execution.

Finally, the absence of a phase-in plan for a new supplier may result in additional costs and thus affect the effectiveness of the process. Suppliers may lose their skills due to losing their routines.

5.3.3. Specification

The issues in the project regarding specification were traced back to product, process or localization related. Process related specification problems cover missing procedures and missing process knowledge. These have led to efficiency problems due to an increased number of iterations.

Product related specification problems mainly consist of incomplete or bad technical documentation. Also these have caused the need for more iterations and thereby mainly affect efficiency.

The localization branch contains problems related to the localization of the Approved Vendor List of standard components. The use of these lowers the cost reductions resulting from sourcing globally. If these costs would be eliminated the effectiveness would increase.

5.3.4. Awareness of Asia

The final category refers to the lack of preparation or awareness of the difficulties of sourcing from Asia. Communication difficulties include problems which have made communication with the supplier more difficult. Cultural differences are mainly formed by a mismatch between expectations of the behavior of the supplier and the difference between the Dutch and Taiwanese culture.

A low-cost low-quality perception of Asia has caused resistance and delays for the project. This was mainly due to the lack of confidence in the supplier and insufficient insight in local circumstances.

5.4. Cause and effect diagram

Based on the problems identified in the empirical analysis a cause and effect diagram has been constructed. The diagram in Figure 15 and in a larger version in Appendix 7 shows which problems have led to the delay and additional indirect costs of the project. The colors of the main problem areas shown in the diagram correspond to those of the Ishikawa diagram (Figure 14).

This diagram supports the finding that ineffectiveness and mostly inefficiency are real problems caused by the need for iterations in sample production. Ineffectiveness in turn is caused by additional costs resulting from these iterations and an unclear fit of the new supplier within the supply base.

The main cause for the inefficiency in the project is the existence of iterations to attain the specified levels of supplier performance. These levels in terms of QLTC were specified by ACE at the start of
the qualification process. Four findings are related to the need for iterations and non-complying samples: construction errors, use of wrong tooling, technical communication issues and an over-emphasis on quality. The issues are a result of the interplay between the supplier and ASML. From the ASML side, the quality and completeness of the specifications have resulted in misunderstandings of how the sample should be produced and which requirements it should meet. The effects of newness of the relationship and non-established ways-of-working between buyer and supplier, as indicated in the interviews, also played a significant role. This can be concluded from the fact that the former supplier had no issues with the incomplete specifications and ASML requirements. With respect to the supplier it can be argued based on the audit reports and interviews that the supplier was not fully capable of producing a cable set as required by ASML. This was expected, but since it was the only supplier left and corporate pressure necessitated the establishment of a supply base it was decided to continue. The reason that there was no other supplier left was that of the two selected suppliers, one retreated due to non-matching types of business. This was found out only after the audit had already taken place, since the audit does insufficiently cover the strategic fit between businesses. This is supported by the inclusion of business criteria in the audit to assess this. These criteria however do not match the intended supply base fit and strategic fit of the PFT.

Figure 15: Cause-and-effect diagram of the CMS transfer
The interplay of specification issues and supplier capability thus resulted in low-quality samples. Finally, the over-emphasis on quality can be traced back in the interviews to the perception of Asia as a low-cost low-quality region, contrary to the firm belief in supplier capabilities from the side of ACE.

The ineffectiveness of the project was to a lesser degree a problem and was also evaluated accordingly. There are however two issues with respect to the implicit or explicit goals of the transfer. First, it is not clear whether a supply base has been established for cables in accordance with the requirements by the PFT and the director electrical procurement. These goals have not been made explicit and the fit has insufficiently been covered throughout the searching and selection process. Furthermore, a long-term agreement has been signed with a supplier for which it is not proven whether ASML wants a long-term relationship with it. These issues can be traced back to the alignment between ACE and the PFT in Veldhoven. Expectations and requirements regarding supply base fit were unclear and not explicit. Secondly, although this was not the primary objective of the transfer, additional costs have been incurred lowering the savings from global sourcing opportunities. The before-mentioned iterations have led to the production of more samples and extra supplier management effort. This was underlined by the interviewees mentioning that the extra costs had been paid by Supplier 1. Furthermore, the use of standard qualified ASML components which were not locally available have led to transportation costs, lowering the savings.

### 5.5. Diagnostic story

The cause-and-effect tree (Appendix 7) thus shows several root-causes of the ineffectiveness and inefficiency of the CMS transfer. These reveal first of all that the first part of the transfer under responsibility of the PFT and the second part under responsibility of ACE are insufficiently aligned, thereby causing that the intentions and requirements from the PFT are insufficiently covered. Second, since global sourcing experts with knowledge about the suppliers’ procedures were not involved, problems were insufficiently foreseen. Although a mature product was chosen to anticipate on this, it was not clear enough whether the product met the assumptions of completed specifications. Thirdly, since the audit did not adequately cover strategic alignment the team was confronted in a late stage of the process with one remaining supplier. Fourthly, a group of causes related to familiarity of the global market can be recognized in the low-quality perception. Fifthly, the distance of the global market has led to translation difficulties and issues taking time to be solved.

If we compare these findings to the main branches from the Ishikawa diagram, the same problem areas can be recognized. The cause-and-effect diagram however shows them traced back to their causes showing the alignment of the project, knowledge and familiarity with the global market and the supplier selection as main causes. These problem areas will serve as input for the solution design in the following section which should reduce ineffectiveness and inefficiency in the transfer.
6. Solution design

Following Van Aken et al. (2006) the next step in the regulative cycle is the design of a solution. They propose a general model (Figure 16) for a design process which starts with a problem analysis and furthermore consists of several steps. First, specifications should be developed which the design should comply with. It then continues through sketching to an outline design which is then in a next step further detailed resulting in a final design. This model was used throughout the design process and the steps will be described accordingly below.

![Figure 16: General model for a design process (adopted from Van Aken et al., 2006)](image)

6.1. Specification

The analysis and definition of the problem serves as input for the design and specification of requirements, together with a model of the present business system and ideas for possible solutions. With respect to these requirements Van Aken et al. (2006) distinguish four categories: functional requirements describing the performance of the design, user requirements, boundary conditions which should unconditionally be met, and design restrictions which describe a preferred solution space.

Based on these four categories several specifications have been formulated for this design (Table 9). The right column of the table also shows how these specifications of the design could be verified.

Table 9: Specifications for the solution design

<table>
<thead>
<tr>
<th>Specification</th>
<th>Functional</th>
<th>User requirements</th>
<th>Boundary conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution should reduce inefficiency</td>
<td>Solution should reduce ineffectiveness</td>
<td>The new design should fit within the existing way of working</td>
<td>Solution should fit within the current organizational boundaries</td>
</tr>
<tr>
<td>Solution should reduce ineffectiveness</td>
<td>The solution should solve as many root-causes as possible</td>
<td>The solution should fit within the current organizational structure</td>
<td></td>
</tr>
<tr>
<td>The solution should impact the four main problem areas</td>
<td>The solution should impact the four main problem areas</td>
<td>The use of the solution should be attractive to the stakeholders</td>
<td></td>
</tr>
<tr>
<td>The solution should fit within general transfer processes within ASML</td>
<td>The solution should fit within general transfer processes within ASML</td>
<td>Users should be forced to go through the entire process</td>
<td></td>
</tr>
</tbody>
</table>

The specifications guide the design through providing boundaries and directions for the solution. The rough design which follows from the specifications and causes of the problem is described in the outline design.
6.2. Outline design

The diagnosis and analysis of the project shows that the main causes for delay are related to supplier selection, project alignment, specification issues and insufficient awareness of Asia. In order to improve the business process performance the solution should thus impact these three areas through the design. The areas four areas are displayed below in a simplified way in Figure 17.

![Figure 17: Main causes of ineffectiveness and inefficiency](image)

Several scholars have provided guidelines or requirements for global sourcing and outsourcing projects which have been addressed in the literature review of this study. These have during the sketching process served as input for ideas. These prerequisites of global sourcing and outsourcing are listed below and are followed by a description of how they could be applied to the ASML business problem.

6.2.1. Requirements of the solution design

A first source of ideas has been the success factors for global sourcing as listed in the literature review (Table 5). The development of skills for global sourcing, knowledge of foreign business practices, planning for global sourcing, expert assistance and the establishment of foreign buying offices have been listed as requirements by Birou and Fawcett (1993).

The factors listed by Trent and Monczka (2003) show an overlap, but add the interest of suppliers in global contracts, support of global sourcing in the operations, cross-functional teams for developing global strategies, a centralized procurement structure and direct site visits to suppliers. These factors would argue to use the expertise of the established purchasing office ACE about local suppliers, procedures and risks of global sourcing. The use of cross-functional teams with specialized knowledge about local circumstances, product knowledge and procurement strategies would further support global sourcing. Furthermore, they imply the development of knowledge and lessons from experience. Finally, a company should plan carefully for global sourcing which can be interpret as establish an organization and project plan.

Also the studies by Van Weele (2008) and Momme and Hvolby (2002) provide valuable insights in requirements of global outsourcing. Van Weele lists the formulation of a strategic vision and plan, the selection of the right vendor as important requirement. Momme and Hvolby (2002) add the understanding of processual incentives through the establishment of a framework.

All these requirements and challenges can be used as building blocks of a solution, but will have to be designed and adapted specifically for the situation of ASML. The sections below address these items and show a possible design in the ASML context.
6.2.2. Global sourcing skills and creation of a knowledge base on outsourcing
As more projects are executed ASML gains more and more knowledge of how transfer projects should be undertaken. This relatively new practice requires skills and knowledge of which activities to execute, and how they should be executed. Momme and Hvolby (2002) underline this and suggest the inclusion of functional representatives in the team and creation of a knowledge base provides insight in the risks of global sourcing and its potential pitfalls. Team members can then early identify them and anticipate. Furthermore, a knowledge base on global outsourcing would facilitate the quick and effective absorption of newcomers. A framework would provide better understanding of processual incentives and pitfalls in the transfer. The build-up of knowledge is thus essential and a basis to build on should be part of the solution.
In order to keep this knowledge up to date and exhaustive the project should end with an evaluation of the process to create a base of knowledge about past projects. Questions to address may be whether the goals in the project have been met, or why not?

6.2.3. Knowledge of foreign business practices
The possession of knowledge of foreign business practices both in terms of types of business as well as technical procedures has show indispensible in the CMS case. The local experts at ACE are the obvious people to posses this knowledge as they have shown. The experience of ACE about the local conditions and markets has to be included in the project team at an early stage. This will ensure that pitfalls in both matching of businesses and operational practices are early identified. Furthermore, they should make sure to share their knowledge and experiences in the team to create awareness of risks and opportunities and take away the resistance towards Asian suppliers.

6.2.1. Understanding of processual incentives
In line with the requirements above is the understanding of processual incentives, as addressed by Momme and Hvolby (2002) in their framework. Where the framework only addresses rough activities, a further operationalization should be made to plan the entire transfer project. A standard work breakdown structure can ensure that there is a basic insight in which steps should be taken, what is required and how long the process will take. Since the content and necessity of some steps depends on decisions taken during the process, the further detailing of these steps can be done during execution of the process once new information comes available. Communication of this work breakdown structure among all team members will ensure that expectations are aligned.

6.2.2. Establish foreign buying offices
Birou and Fawcett (1993) also mention the establishment of foreign buying offices as a requirement for global sourcing. This without doubt a necessity, as the case has shown. The already established foreign buying office has shown to play an important mediating role between cultures, global distances and in communication. It should however be investigated during the project whether the right tools and knowledge for the transfer process are available to meet the expectations of the PFT, since the office is still developing. The CMS case has shown that a lot of technical knowledge still resided in Veldhoven and had to be transferred to ACE. As the other cases have shown, ACE is increasingly able to execute activities independently.
6.2.3. Interest of suppliers in global contracts

The business volume only has shown insufficient incentive for many foreign suppliers. Other sources of value should be considered as well to be an interesting customer and have sufficient choice the selection of a supplier. The paper by Ramsay and Wagner (2009) about the evaluations suppliers make between perceived benefits and costs is in this a good starting point for a strategy. The attention in this respect should not only be on creating benefits, but also considering how to minimize the effort required from a supplier to meet requirements. The PFT should consider how they can be an interesting customer before supplier selection so that the number of suppliers on the short-list is increased.

6.2.4. Support global sourcing in operations

The transfer of production to a new supplier implies that the former supplier will lose (a part of) its business. This will also result in changes in logistics and for the purchasing organization since they will have to deal with a new supplier. Logistics should make sure that they have planned for this change and those logistical measures such as warehouses have been taken. The cutting down on supply from the former supplier and the build-up of supply for the new supplier, as referred to in the cases, should receive special attention since its absence could result substantial financial and quality issues at the new supplier.

6.2.5. Cross-functional teams for global strategies

Various disciplines possess different kinds of knowledge regarding global sourcing, which are all required during the process. A cross-functional team should be established in which it is clear to all members what is expected of them and in which stage. With respect to the cross-functionality of the global outsourcing process Momme and Hvolby (2002) present ten disciplines that may be involved. They are displayed in Table 10 below, showing the responsibility and which organizational unit at ASML could be assigned this responsibility based on their current activities.

Table 10: Responsibilities in a global outsourcing project

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Organizational unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy</td>
<td></td>
</tr>
<tr>
<td>Developing new supply markets</td>
<td>PFT</td>
</tr>
<tr>
<td>Strategic planning</td>
<td>PFT</td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
</tr>
<tr>
<td>Documentation of the design</td>
<td>VHN D&amp;E</td>
</tr>
<tr>
<td>Product development</td>
<td>VHN D&amp;E</td>
</tr>
<tr>
<td>Technical specifications</td>
<td>VHN D&amp;E, VHN SCE</td>
</tr>
<tr>
<td>Project management</td>
<td></td>
</tr>
<tr>
<td>Project execution</td>
<td>PFT representative</td>
</tr>
<tr>
<td>Project operations planning</td>
<td>PFT representative</td>
</tr>
<tr>
<td>Project management</td>
<td>PFT representative</td>
</tr>
<tr>
<td>Quality</td>
<td></td>
</tr>
<tr>
<td>Quality assurance</td>
<td>ACE SCE &amp; ACE D&amp;E</td>
</tr>
<tr>
<td>Corrective and preventive actions</td>
<td>ACE SCE &amp; ACE D&amp;E</td>
</tr>
<tr>
<td>Auditing</td>
<td>ACE SCE &amp; ACE PR</td>
</tr>
<tr>
<td>Resources</td>
<td></td>
</tr>
<tr>
<td>Training of ACE employees</td>
<td>VHN SCE &amp; VHN D&amp;E</td>
</tr>
<tr>
<td>Team set-up/securing resources</td>
<td>PFT chairman</td>
</tr>
<tr>
<td>Contract negotiation</td>
<td>ACE PR</td>
</tr>
<tr>
<td>Request for quotation</td>
<td>ACE PR</td>
</tr>
<tr>
<td>Supplier benchmarking</td>
<td>ACE PR</td>
</tr>
<tr>
<td>Managing logistics</td>
<td>Logistics</td>
</tr>
<tr>
<td>Secure confidentiality</td>
<td>ACE PR</td>
</tr>
<tr>
<td>Supplier approval</td>
<td>Project team</td>
</tr>
</tbody>
</table>

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They list strategic planning and development of new (supply) markets and the examination of the effects of outsourcing as responsibilities which are currently fulfilled by the PFT.

6.2.6. Centralized procurement structure
A centralized procurement team is by Trent and Monczka (2003) suggested found to be a requirement for global sourcing. A cross-functional commodity team should according to them take strategic decisions regarding what to source globally and what not based on the requirements of the commodities. This role is at ASML fulfilled by the PFT who are also the obvious team to have the responsibility to establish a project team which will execute the transfer. The centralized unit should consist of a director of procurement and the product family team to ensure that strategic decisions are included in the transfer process.

6.2.1. Strategic vision and plan
Closely related to the above structure is the establishment of a strategic vision and plan. These should guide the sourcing decisions and be tailored to global opportunities. The PFT and the department director of procurement should formulate a plan which strategic goals they want to attain through global sourcing. During the transfer process it is important to assess these goals as to whether they can still be attained. Decision moments during the transfer can be used to reflect on the feasibility of attaining these objectives and the necessity of a transfer. In this respect the definition of global sourcing by Quintens et al. (2006) touches the essence of these decisions. This can be interpreted as that global sourcing should not be an end in itself, but a means to attain worldwide competitiveness. If the worldwide competitive suppliers are local suppliers, these should be selected in favor of global suppliers.
Furthermore, the PFT should make sure that they explicitly specify their needs from a supplier, not only in performance, but also strategically. This should ensure that strategic considerations by the PFT regarding the supply base are also included in supplier searching and selection.

6.2.1. Selecting the right vendor
The selection of the right vendor is by both Van Weele (2008) and Monczka et al. (2000) emphasized as crucial. The transfer requires substantial investments and, as Berggren and Bengtsson (2004) state will have consequences on the learning curve and the associated supplier development costs. Criteria to which a vendor should comply should be listed in advance of the searching process and include the QLTC requirements as well as the strategic requirements regarding supply base fit. In this respect it is important to consider the strategic plan. If no global supplier is available who is able to meet these criteria within a reasonable amount of time, sourcing from foreign suppliers may not be the best option.

6.2.2. Direct site visits to suppliers
Since supplier selection is one of the most important elements in the project this step has to be executed thoroughly. Direct site visits are essential and should be undertaken by team members from both Veldhoven and ACE and from the disciplines supply chain engineering and procurement to ensure that a supplier is selected who complies with all requirements and meets the expectations and has the confidence of all team members.
6.2.3. Identification of tacit knowledge

Despite that no attention is given to the diffusion of knowledge to suppliers by the researchers of success factors, the consideration of knowledge transfer is justified by the study by Ivarsson and Alvstam (2004). Although the transfer of tacit knowledge remains a matter of learning-by-doing (Grant & Gregory, 1997), Appendix 9 lists several means which can foster the diffusion of tacit process knowledge. During the planning of the process it is important to realize in an established buyer-supplier relation a lot of tacit knowledge is developed. This knowledge is hard to document and transfer, however through technical assistance of experts, reverse engineering and observation the transfer of knowledge is facilitated. Furthermore, not all undocumented knowledge is tacit, and should be made explicit before establishing a relation with a supplier. A good means to attain this is first transferring the knowledge to engineers at ACE forcing them check the completeness of documentation. They then can also provide local assistance to the supplier.

The success factors above indicate that successful transfer projects should be well prepared through identification of and anticipation on risks and an organization which is tailored to support the project. The first is fostered by knowledge of global sourcing risks originating from the geographical dispersed character, the products and organizational factors such as preparation of requirements.

In the next section a design will be proposed which combines these elements into a transfer preparation and success assessment tool. As the outline shows the emphasis of the solution is on the management of the project and thorough preparation based on global sourcing knowledge. In the design section these directions will be further elaborated.
6.3. Three phase transfer cycle

The objective of the final design is to impact the main causes of ineffectiveness and inefficiency as shown in Figure 17. Knowledge of global sourcing practices and identification of processual incentives were by several scholars listed as important prerequisites for successful global outsourcing.

In order to help ASML prepare their transfer projects better before execution, help them identify risks in the process and assess the feasibility of the transfer goals a ‘Transfer preparation and success assessment tool’ was developed. This solution entails three phases: preparation, execution and evaluation (Figure 18). Since the preparation involves the most important activities to secure effectiveness and efficiency throughout the transfer the emphasis will be on this step. The execution, which involves carrying out the plan and evaluation, which entails the assimilation of learnings for future transfers, will only briefly be addressed.

The preparation of the transfer is thus the first step in the process and requires an input to be processed. The most important input is a commodity group which is suited for a transfer to Asia and should be selected by the sourcing committee. For this purpose they can make use of the product characteristics table (Table 12) which is presented further on in this chapter. This table can, although not designed for this purpose, help then assess the suitability of a commodity group.

Triggers such as total cost reductions, changes in the supply base or positioning of a commodity in the portfolio of a supplier of a commodity group can be incentives for this assessment. The strategic document formulated by the associated SPFT with the directives for the sourcing strategy of a commodity group serves as second source of input for the cycle. This document should contain measurable and specific criteria to which suppliers of the commodity should comply. The QLTC requirements are already formal in this respect; however strategic supply base considerations and strategic objectives of the transfer are not. The availability of such criteria is essential so that they can be incorporated in the subsequent project. During the preparation these directives will be translated into operational activities, which make the preparation a more or less tactical step between strategic and operational. The tool consists of six sequential steps (Appendix 10) which address the actions to be taken, and results to be attained. After each step a formal sign-off by the project manager is required to continue to the next step. The stepwise preparation process is illustrated in the following sections.

Since the project entails a risk of failure and the stability of the supply chain should not be put at risk, dual sourcing is preferred during execution.

![Figure 18: Three phase transfer cycle](image-url)
6.3.1. Step 1: Compose a cross-functional transfer team

As a first step in the strategic phase a team should be formed that is capable of executing a transfer project. This cross-functional team should, as listed in the previous section consist of team members from the relevant disciplines involved in the transfer. Table 11 below shows the composition of the cross-functional commodity team for ASML and their responsibilities. Representatives from both the offices in Veldhoven and Taiwan are required in the team. The formal responsibility for the team and the execution of the preparation is carried by the PFT representative. Furthermore, the SPRC department at Veldhoven should supply a team-member who will be involved throughout the different transfer projects to enhance knowledge sharing between different procurement departments. As a final activity the required human resource demand should be discussed with the superiors of the team-members.

This step results in a team which is capable to identify potential risks in the process and anticipate on these, and operationally capable of executing the transfer. Furthermore, a commitment is needed from the managers to ensure that the required resources are available when needed.

Table 11: Composition of the cross-functional commodity team

<table>
<thead>
<tr>
<th>Team member</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFT representative</td>
<td>Secure strategic direction; Chairman; Execution of transfer plan; Monitoring and control; Supplier selection; Strategic alignment requirements</td>
</tr>
<tr>
<td>VHN Supply chain engineering</td>
<td>Product and process knowledge; Quality &amp; Technical requirements</td>
</tr>
<tr>
<td>VHN Development and Engineering</td>
<td>Product knowledge; Availability of technical documentation</td>
</tr>
<tr>
<td>VHN Materials Ordering</td>
<td>Logistics measurements; Phase-in plan; Logistics requirements</td>
</tr>
<tr>
<td>VHN Procurement Account Manager</td>
<td>Current supply base; competitiveness local supplier; Quotation; Costs requirements</td>
</tr>
<tr>
<td>ACE Procurement</td>
<td>Knowledge of global market characteristics; Sharing knowledge of risks and insights; Supplier searching; Quotation; Supplier selection; Auditing; Contracting</td>
</tr>
<tr>
<td>ACE Supply chain engineering</td>
<td>Knowledge of global technical practices; Sharing knowledge of risks and insights; Supplier selection; Auditing; Qualification</td>
</tr>
<tr>
<td>VHN SPRC Global sourcing expert</td>
<td>Assistance in the project, Sharing knowledge of risks and insights, Securing evaluation and updating of process.</td>
</tr>
</tbody>
</table>

6.3.2. Step 2: Select product

Using the SPFT directives and commodity strategy as a starting point the cross-functional team should identify a product within the commodity group to be global sourced and suited for transfer to Asia. To help the team assess the appropriateness of Asia sourcing and the implications for the transfer resulting from the product characteristics Table 12 was developed. The product should be evaluated by these characteristics to evaluate the risks.
6.3.3. Step 3: Formulate the objectives of the transfer

The goals for the transfer have to be formally determined in a next step of the project. The directives from the SPFT regarding supply base development and QLTC objectives should again serve as input for this to ensure that strategic goals are attained. However, it is important to make these goals measurable so that they can continuously be evaluated on their feasibility throughout the process. Furthermore, making project goals explicit helps the alignment of team-members in different disciplines and departments.

The goals can be based on those found in the literature (Table 4):

- Supply base development
- Technology access
- Competitive positioning in supply base
- Worldwide competitiveness
- Total Acquisition Cost reductions
- Quality improvement
- Capacity problems
- Shorten lead-time

Cost reductions should be assessed using a cost evaluation based on Total Acquisition Costs as referred to by Song et al. (2007) and include both direct cost savings, indirect costs, eliminated costs, and competitive reactions from the supply base. For an overview of total acquisition costs I refer to Appendix 2.
Table 12: Product identification and transfer risk assessment

<table>
<thead>
<tr>
<th>Product characteristic</th>
<th>Purpose</th>
<th>Risk</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>High labor content</td>
<td>Lower labor rates result in higher savings when labor content is high.</td>
<td>Products with high-labor content generally have higher savings. If savings on labor are low, total cost savings are less likely to be attained.</td>
<td>Consider Total Acquisition costs for total savings resulting from transfer, assess likelihood of savings.</td>
</tr>
<tr>
<td>Transportation costs</td>
<td>If these can be eliminated savings are more likely.</td>
<td>Products with transportation that can be eliminated generally have higher savings. If these cannot be prevented, total cost savings are less likely to be attained.</td>
<td>Consider Total Acquisition costs for total savings resulting from transfer, assess likelihood of savings.</td>
</tr>
<tr>
<td>Supplier capability</td>
<td>Sufficient capable suppliers should be available.</td>
<td>If insufficient capable suppliers are available you may end up with a less capable supplier. This requires extra time and investments as well as assistance.</td>
<td>Reconsider the appropriateness of the transfer. Assess the Total Acquisition Costs including additional resources for technical assistance and extra iterations.</td>
</tr>
<tr>
<td>Supplier value of the business</td>
<td>Maximize the availability of suppliers through attractive business.</td>
<td>The availability of interested suppliers may be limited. In that case there is little room to select a capable supplier. Insufficient supplier capability is likely to lead to project delays due to extra iterations.</td>
<td>Optimize supplier value through maximizing perceived benefits and minimizing perceived costs from supplier’s perspective. For an overview of sources of supplier value see Ramsay and Wagner (2009).</td>
</tr>
<tr>
<td>Transferability of technical product documentation</td>
<td>Prevent misunderstandings between buyer and supplier.</td>
<td>When technical documentation cannot be transferred complete, misunderstandings, project delay and additional costs will result. TPD is maintained by supplier. Supplier should be willing to transfer TPD, else ASML should take actions.</td>
<td>Secure resources for TPD check and subsequent update. Extra technical assistance may be required to tackle problems. Secure product knowledge and resources at ACE.</td>
</tr>
<tr>
<td>Product maturity</td>
<td>Mature products have more structured knowledge, but also have accumulated more tacit knowledge.</td>
<td>Former supplier may have accumulated tacit process knowledge. Transferring this requires time and technical assistance so that costs and time may increase.</td>
<td>Secure the availability of sources to transfer tacit knowledge: Technical documentation, samples for reverse engineering, frequent technical assistance, allow for practice time.</td>
</tr>
<tr>
<td>Product knowledge at ACE</td>
<td>Higher potential for local technical assistance</td>
<td>When little product and process knowledge is available at ACE, technical assistance and qualification cannot</td>
<td>Local technical assistance is quite essential. SCE should take actions to train ACE people to assist during the</td>
</tr>
<tr>
<td>Knowledge specificity</td>
<td>A higher amount of product and process specific knowledge is harder to transfer.</td>
<td>If more specific knowledge has to be transferred, the process is likely to take longer. Furthermore, more tacit knowledge may have accumulated and should be transferred. The supplier may require more time to adopt knowledge.</td>
<td>Document knowledge if possible. Not all undocumented knowledge is tacit. More technical assistance required, secure resources and capabilities. Savings are likely to be lower due to longer transfer. Consider the Total Acquisition Costs.</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Asset specificity</td>
<td>High asset specificity requires more investments in specific tooling</td>
<td>If higher investments in specific tooling are required, savings will be lower. Consider the Total Acquisition Costs. Specific tooling may cause lead-time if ordered globally.</td>
<td>Consider whether specific tooling is required or standard tooling can be used as well. Smoothen supply chain for tooling to minimize lead-time.</td>
</tr>
<tr>
<td>Supply base effects</td>
<td>Transferring to a new supplier may cause competitive reactions by suppliers, both positive and negative.</td>
<td>Current supplier’s loyalty may decrease. Price reactions with respect to other products may occur.</td>
<td>Evaluate whether these effects are desirable. Is a transfer desired then? Formulate a strategy to maintain a good relation with former supplier. Discuss future business with the supplier.</td>
</tr>
<tr>
<td>Supply base competition</td>
<td>Adding suppliers to the supply base may involve competitive price reactions by suppliers.</td>
<td>Although overall total cost reduction may be higher, prices may rise if the volume is split.</td>
<td>Savings may be lower. Consider the Total Acquisition Costs to evaluate all costs.</td>
</tr>
</tbody>
</table>
6.3.1. Step 4: Assess the feasibility of the objectives
This step should involve an assessment of how to attain the goals and their feasibility. This preliminary assessment forms the basis for reflection on the objectives during the transfer process. The measures that have been determined in the previous step should be used as a basis for the assessment. A lot of information may not be available yet, however it is important to strive for a good assessment to become aware of project risks and preventive measures. Furthermore, based on these objectives it should be determined when the project will not attain its objectives and should be terminated. This will prevent continuation of a project when its initial objectives are not feasible any more.

6.3.2. Step 5: Establish a plan of required activities
Being aware of potential pitfalls, a work breakdown structure should be constructed in a project management software tool, consisting of all the activities and as detailed as possible. The high-level WBS in Appendix 11 can serve as a basis for this. Especially the SCE department at ACE uses a more detailed WBS which can be used to complete the preliminary plan. Several important aspects per activity should be listed:
- Responsibilities per activity
- Finishing date of the activity
- Duration
- Directly preceding activities that should be finished
- Direct successors
- Amount of human resources required
- Go/No-go milestones

Based on this information resources can be discussed with the management to obtain a commitment. Furthermore, the costs and duration of the project can now accurately be estimated. Critical activities can be identified and should be monitored closely during execution to prevent delays.
Finally, the project team should agree on the activities. This is an important requirement to align expectations and to ensure that everyone is aware what is expected of them at which point in the project.

6.3.3. Step 6: Update the total acquisition costs evaluation based on activities
Since more insight is available into the specific duration of the project and the resources that have been allocated, the indirect costs associated with the transfer can be estimated. This allows the project team to evaluate the benefits and costs of the transfer and assess the profitability in terms of total cost. The total acquisition costs evaluation should thus be updated and the pre-defined goals should be checked for their feasibility.

Based on the previous activities and feasibility assessment the team should be aware of the likelihood of success of the project and which parts require special attention. The output of the six-step process is thus a qualitative assessment of the likelihood of success. Once the team is convinced that the goals can be attained, the project can continue to the execution phase.


6.3.4. Execution of the plan
At this point in the project it is clear that by execution of the plan the goals can be obtained. Despite the attempt to plan the transfer in detail, unexpected issues may show up. Therefore it is important to constantly monitor and update the plan during execution as new information comes available. Furthermore, the feasibility of the goals may change as new information is incorporated in the total acquisition costs evaluation. The project manager should be aware of this and use the pre-defined milestones in the project to assess this, and if the project cannot attain the objectives within the set margins decide to terminate it.

6.3.5. Evaluation and update
After finishing the project its course should be evaluated. This step is likely to be forgotten since it has no direct need, however to establish a knowledge base of global sourcing it is important to include the learnings in the product evaluation and the work-breakdown structure. For this purpose the team has a global sourcing expert who should make sure new information is assimilated and shared throughout the procurement departments.

Questions that should be asked during evaluation are:

- Have the pre-defined goals been met?
- Has the schedule been met?
- What have we learned?
- How should we change the plan for next time?

6.4. Change plan
Organizational change is according to Van Aken et al. (2006) a complex process of which the outcomes may be uncertain. They also state that the process is however not unmanageable and that a change plan can steer the process. Such a change plan consists of several elements which will be addressed below. It should be noted that the change entails the implementation of process steps which were to some extent done already in the existing business process. Departments and the functions of people will not be affected and for those reasons the implementation is considered a small change.

The first element is “a specification of the business system and its intended performance, the objectives of the change process, plus a delta-analysis” (Van Aken et al., 2006). The designed business system is a preparation phase accompanied with several tools which help the transfer project team select a product, assess the associated risks, evaluate the feasibility of the objectives of the transfer, initiate preventive actions and assess the likelihood of attaining the transfer goals. The objective of this design is to increase the effectiveness (i.e. the attainment of predefined objectives such as supply base development and total cost reductions) and the efficiency (i.e. the extent to which the transfer is executed as planned) of the transfer project.

A delta analysis, according to Van Aken et al. (2006), entails an analysis of the differences between the current situation and the redesigned situation. Several major differences between these states should occur by implementation of the solution. First, the solution provides a basis for control in terms of achievement of objectives and time schedule. In the current situation the process was controlled during the “select and qualify” process, but control of the attainment of initial strategic goals and schedule lacked. Second, a continuous focus on the transfer objectives and their feasibility should ensure that the process is terminated if goals cannot be attained anymore. In the current
situation goals were defined, but the project was not assessed during its execution on whether these
goals could still be attained, and whether the project was beneficial to the company. Thirdly, the
solution requires measurable and predefined strategic objectives by the SPFT which should be
attained by execution of the transfer. Although a strategic document with these objectives was
available, the objectives regarding supply base fit and requirements other than the QLTC
requirements were not taken to the supplier searching phase. The solution thus requires these goals
to be made explicit for a product category, so that the project team can assess the feasibility
throughout the process. Fourthly, in order to improve the assessment of feasibility of products for
transfer and identify processual incentives to improve the transfer project a global sourcing expert
who is responsible for sharing knowledge across the procurement departments and continuous
improvement of the proposed solution should be appointed. In the existing business process
knowledge was insufficiently shared throughout the organization, although it was essential for a
smoothly evolving process. The proposed solution provides for this by assigning this global sourcing
expert. Fifthly, the design suggests the composition of a formal cross-functional project team with
clear responsibilities. The current business process was executed by ad-hoc assigned team members
who were no formal team. Responsibilities were clear, but not every team member was involved
throughout the process and as a result of that unaware of decisions and considerations made in an
earlier stage. A formal team ensures that all relevant disciplines can share their knowledge of project
risks and are aware of what is expected of them at which stage.

The second and third element of the change plan is the specification people and their actions.
For the implementation of the plan the existing SPRC department of ASML, which is responsible for
the implementation and execution of new processes within the procurement department, is best
suited. They are by Van Aken et al.’s (2006) classification considered the change organization. In
consultation with the procurement directors they should first assure that the required input for the
design is delivered by the SPFT. It is likely that this step will result in resistance from the SPFT
members and procurement directors. It requires extra work for them and they may not see the need
to change the existing business process. They have to be convinced of the use of the design by
explaining them the analysis in this research.

Second, the solution itself has to be implemented. This requires the commitment from the different
departments involved in the project team and higher management. The managers of those
departments have to be convinced of the need of their involvement. Showing them the necessity of
their knowledge and the effect of the solution is likely to help take away the resistance. In fact, their
expertise was already required but this has now been given a formal and structured form.

Thirdly, the team members themselves have to be convinced of this structured way of working. Especially the team members who were also involved in the cases that were analyzed may resist to
this implementation. They may not perceive the problem in this research as a problem, since it was
evaluated in different ways by them. Furthermore, it was not shown in this research that any of them
underperformed in the execution of their task; it is merely the alignment of activities that caused the
problems. Also here the analysis in this research can be helpful in showing the activities in their
broader perspective and convince them of the need of the solution.

Thirdly, a very important action is to train the project manager to manage his team. A structure for
this management has already been defined in the solution; however it requires skills like knowledge
sharing and commitment to the transfer project to successfully execute the project. The project manager should thus be trained to motivate the team to follow the proposed preparation steps and communicate their opinions of the transfer risks frequently. Furthermore the solution implies that more monitoring, updating and managerial work is under his responsibility. It is therefore important that he has the possibility to delegate especially the maintenance of project documents to team members. His functional manager should ensure that sufficient time is available for him to perform these tasks.

Fourthly, the global sourcing expert should be assigned the responsibility to evaluate and improve the tool. Since this person is a member of the SPRC department the development and maintenance of business processes and reporting of project learnings is already his responsibility. Despite the additional work this will cause, the resistance is likely to be lessened by the key-role this person will play in all transfer projects and the substantial contribution his effort can bring to transfer success.

The elements of the change plan as described above should ensure a successful implementation of the proposed solution design.

In summary, based on the four problem areas identified in the analysis building blocks for an outline design were searched. Several researchers have made contributions regarding outsourcing, global sourcing and its challenges, and technical knowledge transfer. These were combined in a three-phase transfer cycle consisting of a preparation phase, an execution and evaluation. The emphasis has been on this first phase which consists of six steps to establish a project team, identify a product and assess its risks in the transfer and initiate actions and assess the feasibility of transfer objectives based on these. Using the strategic input from the PFT in the form of measurable strategic objectives and a commodity group, the project team develops a qualitative assessment of the success of the transfer. During the execution phase the emphasis should be on control of the initial plan, and adapting it as more information comes available. Furthermore, the predefined objectives should be checked frequently. An evaluation phase, led by the global sourcing expert should improve the tool and incorporate new knowledge of risks into the existing solution to improve future projects.

The implementation of this solution is best conducted by the SPRC department at ASML which is currently in charge of procurement processes. The implementation is considered a minor organizational change, since no functions will change apart from the appointment of a global sourcing expert. It is though likely that team members and managers have to be convinced of the need of this solution, since they perceive the transfer process from a different functional perspective. An emphasis on the importance of their knowledge and the analysis in this report may help to convince them and have their commitment for the transfer.
7. Conclusion and discussion

This research has shown, in line with what was indicated by Trent and Monczka (2003) that global sourcing is a complex practice and that it is difficult for a company to benefit from the strategy. Starting from this observation a single case study research was initiated at ASML to study the exact reasons for this difficulty. The literature review showed that outsourcing in a global context can be separated in three phases: a strategic phase, a transition phase and an operational phase. Difficulties can originate from all the three phases; however the perspective of a strategic transfer decision and its subsequent execution has been taken. This implies that problems in the operational phase in which a relationship is maintained have been left out of the scope of this research.

This chapter will subsequently address the findings of this study and its implications for theory. Furthermore several recommendations and its limitations will be discussed.

7.1. Findings of the study

The Custom Made Cable set that was transferred by ASML has been the main unit of analysis. The transfer project showed inefficient and to a lesser degree ineffective. The causes of both these business performance problems were examined using interviews and archival data in order to answer the main research question: “How can the efficiency and effectiveness of the relocation process for development activities and production processes for components from European to Asian suppliers be improved?”

To guide the research and to secure the internal validity of the research a framework (Figure 8) based on the initial framework for outsourcing by Momme and Hvölby (2002) (Figure 2) and a model (Figure 9) were developed. A literature review focusing on global outsourcing was conducted to detail the steps in the framework by recent insights and thereby focus the analysis. The resulting framework can be seen as a further operationalization of the initial framework by Momme and Hvölby (2002). The model shows how this transfer process is influenced by factors resulting from global sourcing as listed by several scholars (e.g. Birou & Fawcett, 1993).

The first sub research question addressed the drivers behind the transfer project. The relocation project at ASML was initiated for a number of strategic reasons. Securing worldwide competitiveness, as a result of pressure from customers and competitors through the establishment of an Asian supply base, has been the main driver for global sourcing. Furthermore, sources of competitive advantage have led to the transfer through lower product costs and elimination of transportation costs and shorter lead-times. The product was selected since it was mature and fully developed and had a high proportion of labor and transportation costs. A reflection on the drivers of global sourcing found in previous research by Monczka and Trent (1992), Quintens et al. (2006) and Bozarth et al. (1998) and those in this research shows a large overlap. Cost and lead-time advantages to attain competitiveness were also listed by them. However, quality improvement, access to technology, flexibility and local content requirements were not found as drivers. A likely reason for that lies in the quality of the local supply base. The suppliers of ASML have developed along with the requirements of ASML through the years and match these perfectly. With respect to quality and technology the Asian suppliers currently often do not outperform the local suppliers. The comparative advantage as a result of lower labor rates and smaller distances to ASML’s current...
customer base are the areas in which the Asian suppliers distinguish themselves. The reasons for transferring a product are thus dependent both on the external forces on a company and the characteristics of its existing supply base.

With respect to the course followed by the transfer project, which was the focus of the second sub research question, more or less the same steps were followed as the developed framework (Figure 8) assumes. An identification phase to select a product was initiated by the electrical procurement director. This phase consisted of strategic supply base considerations and an evaluation of which product could successfully be transferred with their current knowledge of risks. The phase was then followed by a supplier searching and selection, which were by Van Weele (2008) in the framework by Momme and Hvolby (2002) classified as strategic activities. Regarding the selection of a product and supplier searching the theory shows a difference with the businesses practice in this case. McIvor (2003) for instance states that the selection of an activity or product to outsource is dependent on the availability of suppliers. In relation to the sequentiality of the steps of the framework this leads to a problem. The product is first identified and specified, after which a supplier is searched. At the time of the selection there is thus no information about the availability of suppliers. One of the options left for a business is thus to secure the attractiveness of their business and then start searching and evaluate during the supplier selection whether it is still attractive to switch suppliers.

During the supplier searching and selection process the strategic considerations from the first phase were insufficiently translated to criteria for these activities. The supplier searching and selection mainly involved tactical and operational activities, and should thus be classified accordingly. In the subsequent transition phase the supplier qualification and transfer of knowledge took place. The framework (Figure 8) assumes that only after contracting of a supplier, knowledge is transferred. However, also during the product and process audit and construction of a sample product knowledge is transferred. Furthermore, analysis of the business practice has shown that, in line with the distinction by Spekman (1988), two types of supplier selection take place and that auditing is conducted in between. The first type of selection is pre-selection based on RFQ information, whereas the second involves the final selection of a supplier based on the audit results. The framework should thus be adapted accordingly.

Several problems have led to ineffectiveness and inefficiency, which is addressed by the third sub research question. As the cause-and-effect diagram (Figure 15) clearly shows, a number of additional iterations to attain the required supplier performance have delayed the project substantially, causing ineffectiveness. The analysis of these issues by means of an Ishikawa diagram (Appendix 8) shows that these inefficiency problems can be traced back to three areas: a lack of awareness of Asian supply market conditions and practices, issues in supplier selection practices and issues in the availability of specifications. These problems have impacted the transfer project on different places as will be explained next.

First, the awareness of the Asian supply market conditions helps the company to see global sourcing opportunities. Supply market conditions entail the performance of suppliers, the types of business and its characteristics that can be sourced as well as the (manufacturing) practices by which they operate their businesses. Knowledge of these also enables a company to estimate the risks of global sourcing, select a product that minimizes those risks and finally to initiate actions to mitigate risks. In
this respect I refer to the study by Mantel et al. (2006) who address the selection of a product by assessing the strategic risks for a company. This problem area thus mainly impacts the identification in the strategic phase in the framework. The resulting selection of a product has its implications for the complexity and effectiveness of the remaining project.

Secondly, the selection of a supplier impacts the effectiveness of the transfer through supplier capability. The supplier selection issues show that the availability of a supplier as a result of perceived benefits and costs of the business has led to a supplier which had no experienced with respect to ASML products and requirements. The selection of a supplier and the associated supplier capabilities thus also affect the further complexity and course of the project. In this case it led to additional iterations further on in the transfer to develop the supplier.

Thirdly, the availability of specifications has impacted the project in the transition phase. Specifications are as argued by several researchers (Grant & Gregory, 1997; Ivarsson & Alvstam, 2003; Karandikar & Nidamarthi, 2006) means to transfer explicit product and process knowledge. In the CMS case this knowledge was not documented since there was an established relationship with the former supplier. This made it harder to transfer the accumulated product and process knowledge which is characteristic for mature products (Grant & Gregory, 1997) and necessitated additional iterations to transfer the knowledge.

If a transfer process is conceptually considered to be a transfer of the production of a certain product to a certain supplier by means of technical product and process knowledge, it becomes clear how the interplay between these sources of risk can cause problems. From a scientific point of view it would thus be interesting to further research these perspectives and to combine these into a comprehensive framework by which transfer processes can be assessed.

With respect to the effectiveness of the transfer project the goal of the project has been to transfer to a new supplier which fits the supply base and is able to contribute to worldwide competitiveness. Although the transfer has been completed the additional indirect costs resulting from the iterations make it unclear whether a total cost reduction has been attained. Furthermore an unclear supply base is the other cause of ineffectiveness, which is the result of supply base requirements that have not been passed through to the supplier selection phase.

The issues from these four problem areas thus manifest themselves in the transition phase, but are mainly caused by decisions made earlier in the strategic phase of the project. The reasons why ASML was not able to benefit optimally from global sourcing thus originate from the lack of focus on project goals by team members throughout the project phases, and in the transfer costs and delay which are the result of product and supplier selection and difficult transfer of product and process knowledge.

The solution to benefitting optimally from global sourcing therefore lays not so much in the improvement of the transfer phase activities such as knowledge transfer, rather in good preparation of the project and anticipation on risks. If we look at the activities that are initiated in the projects this may be no surprise. ASML strategically considers what they want to do and then initiates the project which mainly consists of operational steps. The preparation proposed in the solution can be seen as a tactical step that is missing in between and should involve the formulation of how to obtain the strategic goals through operational actions. This corresponds with the need for global outsourcing knowledge referred to by Momme and Hvolby (2002), who have developed their framework for this purpose. This framework however only addresses the steps that should be taken
to outsource in an operational way. This study thus shows that also tactical considerations which are required to align the strategic considerations and operational activities should be given a place. It further implies that the separation in three phases of the framework by Momme and Hvolby (2002) by Van Weele (2008) should be reviewed and that the identification or “competence analysis” is a strategic action after which the tactical preparation should follow. The transition phase is then more operationally oriented. These changes imply that the “operational phase” has a rather deluding name from a transfer point of view.

The proposed solution design which is addressed by the fourth sub research question fulfills the need for a tactical phase by proposing a three step process consisting of a preparation, an execution and an evaluation phase. The preparation consists of several steps which force the project team to focus on the goals of the transfer and their feasibility and to identify risks and initiate preventive actions to increase both effectiveness and efficiency.

During the research the complexity of the transfer processes and management of foreign suppliers often led to the question whether they should execute transfers themselves. The current supplier often has no interest in cooperating with the transfer since he will lose business. He is however the party that holds the product and process knowledge that should be transferred. External service providers seem to have seen this as an opportunity and offer transfer to and management of global suppliers as a service. Another solution that would improve efficiency of the transfer is to create an incentive for the current supplier to reduce costs by transferring the product himself. Despite that this would require a lot of effort from him; it is also likely to result in a competitive advantage in the future since the supplier learns to source globally.

Finally, reflecting on the report it is striking that this started as a rather descriptive report, and has evolved into a prescriptive design as to what a company should do to increase its global sourcing performance.

7.2. Contributions to existing theory
This research has contributed to the existing literature in several ways. First of all, the framework that has been developed by Momme and Hvolby (2002) has been further operationalized, by a description of activities and considerations for each step. Furthermore, this operationalization was done with a focus on international transfers, for which no step-wise framework existed.

The research has led to improvements for the framework as described above by adding a tactical phase. It has also shown that decisions made early in the transfer project can cause problems in a later stage. Knowledge of those risks and processual incentives to which Momme and Hvolby (2002) also refer are of great importance for estimating and mitigating the risk of problems.

Secondly, the tool in which this research has resulted for evaluating product characteristics and their associated risks is a contribution to both practice and theory. Comparable frameworks for identification of activities for outsourcing have been developed by several researchers (e.g. McIvor, 2003; Sislian & Satir, 2000), but these were not applicable to the assessment of products for global sourcing. A tool like the one developed in this study has, to the knowledge of the author, not been developed before and forms a good starting point for further research and detailing.

Thirdly, an exploration was made of reasons why the company in this case was facing difficulties in benefitting from global sourcing, as was indicated by Trent and Monczka (2003). The company in this
case was characterized by high mix, low volume products in the high tech sector. In comparable cases companies may be facing similar problems in knowledge of global markets, supplier selection issues, project alignment and specification issues resulting in ineffectiveness and inefficiency of the transfer. It should however be researched further whether these findings also hold in other domains that the current case.

Fourthly, the literature review has shown that since 2004 very little research has been conducted on global sourcing, despite the remaining problems in the industry. This study has combined recent insights and provided new directions to improve global sourcing performance.

7.3. Recommendations

Several recommendations with respect to the implementation and outcomes of this research can be made. First, the solution design should be implemented and post-tested as to whether it improves the performance of transfer processes. The design was in this research only theoretically tested by showing where it impacts the problem areas in the change plan. For this implementation the input requirements from the SPFT should be secured (see Chapter 6). Furthermore, a global sourcing expert should be appointed who has responsibility over the implementation, evaluation and improvement of the solution. For this purpose it is important to formulate measurable targets for effectiveness and efficiency of a transfer project. This will lead to increased understanding of risks and processual incentives as well as a more detailed standard activity plan for transfer projects. Accumulated and shared knowledge from following the proposed solution will result in a more detailed or quantitative assessment of the success of the transfer project, as well as a better insight in the costs of a transfer process. Furthermore, the research has mainly focused on global sourcing of cables and therefore the solution should be tested on whether it also holds for other products and departments.

Secondly, the solution design of this research has focused on the preparation of the transfer. Several problems such as the improvement of the technical documentation and its check for completeness and the absence of a phase-in and phase out plan have remained unaddressed. Further research can be conducted on how these issues can be improved. It should also address how and to what extent these issues form sources of risk for the performance of the transfer.

Thirdly, Trent and Monczka (2003) indicated that companies face difficulties in benefitting from global sourcing. This research has focused on the first steps of global sourcing: the identification of a product, a supplier and the transfer. It has shown that the complexity of the process as a result of the product selection, supplier selection and knowledge transfer can lower the benefits. The subsequent operational phase in the framework by Momme and Hvolby (2002), has however not been addressed but is likely to bring forth other problems. Future research should address which issues may arise in this phase and how these can be prevented by a thorough preparation phase.

Finally, the solution was developed for sourcing high-tech components. Further research can be conducted on whether the four problem areas (awareness of global markets, supplier selection, project alignment, specification) are also present in other industries that source globally and other global supply markets, and if so whether the proposed solution increases performance. It should in this respect be taken into account that the context of this research was characterized by the presence of an international purchasing office which has played a very important role in the project.
7.4. Limitations

Several limitations regarding the collection of data, the interpretation of the data and the domain of the findings were found in the research.

First, the context of this research had several characteristics that may have influenced the outcomes and generalizability of the findings. The type of business of the company has a high variety of products, and a low volume. Industries with less variety and higher volumes may face different problems. Furthermore, the context was characterized by a main office in Europe and an international purchasing office in the foreign supply market. The absence of such an international purchasing office is likely to change the outcomes and result in different problems that have been absent in this research. Geographical issues (culture, time, no direct assistance, transparency of the market) will then most likely play a more important role.

Secondly, the research was limited by data collection in several ways. Data to reconstruct the case was sometimes hard to find. The research depends on the availability of it and the sources that supply it. During this project it was sometimes hard to find accurate data, or it came available in late stage. Despite this it was attempted to gather as much data as possible to enhance the internal validity of the findings and if pieces of information were missing other sources were consulted. The most important source in the study. These were found to be biased by sensemaking (Weick et al., 2005) of the interviewees. The interviewees have to reflect on the occurings in hindsight and thereby interpret the events. As a result of this data are unreliable in their accuracy. However, as a starting point for data collection, for causal relations and expert knowledge interviews form very useful. During the research it was attempted to lessen the effect of this bias by triangulation with archival data.

Thirdly, biases in interviews not only come from the side of the interviewee, also the interpretation and question posing of the interviewer are a source of bias. During the interview the researcher interprets and the data that is collected is dependent on which questions are asked and continued to ask as a result of this interpreting. To counter this bias the interviews were recorded and literal transcriptions were made. During the analysis of these data it was found that misunderstandings do occur in interviews and that the transcription has been a useful backup. Furthermore, other sources of evidence were used when indistinctness of the facts was found.

Besides these biases, the cases that were selected took place in a business context. This context changes and as a result the case and the findings are subject to organizational change. The effect and time of occurring of this change is hard to capture. An example of this in this research is the change of management’s strategic directions during the transfer of the CMS. To counter this bias other units of analysis have been researched and interviews were conducted to reveal these organizational changes. In line with this is also the notion that the historic cases that were selected and have been completed may not be representative for current situation in the company. The company is likely to have learned from experiences and have adapted to these and solved problems that occurred.
Bibliography


North, K., (1997), *Localizing Global Production, know-how transfer in international manufacturing*, International Labour Organization


Appendix 1. Interview questions

Introduction
Interview is used for the analysis of the transfer processes of parts from Veldhoven suppliers to Asian suppliers.
I would like to have an elaborate overview of the process and get to know specific problems you’ve encountered.
As I’ve understood the transfers are both in terms of savings and in terms of schedule adherence not very effective and efficient, or am I then too strict?

Questions

General
1. How would you describe your role in the transfer briefly? (e.g. in one word?)
2. What kind of product has been transferred?
3. Who were the suppliers before the transfer?
4. When was the project started?
5. What is the current status?
6. Which parties were involved in the relocation process?
7. Were they involved in each phase of the process?

Process
8. Can you describe how and why the product has been selected to be transferred?
9. What were the goals of the transfer and how have these been determined?
10. Has there been specified what the requirements regarding the product and the expectations from the supplier?
11. Has a business case been made for the product? What was it based on?
12. How has the supply market been searched for suppliers?
13. Based on what has a supplier been selected?
14. How has the supplier been audited?
15. How would you evaluate the contracting phase?
16. What did the transfer of production activities look like?
17. Was there plan for the development of the supplier?
18. How has the quality approval of the supplier been undertaken?

Evaluation
19. Looking back at the transfer, has it been effective in terms of the goals set?
20. Has it also been executed efficiently?
## Appendix 2. Overview of Total acquisition costs

**Table 1: Framework of total costs of overseas sourcing (Song et al., 2007)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information collection, supplier selection and negotiation (one-off)</strong></td>
<td>Gather information and codify knowledge of the process transferred</td>
</tr>
<tr>
<td></td>
<td>Package the process for IP protection</td>
</tr>
<tr>
<td></td>
<td>Modify and pilot the process outsourced or re-sourced</td>
</tr>
<tr>
<td></td>
<td>(including modification due to different climate)</td>
</tr>
<tr>
<td></td>
<td>Search for and visit supplier</td>
</tr>
<tr>
<td></td>
<td>Quality audit cost</td>
</tr>
<tr>
<td></td>
<td>Tooling cost</td>
</tr>
<tr>
<td></td>
<td>Negotiation with supplier</td>
</tr>
<tr>
<td></td>
<td>Add supplier to internal IT system</td>
</tr>
<tr>
<td></td>
<td>Invest in suppliers’ IT systems (e.g. MRP, ERP, TCM, etc.)</td>
</tr>
<tr>
<td><strong>Price (ongoing)</strong></td>
<td>Price (knowing supplier’s cost structure)</td>
</tr>
<tr>
<td></td>
<td>Discount term</td>
</tr>
<tr>
<td></td>
<td>Tax and duty</td>
</tr>
<tr>
<td></td>
<td>Benefit from payment terms changes</td>
</tr>
<tr>
<td></td>
<td>Currency fluctuation</td>
</tr>
<tr>
<td><strong>Administration (ongoing)</strong></td>
<td>Ordering process</td>
</tr>
<tr>
<td></td>
<td>Payment/billing process</td>
</tr>
<tr>
<td><strong>Logistics and inventory (ongoing)</strong></td>
<td>Transportation</td>
</tr>
<tr>
<td></td>
<td>Expediting</td>
</tr>
<tr>
<td></td>
<td>Lost sales owing to late deliveries</td>
</tr>
<tr>
<td></td>
<td>Holding and administrative costs related to early delivery</td>
</tr>
<tr>
<td></td>
<td>Receiving (including moving heavier packaging for shipment protection)</td>
</tr>
<tr>
<td></td>
<td>Inspection</td>
</tr>
<tr>
<td></td>
<td>Holding inventory (heating costs, warehouse maintenance, etc.)</td>
</tr>
<tr>
<td></td>
<td>Insurance</td>
</tr>
<tr>
<td></td>
<td>Obsolescence</td>
</tr>
<tr>
<td></td>
<td>Capital charge for keeping inventory</td>
</tr>
<tr>
<td><strong>Quality issue (ongoing)</strong></td>
<td>Rejection, return and re-receiving</td>
</tr>
<tr>
<td></td>
<td>Defective material disposition</td>
</tr>
<tr>
<td></td>
<td>Rework</td>
</tr>
<tr>
<td></td>
<td>Scrap</td>
</tr>
<tr>
<td></td>
<td>Line down</td>
</tr>
<tr>
<td></td>
<td>Repackaging</td>
</tr>
<tr>
<td></td>
<td>Retesting</td>
</tr>
<tr>
<td></td>
<td>Warranties and customer complaint handling</td>
</tr>
<tr>
<td></td>
<td>Outgoing credit note</td>
</tr>
<tr>
<td></td>
<td>Loss of brand reputation</td>
</tr>
<tr>
<td></td>
<td>Learning curve for quality improvement should be considered</td>
</tr>
<tr>
<td><strong>Supplier management (ongoing)</strong></td>
<td>Supplier training and technical support</td>
</tr>
<tr>
<td></td>
<td>Co-operation with supplier for innovation</td>
</tr>
<tr>
<td></td>
<td>Update forecast and convey it to suppliers</td>
</tr>
<tr>
<td></td>
<td>Performance review and meeting</td>
</tr>
<tr>
<td></td>
<td>Renegotiation</td>
</tr>
<tr>
<td></td>
<td>Costs of phone calls, faxes, video conferences</td>
</tr>
<tr>
<td></td>
<td>Litigation</td>
</tr>
<tr>
<td></td>
<td>Impact on residual supply from the previous supplier</td>
</tr>
<tr>
<td><strong>Other costs</strong></td>
<td>Personnel recruit and training (one-off)</td>
</tr>
<tr>
<td></td>
<td>Send staff to work abroad (one-off and ongoing)</td>
</tr>
<tr>
<td></td>
<td>Get rid of redundant capacity and labour (one-off)</td>
</tr>
<tr>
<td></td>
<td>Dealing with inferior infrastructure (one-off and ongoing)</td>
</tr>
<tr>
<td></td>
<td>Special regulations from local government (environmental policy, working hours and pattern restriction, etc.) (ongoing)</td>
</tr>
<tr>
<td></td>
<td>Culture and language issues (additional costs for training and re-designing of job process, performance measurement system, etc.) (ongoing)</td>
</tr>
<tr>
<td></td>
<td>Cost for dealing with counterfeit products (one-off and ongoing)</td>
</tr>
<tr>
<td></td>
<td>Loss from IPR infringing</td>
</tr>
<tr>
<td></td>
<td>Dealing with corruption of local government (ongoing)</td>
</tr>
</tbody>
</table>
Appendix 3. Framework for global outsourcing

Global outsourcing process

Strategic phase
- Identification
- Specification
- Monitoring
- Selection
- Audit & approval

- Core competencies
  - Strategic risk
    - Specificity
    - Cost evaluation
  - Competitive advantage
    - Total acquisition costs
    - Supplier availability
    - Dependency
  - Cost evaluation
    - Specificity
    - Risk analysis
    - Supplier availability
    - Dependency
  - Strategic risk
    - Specificity
    - Risk analysis
    - Supplier availability
    - Dependency
  - Competitive advantage
    - Total acquisition costs
    - Supplier availability
    - Dependency

Transition phase
- Contracting
- Transfer

- Responsibilities
- Identification
- Diffusion
- Acquisition & Adoption

- Legal international conditions
- Long-term agreements
- Technical documents
- Service activities
- Reverse engineering
- Assembly activities
- Observation
- Simple parts
- Complex development
Appendix 5. Activities and their characteristics in the CMS transfer

Transfer process

Identification
- Business volume
  - Pre-selection
- Product maturity
- Product complexity
- Supply base fit

Supplier searching
- Required competences
  - Quality requirements
- Logistics requirements
- Technology requirements
- Total Costs requirements
- Investment
- Direct cost savings
- Business alignment
- Supply base fit

Supplier selection
- Cost evaluation
  - RFQ
- Process audit
  - Quality performance
- Logistics performance
- Eliminated costs
- Investment
- Business alignment
- Supply base fit
- Total Costs performance
- Business performance

Supplier development
- Manufacturing knowledge transfer
- Diffusion & adoption
- Technical documents
- Reverse engineering
- Technical assistance
- Observation
- Visual work preparation

Qualification
- Contracting
  - Long Term Agreement
  - Technical documents
  - Dutch legal system
- Manufacturing
- Testing
- Move rate
- Work preparation
- On site inspection
- Implementation of testing procedures
- Secure material availability

Product
- Process
  - Technical documents
  - Reverse engineering
  - Technical assistance
  - Observation
  - Visual work preparation

Process
- FMEA
- Testing
- Move rate
- Work preparation
- On site inspection
- Implementation of testing procedures
- Secure material availability
### Appendix 6. Supplier profile Supplier 1

<table>
<thead>
<tr>
<th>Supplier Profile</th>
<th>Supplier name + number</th>
<th>Revision Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sinbon 1</td>
<td>04 jul 2007</td>
</tr>
</tbody>
</table>

#### Quality
- Material Quality Performance - Q1
- Introduction of new products - Q2
- Process control - Q3
- Insight into the supply-chain: Supplier selection criteria - Q4
- Version control and archiving - Q5
- Complaint Handling - Q6
- Spare Parts Quality at End-Customers - Q7
- Dead-on-Arrival Parts at End-Customers - Q8
- Environmental Performance - Q9
- Health & Safety Performance - Q10
- Customer focus and craftsmanship - Q11

#### Logistics
- Order fulfillment flexibility (Rlip) - L1
- Delivery Reliability (2ndClip) - L2
- Order Time - L3
- Cycle Time reduction - L4
- Repair Cycle Time reduction - L5
- Flexibility/ Agility - L6
- Process Control: ERP-system - L7
- Insight into the supply chain: Risk Assessment - L8
- Customer Focus and Craftsmanship - L9

#### Technology
- Module / Sub-system Development - T1
- Development Process - T2
- Organization Structure of technology development - T3
- Technology Knowledge - T4
- Engineering / Early Supplier Involvement - T5
- Process Engineering - T6
- Continuous Engineering Improvement - T7
- Engineering Change Management - T8
- Technical Support - T9
- Customer Focus and Craftsmanship - T10

#### Total Cost
- Market Conformity - C1
- Open Costing - C2
- Cost Reduction Programs - C3
- Dependency: ASML & Semicon Market - C4
- Payment Terms - C5
- Warranty according to ASML Customer expectation - C6
- Customer Focus and Craftsmanship - C7

#### Change Profile Data

<table>
<thead>
<tr>
<th>Wish</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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#### Value

<table>
<thead>
<tr>
<th>Overall Vendor Rating</th>
<th>C</th>
<th>78%</th>
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<tbody>
<tr>
<td>Quality</td>
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<td>81%</td>
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<tr>
<td>Logistics</td>
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<td>83%</td>
</tr>
<tr>
<td>Technology</td>
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<td>86%</td>
</tr>
<tr>
<td>Total Cost</td>
<td>D</td>
<td>63%</td>
</tr>
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</table>
Appendix 7. Cause and effect diagram transfer process
# Appendix 9. Means for knowledge transfer

## Table 5: Overview of knowledge transferring methods

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Product knowledge</th>
<th>Process knowledge</th>
<th>Managerial knowledge</th>
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</thead>
<tbody>
<tr>
<td>Ivarsson &amp; Alvstam</td>
<td>2003</td>
<td>Patents</td>
<td>Modern machinery</td>
<td>Inventory management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Licenses</td>
<td>Technical support in planning</td>
<td>Logistical systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Product designs</td>
<td>Inspection and testing</td>
<td>Upgrading human resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technical specifications</td>
<td>Advice on tooling</td>
<td>Supplier evaluation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technical consultations</td>
<td>Advice on maintenance</td>
<td>In-plant training</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regular feedback on product performance</td>
<td>Advice on production layout</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organized R&amp;D collaboration</td>
<td>Advice on operations</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Support to improve existing technology</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Assistance with quality systems</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Local procurement allows for Lower TC and closer monitoring</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Trust building when high tech specs and high quality</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>North</td>
<td>1997</td>
<td>Acquisition of equity in subsidiary</td>
<td>Purchase of capital goods</td>
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<tr>
<td></td>
<td></td>
<td>Establishment of a license agreement</td>
<td>Standard machinery</td>
<td></td>
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<td></td>
<td></td>
<td>Outright purchase of equipment</td>
<td>Technical assistance from buyers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Detailed specifications or blueprints</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Flow of human resources</td>
<td></td>
<td></td>
</tr>
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<td>Kim</td>
<td>1997</td>
<td>Catalogues</td>
<td>Purchase of capital goods</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blueprints</td>
<td>Standard machinery</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technical specifications</td>
<td>Technical assistance from buyers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trade journals</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Observation of foreign plants</td>
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<tr>
<td></td>
<td></td>
<td>Imitation</td>
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<tr>
<td></td>
<td></td>
<td>Reverse engineering</td>
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<td></td>
</tr>
<tr>
<td>Grant &amp; Gregory</td>
<td>1997</td>
<td></td>
<td></td>
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<td>Physical equipment</td>
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<td>Reproduction of documentation</td>
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<td></td>
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<td>Face-to-face training</td>
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<td>Practice</td>
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<td>Contact with knowledgeable staff</td>
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<td></td>
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<td>On-the-job training</td>
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<tr>
<td>Karandikar &amp; Nidamarthi</td>
<td>2006</td>
<td>Availability of documentation</td>
<td>Allocation of simpler tasks and gradually increase complexity</td>
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<td>Rotation of technical personnel</td>
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<tr>
<td>Duanmu &amp; Fai</td>
<td>2007</td>
<td>Product blueprints</td>
<td>New facilities/equipment use</td>
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<td></td>
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<td>Product assessment reports</td>
<td>Product quality analysis skills</td>
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<td>Product analysis reports</td>
<td>Operation techniques</td>
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<td>Product design knowledge</td>
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<td>New product test knowledge</td>
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<td>R&amp;D management</td>
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<td>Quality system maintenance</td>
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<td>Product cost portfolio analysis</td>
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<td>Environment protection requirements</td>
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<td>Material sourcing information</td>
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<td>Market information</td>
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<td>Material management</td>
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<td>Supplier management</td>
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<td>Customer management</td>
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<td></td>
<td>Ideology</td>
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</table>
### Appendix 10. Transfer preparation and assessment tool

<table>
<thead>
<tr>
<th>STEP</th>
<th>Compose team</th>
<th>Select product</th>
<th>Formulate objectives</th>
<th>Assess feasibility</th>
<th>Establish project plan</th>
<th>Update TAC &amp; Go/No-Go</th>
</tr>
</thead>
</table>
| ACTIVITIES | - Assign project leader from PFT  
- Determine required disciplines  
- Establish cross-functional team  
- Secure resources with managers | - Explore commodity group  
- Include entire team in this step  
- Assess product by characteristics  
- Evaluate the success of a transfer by risks  
- Select a product | - Interpret strategic SPFT goals  
- Formulate and document transfer project goals  
- Determine measures for goals  
- Agree on goals | - Assess feasibility of objectives using measures  
- List termination-criteria  
- Establish Total Acquisition Costs evaluation  
- Create awareness of risks and actions | - Establish WBS  
- Anticipate on risks  
- Determine responsibility, finishing-time, duration, predecessors, successors, resources, milestones.  
- Secure resources with management | - Detail projects’ Total Acquisition Costs evaluation with resources and activities  
- Update objective feasibility assessment  
- Determine success of the project  
- Decide on continuation |

| RESULTS | - Cross-functional team established  
- Commitment from managers  
- Go/No-Go | - Product selected  
- Risk evaluation documented  
- Team agrees on product selection  
- Go/No-Go | - Goals documented  
- Measures determined  
- Team agrees on goals  
- Go/No-Go | - Feasibility document  
- Termination criteria  
- Total Acquisition Costs document  
- Go/No-Go | - WBS overview  
- Commitment for resources  
- Project team agrees on plan  
- Go/No-Go | - Updated TAC  
- Updated feasibility document  
- Execution Go/No-Go |
### Appendix 11. Preliminary WBS for transfer projects

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Establish a plan of required activities</td>
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<tr>
<td>2.</td>
<td>Formulation of supplier requirements</td>
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<tr>
<td>3.</td>
<td>Supplier searching</td>
</tr>
<tr>
<td>3.1</td>
<td>Searching sources</td>
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<tr>
<td>3.2</td>
<td>Establish long-list of capable suppliers</td>
</tr>
<tr>
<td>3.3</td>
<td>Send RFI and ask for first quotation on volume</td>
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<tr>
<td>3.4</td>
<td>Assess suppliers on preliminary requirements</td>
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<tr>
<td>3.5</td>
<td>Establish short-list</td>
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<tr>
<td>3.6</td>
<td>Decision: Sufficient supplies? Can the goals still be met?</td>
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<tr>
<td>3.7</td>
<td>Review business case on new insights</td>
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<td>3.8</td>
<td>Check requirements for next phase:</td>
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<tr>
<td></td>
<td>• Has the TPD been reviewed?</td>
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<td></td>
<td>• Can the supplier now make it?</td>
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<td></td>
<td>• Is everyone aware of local circumstances?</td>
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<td></td>
<td>• Are components available?</td>
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<td></td>
<td>• Can we localize products?</td>
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<td></td>
<td>• Make sure ACE can qualify and test the product locally (this requires product knowledge, testing procedures, complete TPD)</td>
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<td></td>
<td>• Interesting customer plan (which sources of supplier value do we have?)</td>
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<td></td>
<td>• How will the supply base respond, which implications will it have?</td>
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<td></td>
<td>Make sure you have solved internal problems internally, don’t let it disturb your supplier relation.</td>
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<tr>
<td>3.9</td>
<td>Go/no-go to next phase</td>
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<tr>
<td>4.</td>
<td>Supplier selection</td>
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<tr>
<td>4.1</td>
<td>Send technical documents</td>
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<td>4.2</td>
<td>Send RFQ to suppliers for sample set AND final product</td>
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<td>4.3</td>
<td>Review Quotations</td>
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<tr>
<td>4.4</td>
<td>Update business case</td>
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<td>4.5</td>
<td>Process audit</td>
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<td></td>
<td>• QLTC</td>
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<td></td>
<td>• Supplier site-visits</td>
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<td></td>
<td>• Strategic alignment</td>
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<tr>
<td>4.6</td>
<td>Product audit</td>
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<td>4.7</td>
<td>Construction</td>
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<tr>
<td>4.8</td>
<td>Local compliancy check</td>
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<td>4.9</td>
<td>Reflection on objectives</td>
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<td>4.10</td>
<td>Select supplier with entire team</td>
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<td>4.11</td>
<td>Review plan based on selected supplier</td>
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<tr>
<td>5.</td>
<td>Qualification</td>
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<td>5.1</td>
<td>Work preparation</td>
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<td>5.2</td>
<td>Qualification product production</td>
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<tr>
<td>5.3</td>
<td>Local compliancy check</td>
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<td>5.4</td>
<td>Ensure process quality</td>
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<tr>
<td>5.5</td>
<td>Ensure logistics capabilities</td>
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<td>6.</td>
<td>Release for volume</td>
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