

## MASTER

### The effect of the functional diversity of the supplier on inter-organizational knowledge transfer

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**The effect of the functional  
diversity of the supplier on inter-  
organizational knowledge transfer**

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in partial fulfillment of the requirements of the degree of

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in Innovation Management**

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**Subject headings:** functional diversity, inter-organizational knowledge transfer, knowledge, network, goals, organizational culture

## **PREFACE**

This report is the result of my graduation project for the Master of Science degree in Innovation Management. This graduation project was performed at FEI Company, and was supervised by the faculty of Innovation, Technology, Entrepreneurship and Marketing. It describes an exploratory study on the effect of functional diversity on inter-organizational knowledge transfer.

I would like to take this opportunity to express my gratitude to those who helped me realize this research. Special appreciation goes out to Jeroen Schepers, my primary supervisor, for his guidance and comprehensive feedback. Further, I am thankful for all the help of my secondary supervisor, Isabelle Reymen, which she has given me concerning the methodology of my research. Additionally, my gratefulness goes to my supervisor at FEI Company, Paul Flamend, who assisted me throughout the project and pointed me towards interesting theories. Finally, I would like to thank my farther for his input.

This project has been a valuable experience on both an academic and professional level, and has made the final hurdle of my academic education one to remember.

## **MANAGERIAL SUMMARY**

### **INTRODUCTION**

The fast changing technological landscape makes it more difficult for organizations to remain competitive in multiple areas of technology at the same time. To be innovative and competitive, organizations focus their activities on what they excel in and rely on external sources of knowledge to provide knowledge of technological fields which are not covered internally (Chesbrough, 2003). The involvement of suppliers is increasingly being recognized as a source of new knowledge, to remain competitive in the fast changing technological landscape (Meier, 2001; Grant, 1996; Simonin, 2004; Spender, 1996).

FEI Company too realized that suppliers are a key source of new knowledge, and valuable in FEI's pursuit of innovative and competitive product design. Therefore FEI Company adapted their new product development processes by involving suppliers in the process. The involvement of suppliers potentially brings new knowledge to the table. However, as FEI Company discovered, the transfer of knowledge is inadequate and sometimes even counterproductive if the collaboration is limited to only a few functional specialties.

Functional diversity refers to the degree in which different functional specialties, such as for example R&D, sourcing, sales and marketing, are represented in a new product development team (Ancona & Caldwell, 1992; Brown & Eisenhardt, 1995; Gupta, et al., 1985; Hill, 1982; McDonough III, 2000; Ratcheva, 2009). Although functional diversity is extensively documented in academic research, little is known about its role and importance in the process of supplier involvement. As FEI Company discovered, a limited presence of functional specialties (= limited functional diversity) can make the involvement and the input of suppliers less valuable. Functional diversity in a product development team may have a beneficial effect on the outcome.

The present study explores the effect of the functional diversity of a supplier's team on the knowledge transfer between both organizations to answer the following research question:

***How should FEI Company adapt its supplier management process based on the functional diversity of the supplier's project team to increase the inter-organizational knowledge transfer?***

### **RESEARCH METHODOLOGY**

The present study starts from academic research, and builds to in theory and practice grounded design principles to increase FEI's inter-organizational knowledge transfer with its suppliers. An extensive review of literature on both functional diversity and inter-organizational knowledge transfer was performed. The findings from this literature review were used to construct the conceptual model for the empirical research. The empirical research, which is used to examine and adjust the conceptual model, is case study based. Within FEI Company six cases were studied through in-depth semi-structured interviews. The interviews were recorded, transcribed and thereafter analysed using a combination of open codes and predefined codes in NVIVO. As depicted in figure A, the outcome of the

empirical research is used to construct the final research model which enabled the development of the in theory and practice grounded design principles.

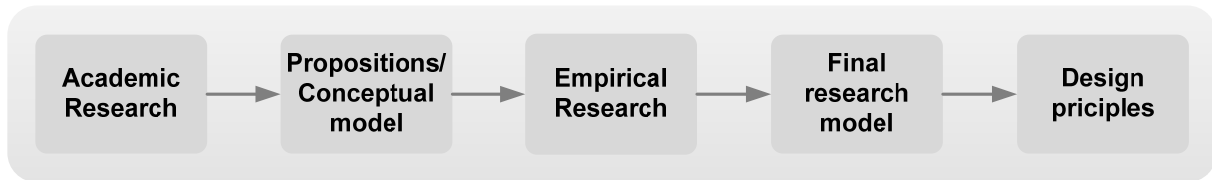


Figure A, Research Methodology

## LITERATURE REVIEW

Three categories of characteristics are identified which affect inter-organizational knowledge transfer: 1) Knowledge characteristics 2) Organizational characteristics 3) Relational characteristics. Within these categories several factors play their part in inter-organizational knowledge transfer. For example, the organizational characteristics describe how the learning culture present in an organization is of critical importance for inter-organizational knowledge transfer.

In literature on functional diversity it was found that increasing functional diversity would positively affect the amount and diversity of knowledge, the personal and professional network, and the goals and organizational cultures present in the team.

Some aspects of functional diversity within a company correspond to factors found in inter-organizational knowledge transfer literature. For example, the increase of goals and organizational cultures is closely linked to what is found within the relational characteristics as goal / culture coherence. The only difference is that where functional diversity within a company describes its aspects at a team or departmental level, inter-organizational knowledge transfer literature uses the terms at a more organizational level.

The four aspects (the knowledge, network, goals and organizational cultures) brought to the table by functional diversity were linked to factors found within the three categories of inter-organizational knowledge transfer. Figure A gives an idea of the connections of functional diversity and inter-organizational knowledge transfer. However, this figure displays the final model, and is thus already supplemented with empirical data from this study.

## FINAL RESEARCH MODEL

The findings of the conducted case studies were used to transform the conceptual model into the final research model, figure A. The model describes how functional diversity on the supplier's side of the collaboration affects inter-organizational knowledge transfer.

Although the empirical data collected through the case studies was generally in line with the conceptual model and thus literature, some alterations were made to the model as a consequence of the empirical research. The most important findings concerns the conflicts which can arise due to a lack goal and/or cultural coherence. Not only are both factors, goal coherence and organizational culture coherence, subdivided into smaller aspects of both goals and culture, but more importantly the way

they affect inter-organizational knowledge transfer was found to be different. Where in literature no difference was made within conflicts, empirical data has shown a clear distinction in inter- and intra-organizational conflicts. As shown in the model, most conflicts which arise due to functional diversity of the supplier are of an intra-organizational nature. Next to the conflicts, also experience/expertise were found in empirical data as an important factor to consider in the effect of functional diversity, as the amount of knowledge gained through the involvement of a university graduate is significantly lower than that of a person with the same education but with 25 years of experience.

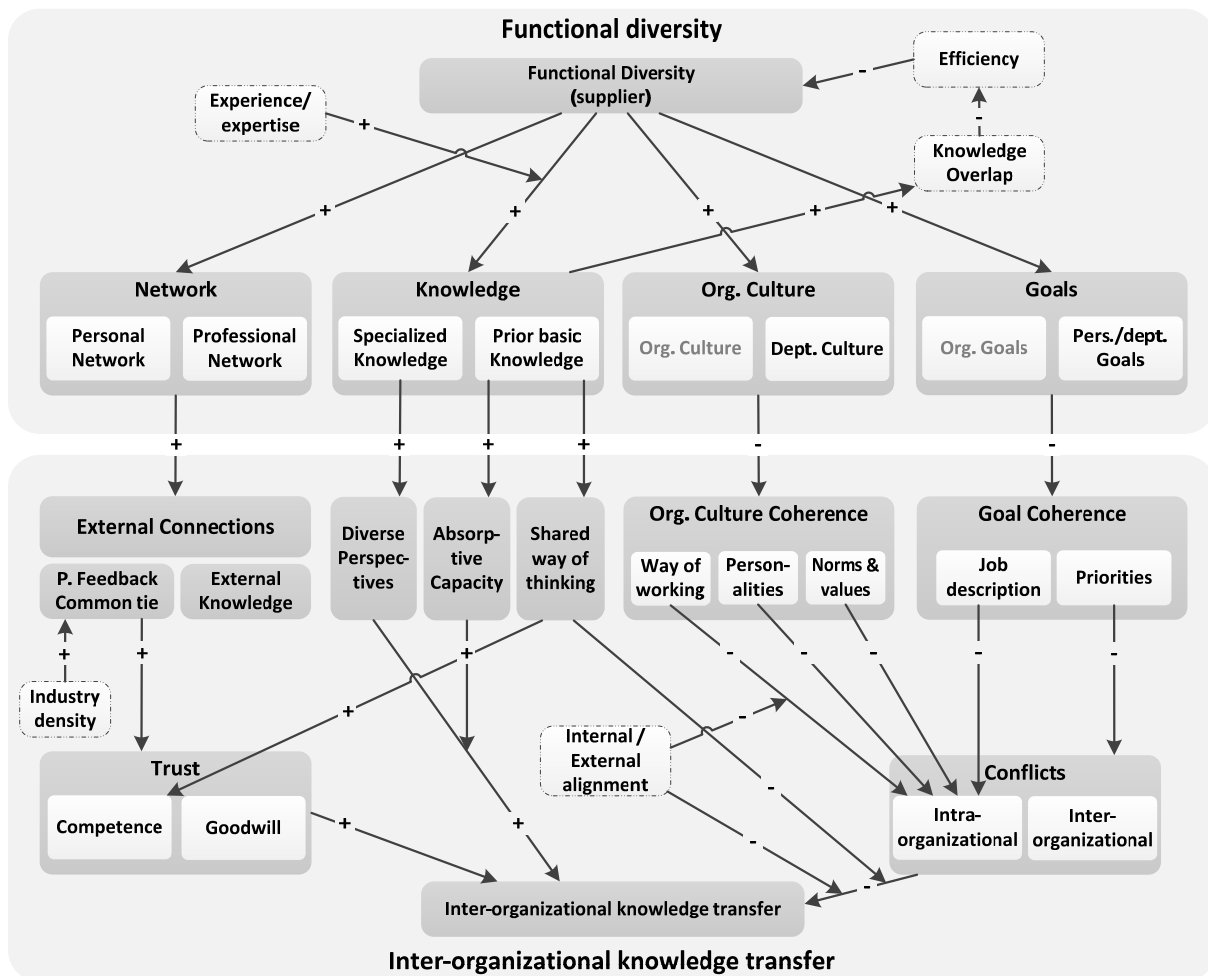


Figure B, Final research model

## CONCLUSIONS

The present study shows that combining supplier involvement with functional diversity of that supplier can bring the transfer of new knowledge to a higher level than either functional diversity or supplier involvement independently. When suppliers increase the amount of functional specialties involved in the project, the amount of knowledge available within the project rises. This enables both teams to transfer more knowledge over organizational boundaries, especially when both organizations are able to link counterparts with similar prior basic knowledge. Through an increase in inter-organizational knowledge transfer organizations can come to more competitive and complete products. Managers

should therefore, especially at the start of new projects when the requirements and scope of the project are still vague, make sure that the widest variety of specialized knowledge is present (meaning more functional specialties or more experienced personnel). This prevents that important issues are overlooked.

However, the implication of functional diversity does require more than just manpower. In order to enhance inter-organizational knowledge transfer both sides of the collaboration should ensure that enough time and resources are invested to generate a comprehensive high-quality statement of work covering all issues. Aligning both organizations through such a document is a clear guideline and forms the basis for a fruitful collaboration. It also helps to prevent conflicts to occur or to overcome them when they arise.

Functional diversity at both sides of the collaboration can make the cooperation more difficult as the wider diversity in goals and organizational cultures make internal and external alignment harder. This study concludes that in order to use functional diversity to enhance inter-organizational knowledge transfer, while remaining internal and external alignment, managers should make sure experienced personnel is appointed to central roles between both organizations. Experienced project leaders on both sides know how to balance priorities and goals, and thereby how to align both organizations internally and externally.

When striving for more inter-organizational knowledge transfer it is important to note that other aspects of the project might suffer. Functional diversity is in a constant struggle with efficiency. More people means more alignment and human resources, and thus more effort and costs. Functional diversity and inter-organizational knowledge transfer should therefore be in constant trade-off with efficiency.



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## **1 INTRODUCTION**

A fundamental question in the understanding of firms' economic activities is: 'Why do firms do what they do?' On the other hand it can be asked: 'Why do firms not do what they do not do?' (Madhok, 2002). Madhok (2002), who credits Ronald Coase (1937) for these thoughts, states that competitive advantage is at the base of answering these questions. 'To do' or 'not to do' boils down to a make-or-buy decision. If a firm is not able to develop a component competitively, it is more valuable to buy it in the market or let another company, which is better equipped for the job, produce it (Madhok, 2002).

The fast changing technological landscape makes it more difficult for organizations to remain competitive in multiple areas of technology at the same time. To be innovative and compete in the current competitive landscape, organizations focus their activities on what they excel in and rely on external sources of knowledge to provide knowledge of technological fields which are not covered internally (Chesbrough, 2003). Through the integration of external and internal knowledge, organizations are able to combine the perspectives of different technological fields and develop more innovative products. Besides universities, institutes, and researches, in today's new product development landscape also suppliers are recognized more and more as a source of knowledge. Therefore, supplier involvement is more often used to remain competitive in the fast changing technological landscape (Meier, 2001; Grant, 1996; Simonin, 2004; Spender, 1996).

Another mechanism for innovation and competitive product development, which finds its way through combining multiple perspectives, is functional diversity (Ancona & Caldwell, 1992; Brown & Eisenhardt, 1995; Gupta, et al., 1985; Hill, 1982; McDonough III, 2000; Ratcheva, 2009). Functional diversity refers to the degree in which different functional specialties, such as for example R&D, sourcing, sales and marketing, are represented in a new product development team. Involving different functional specialties enhances the innovative capacity and the capability development of a team as the combination of diverse perspectives boosts out of the box and creative thinking (Ancona & Caldwell, 1992; Brown & Eisenhardt, 1995; Gupta, et al., 1985; Hill, 1982; McDonough III, 2000; Ratcheva, 2009). Organizations recognize the need for external knowledge and competence development. The use of supplier involvement and functional diversity is common practice in today's NPD processes.

Although both supplier involvement and functional diversity are extensively researched concerning their antecedents, barriers and effects on knowledge transfer, little is known about the way that functional diversity and supplier involvement interact. Knowledge transfer is defined as the process by which knowledge is exchanged from one person, team or organization to another (van Wijk, et al., 2008). Prior research found that knowledge transfer between organizations (Inkpen & Tsang, 2005; van Wijk, et al., 2008; Emden, et al., 2006), but also within functional diverse teams (Ancona & Caldwell, 1992; Hirunyawipada, et al., 2010; Grant, 1996; Dougherty, 1992), is confined by the differences in priorities, ways of working, and professional language. Does this mean that an increase in functional diversity complicates knowledge transfer between organizations (as functional diversity increases diversity in priorities and ways of working)? Or does functional diversity enhance knowledge transfer between organizations when a wider variety of perspectives and external connections becomes

available? This paper explores the gap in literature by investigating how the positive and negative effects of functional diversity affect the transfer of knowledge between organizations.

## **1.1 RESEARCH CONTEXT**

This research is to a large extent conducted within FEI Company, a company that combines hardware and software expertise in electron and ion microscopy. FEI Company as it is today originates from a merger in 1997 between FEI (Field Emission Inc.), a company founded in 1971 as a supplier of electron and ion beam sources, and Phillips Electron Optics. Currently the company has a workforce of more than 2500 FTE divided over sixteen sites. Through sales and service operations acting in more than 50 countries worldwide, FEI Company generated revenues of \$892M in the year 2012. The three main sites, placed in Brno, Eindhoven, and Hillsboro, house the R&D facilities and manufacturing lines. In the High-tech market of electron microscopy FEI Company invested \$95M on R&D in 2012 in order to pursue the goal of market expansion and the penetration of promising adjacent markets.

## **2 RESEARCH PLAN**

In this section the research plan is discussed in the following paragraphs. First, the issues that limit the collaboration between FEI Company and its suppliers are described in the problem statement in section 2.1. The problem statement is then used to define relevant research questions (section 2.2). Thereafter, a detailed description of the research plan is given (section 2.3-2.10)

### **2.1. PROBLEM STATEMENT**

FEI Company foresees innovative product improvements through the use of external knowledge and desires to *enhance collaboration with its suppliers in order to improve product quality, price and time to market*. However, the company indicated to face difficulties involving suppliers into NPD activities.

FEI indicates that the company struggles to effectively collaborate with suppliers. Sourcing professionals at FEI would like to improve and optimize the supplier's input in the product. Often a supplier does exactly what FEI asks to do. They have no or limited own input and thus bring no added value.

*For example, FEI co-developed the casing of one of its microscopes with a supplier specialized in casings. Although the design and manufacturability were outstanding, the costs of the casing were extremely high. When FEI subsequently requested a more and more sophisticated design with smooth edges and the best materials, the price rapidly increased even further. Although the supplier was aware of cheaper design options (such as other materials and a different shaping) that would have been adequate for the design, they did not bring this forward.*

In this example the supplier may be considered a bad supplier. Others, however, describe this phenomenon as logical and do not consider the supplier to be bad in such situations. They believe that the supplier acts completely rational and fair but operates with a "customer is king" mentality. In the

example of the casing, the supplier did not dare to second guess FEI even though they knew a much simpler and less expensive solution was sufficient. The sourcing professionals at FEI believe that the suppliers should be involved more actively in the process.

Further, FEI acknowledges that the involvement of suppliers is, to a large extent, limited to the collaboration with the engineering departments of its suppliers. In such collaboration, the communication with other functional departments often is lacking. As described by the example of the casings, this leads to products that lack a holistic design and fail on certain parameters. Sourcing professionals at FEI believe that the involvement of more functional departments of the supplier can lead to a more holistic design in which all specifications are met.

FEI indicated a strong desire to learn from its suppliers. They believe that only through close collaboration and extensive knowledge transfer between FEI and its suppliers, FEI can maintain and extend its competitive advantage. In the current situation, FEI is under the impression that the company is teaching their suppliers more than the other way around.

To conclude, FEI Company wants to enhance collaboration with its suppliers to design new innovative products. They believe that the involvement of a limited number of functional departments of the supplier confines such collaboration.

## **2.2. RESEARCH QUESTIONS**

This research aims to make recommendations to FEI Company on how to improve their collaboration with its suppliers in NPD projects. The company has a great desire to benefit from knowledge and capabilities of their suppliers. However, at FEI collaboration and knowledge transfer across company boundaries is lacking or insufficient for several functional specialties. At the moment the knowledge and skills present outside organizational boundaries are transferred to a very limited extent to FEI's NPD projects. In line with this problem statement the following general main research question is formed:

### **Main research question**

***How should FEI Company adapt its supplier management process based on the functional diversity of the supplier's project team to increase the inter-organizational knowledge transfer?***

The problem statement is used to identify a solution direction. FEI indicated that collaboration with suppliers is mainly limited to the engineering department and collaboration with other departments is lacking. Functional diversity – a mixture of representatives from several different functional departments – in teams brings a wider variety of perspectives, ways of working, and professional languages to the table and might enhance collaboration and knowledge transfer between organizations on more functional specialties. Within this study the solution direction entails functional diversity.

In order to give a complete and thorough answer to the research question, this study will focus on a set of more specific questions.

- a. By synthesizing existing literature, the following questions will be answered:

**RQ1: What are the key determinants and barriers of Inter-organizational knowledge transfer?**

**RQ2: How can functional diversity be defined, and what are the advantages and disadvantages?**

- b. By collecting and analysing empirical evidence the following question will be answered:

**RQ3: How does FEI Company currently manage supplier involvement and how does it enable knowledge transfer with their suppliers?**

- a. By synthesizing exiting literature and collecting and analysing empirical evidence, the following question will be answered:

**RQ4: Which aspects of functional diversity within the supplier's project team affect inter-organizational knowledge transfer, and how?**

### 2.3. RESEARCH METHODOLOGY

In this section a systematic research plan is designed to enhance the quality and reproducibility of the study (Yin, 2009). This study adopts a science-based design approach towards organizational design. This approach bridges the gap between literature and managerial practice as the science-based design approach focuses on the creation of 'construction principles and design rules grounded in organization science as well as on organizational solutions implemented and tried out in real-life settings' (Romme and Endenburg, 2006; page 287).

The present study starts from academic research where literature is used to develop propositions. As shown in figure 1, the propositions form the base of the conceptual model which is examined and adjusted with input of empirical data. Subsequently, the final research model describes the synthesis of both academic research and empirical data, and is used to develop a set of grounded design principles.



Figure 1, Research methodology

#### ACADEMIC RESEARCH

A literature study is conducted to unravel the antecedents and characteristics within the two main research fields described in the main research question; inter-organizational knowledge transfer (RQ1), and functional diversity (RQ2). These research fields are then brought together in the conceptual model to describe how functional diversity affects inter-organizational knowledge transfer (RQ4). Further, the theory derived from the literature study is used to define the case selection criteria, stipulate rival theories, and generalize the results over the cases (Yin, 2003).

## EMPIRICAL RESEARCH

Case studies are conducted in order to examine and adjust the relations between functional diversity and inter-organizational knowledge transfer that are proposed in literature (RQ4). Furthermore, the case studies are used to gain an understanding of how FEI currently manages its supplier involvement and inter-organizational knowledge transfer (RQ3).

### **2.4. CASE STUDY RESEARCH DESIGN**

The case study design is particularly suited for this study as the boundaries of the studied phenomenon and the context are indecipherable, and the aim is to identify the “how” and “why” behind the relations. Further, the case study approach shows its advantages when underlying motivations need to be identified while accounting for an open and broad spectrum of potential influences (Verschuren & Doorewaard, 2010). Further, in this particular study, control over behavioural aspects is limited, while the examples and events studied are contemporary. Due to the “how” and “why” nature of the study, the limited control over behavioural events, and the contemporary nature of these events a case study design is perfectly suited (Yin, 2009).

Cross-case analysis ensures that no premature conclusions are drawn from the individual cases. Further, the cross-case analysis enables the examination of similarities and differences over the various cases. The cases that are selected for the current study differ in their level of functional diversity (as described in section 2.6). In the cross-case analysis this enables the comparison of the effect of the functional diversity level on the unit of analysis, inter-organizational knowledge transfer. Through the analysis of differences and similarities between the cases, with different levels of functional diversity, the theory derived from literature is investigated. Moreover, by selecting multiple cases for each functional diversity level, the likelihood that the results can be generalized increases.

Within all cases semi-structured interviews are conducted to collect empirical data. As knowledge transfer is not easily traceable, especially the motives behind it, interviews are simply the only viable mechanism to collect data. By conducting semi-structured interviews, the interviewer remains free to explore topics which were not accounted for while keeping track of all required questions.

The aim for each case is to discover the experiences that the interviewee has with the effect of functional diversity in general, but also how it was perceived within the case under study. The general experiences of all the interviewees is used to explore rival theories and as a assessment for the propositions that are drawn from the literature review. Further, the case study focuses on the effect of functional diversity in the particular case. As the cases differ in functional diversity level, the cross case analyses is used to investigate whether or not the experiences of functional diversity in general are in accordance with what is found over the different cases.

## VALIDITY AND RELIABILITY

A study is supposed to represent a logical set of statements that are trustworthy, credible, confirmable, and in which the data is dependable (Yin, 2009). In empirical research four tests are



commonly used to control the quality of the study. The first three tests account for different kinds of validity: construct, internal and external validity. The fourth test copes with reliability.

*Construct validity* deals with the question; whether or not the correct operational measures are used for each concept. Through the development of a sufficient operational set of measures the gathering of “subjective” data can be minimized (Yin, 2009). In this study a *chain of evidence* aims to ensure that no original evidence is lost and thereby addresses the methodological problem of construct validity (Yin, 2009).

*Internal validity* concerns the question; whether or not the uncovered causal relation is justified (Yin, 2009). *Pattern matching* is the first step to overcome problems of internal validity. Pattern matching concerns the linkage from relations found in empirical data to the relations in the developed theory (Yin, 2009). *Explanation building* is a special type of pattern matching that focuses on investigating the “how” and “why”, and is used within the present study to control for internal validity (Yin, 2009).

*External validity* copes with the question whether or not the results of the study can be generalized to other situations (Yin, 2009). Concerning the external validity, it is important to note that two types of generalization can occur: analytical and statistical generalization. Where in statistical generalization the aim is to generalize a particular set of results to a larger universe, analytical generalization aims to generalize to a broader theory. Within a case study research design, statistical generalization is difficult to accomplish. However, just as the present study, case studies generally aim for analytical generalization (Yin, 2009). In order to achieve analytical generalization, in the present study, linkages are made between the empirical data and theory. Further multiple case studies are obtained between which a cross-case analysis is executed in order to control for external validity (Yin, 2009).

The *Reliability* of a study explains; Whether or not repetition of the case study leads to the same results (Yin, 2009). The reliability of the study ensures the minimization of errors and bias, and is therefore of key importance. In order to ensure that the case studies of the present study are reliable, a *case study protocol* is used, and a *case study database* is constructed (Yin, 2009).

Test	Definition	Control measure
Construct validity	Whether or not the correct operational measures for the concepts are used	- chain of evidence
Internal validity	Whether or not the uncovered causal relation is justified	- link observations with theory - explanation building
External validity	Whether or not the results can be generalized to other situations	- use of theory - multiple case studies
Reliability	Whether or not repetition of the case study leads to the same results	- case protocol - database

**Table 1, Research design tests and control measures (Yin, 2009)**

## **2.5. CASE SELECTION**

An important step in the research is to select appropriate cases to investigate the theory that was developed. To ensure a collection of cases competent for the study, several selection criteria are used. These selection criteria are elaborated on in the following paragraphs.

### **RECENTLY COMPLETED**

In order to avoid memory retrieval problems of the interviewees that can be encountered when discussing past events, the first selection criterion is the degree in which the project was carried out recently. Therefore, to meet this criterion the selected projects are obligatory to be concluded not earlier than one year before the interviews for this study.

### **REPRESENTATIVENESS**

The case-study design is commonly used to examine outliers so abnormalities can be explained. However, this study aims to investigate the cases that are representative for FEI Company. Therefore, in order to ensure representativeness, the second selection criterion focuses on only selecting cases that represent the company in its development processes, products, and type of innovation. Concerning the type of innovation, where a distinction can be made between radical and incremental innovations, this study aims on incremental projects.

### **SUPPLIER INTEGRATION**

The main aim of this study is to improve the inter-organizational knowledge transfer. Therefore the cases selected for this study are of an inter-organizational nature, in which the way of supplier integration is similar over the different cases. Further, in order to the account for external validity the characteristics (size, organizational structure, etcetera.) of both supplier and focal firm should remain as stable as possible over the different cases.

### **FUNCTIONAL DIVERSITY**

The present study investigates the effect of functional diversity on the supplier's side on inter-organizational knowledge transfer. Comparison of different levels of functional diversity is essential in order to examine the underlying principles that are in play. Therefore, the last but most important selection criterion is the functional diversity of each case. Cases are selected with two or more functional specialties present in the supplier's team (table 2). Furthermore, another criterion is the similarity in the involved specialties on the supplier's side. This criterion is set in order to keep the boundary conditions as stable as possible over the different cases.

With the focus of the study in mind, nine relevant cases were suggested for field research by Mr. P. Flamend, Global advanced sourcing manager at FEI Company. Following the presented selection criteria six cases were selected from the pool of nine potential cases. The six selected projects varied in the degree of their functional diversity, ranging from two to five functional specialties involved. Table 2 shows the selected cases with the corresponding level of functional diversity. Case descriptions are given in Appendix A.

Supplier	Project	Functional diversity	Functions represented
Technolution	Super X	2	R&D, Project lead
VDL (industrial modules)	Lithicon enclosure	3	R&D, Sales, Project lead
NTS	Thalos	4	R&D, Operations, Sales, Project lead
Frencken	Exsolve stage	4	R&D, Operations, Sales, Project lead
PI	Piezo enhance compu stage	4	R&D, Engineering Sales, Project lead
NTS	Thalos enclosure	5	R&D, Architect, Project lead, Engineering, Sales

**Table 2, Selected cases**

## 2.7 DATA COLLECTION

The present study differentiates between two types of data collection; Desk research and interviews. Both categories are elaborated upon in this section.

### DESK RESEARCH

The desk research of the present study contained a study of both scientific and non-scientific material. Company websites and reports, and project documentation are used to explore the context of the present study and cases analyzed in the case study. Further, a literature review is conducted in order to land the present study in an academic context and develop a theory. Further, the theory derived from the literature study is used to define the case selection criteria, stipulate rival theories, and generalize the results over the cases (Yin, 2003).

### INTERVIEWS

Within all cases semi-structured interviews are conducted to generate empirical data. As knowledge transfer is not easily traceable, especially the motives behind it, interviews are simply the only viable mechanism to generate data. By conducting semi-structured interviews, the interviewer remains free to get in-depth and detailed information on the discussed topics, and address themes that were not found during the literature study. These interviews are obtained within FEI Company.

### INTERVIEWEE SELECTION

The interviews conducted within the different cases are the main source of empirical data. Therefore it is important that the right people are interviewed. In order to ensure a representative collection of empirical data and guard the reliability of the study, the interviewees are not selected at random but according to predefined characteristics. Furthermore, in each case multiple interviews are conducted with different interviewees in different functional specialties. This limits the chance that important data or information are missed, due to a lack of diversity in perspectives. In Appendix B a table is presented with the selected interviewees. In total eighteen interviews were conducted over seventeen different interviewees.

For each case at least the project leader and sourcing professional are interviewed. As the project leader controls most of the data transfer activities, and has great influence on the structure of the project team, his/her insight is of great importance. A sourcing professional is typically in control of the relationship with the supplier and knows their capabilities, which is why they are a key source of valuable information.

Further, dependent on the degree of functional diversity of the supplier's team more interviewees are selected per case. In order to select interviewees, besides the project leaders and sourcing professionals, two criteria were used. First, a mix of different functional specialties should be present among the interviewees. As functional specialties all view the supplier involvement from different angles their opinions on the required functional diversity might differ. Therefore, a variety of perspectives in terms of functional specialisms is perceived as valuable and required. Second, a mix of functional specialties which did, and did not find a counterpart had to be present among the interviewees, so both perspectives are taken into account. Functional specialties that do not find a counterpart in the supplier might think they should, where specialties which do might think differently of involving more functional specialties at the supplier's side.

## INTERVIEW PROTOCOL

The interviews were conducted via a predefined protocol in order to guard the reliability of the study. The interview protocol is presented in Appendix C.

The interview is built from multiple open questions which provide room for further discussions and follow-up questions. As the interviews are used to examine and adjust the conceptual model made from literature, the interview questions are mainly constructed from the propositions made in section 3.3.4. First, the key construct within the propositions are identified. Along this key construct a coding matrix (predefined codes only) is constructed, as described in section 2.10. Combining all codes then gives a feeling of the data which is to be gathered through the interviews. This is then used to create the interview questions. The interviews are built from case-specific questions and from general questions not related to a specific case. This enables the interviewer to go beyond the content of the case and discuss the experience of the interviewee in a broader context.

The via the propositions constructed interview questions focus on four main topics. First, general information about the project is gathered, together with a description of the functions involved and the role of the interviewee. Second, the relationship with the supplier is discussed on an organizational level. Third, the relationship with the different functional specialties of the supplier is debated. Fourth, the interviewees are questioned on the knowledge transfer with suppliers.

## 2.8 DATA ANALYSIS

The analysis of the empirical data is done in two steps. First, the general remarks on functional diversity transfer are used to examine the propositions drawn from literature, and explore rival theories. Thereafter, cross-case analysis is conducted in order to compare the different levels of functional diversity and their effect on inter-organizational knowledge transfer.

According to van Aken et al. (2007), two strategies to analyze qualitative data can be distinguished. One strategy, the grounded theory, has a data-driven approach and aims to develop concepts and relationships among them. The second strategy, the template approach, is theory driven and aims to examine a pre-developed theory. In this study a literature review is used to develop a theory. Therefore, the qualitative data of the interviews is analyzed using the template approach. The template approach is a method in which the transcripts of the interviews and other case related documents are coded according a set of predefined codes in combination with open coding. However, as described in section 2.5 (case study research design) the empirical data is furthermore used to explore rival theories, which indicates that the present study also follows a data-driven approach. This results in a combination of both open coding, and coding via a predefined set of codes. Using the NVivo software package the transcribed texts of the interviews are coded via a predefined set of codes to which additional codes were added via the open coding method. By creating a matrix, projects can be analyzed in a systematic way. The coding matrices in Appendix D give an example of the predefined codes that were used in the analysis of the data.

Concerning the open coding method – “breaking data apart and delineating concepts to stand for blocks of raw data and at the same time qualifying those concepts in terms of their properties and dimensions” (Corbin & Strauss 2008, p. 195) – the empirical data is coded until theoretical saturation is reached. This results in a large amount of codes which are categorized and grouped together. The categorization of codes is done on the bases of two fundamental questions: 1. Why should the supplier involve more functional specialties? and 2. Why should the supplier not involve more functional specialties?

### **3 LITERATURE REVIEW**

The main goal of the literature review is to answer RQ1-2 and make propositions that are to be further examined in RQ4. The two research questions answered in this section are:

RQ1: What are the key determinants and barriers of Inter-organizational knowledge transfer?

RQ2: How can functional diversity be defined, and what are the advantages and disadvantages?

Propositions are prepared for:

RQ4: Which aspects of functional diversity affect inter-organizational knowledge transfer and how?

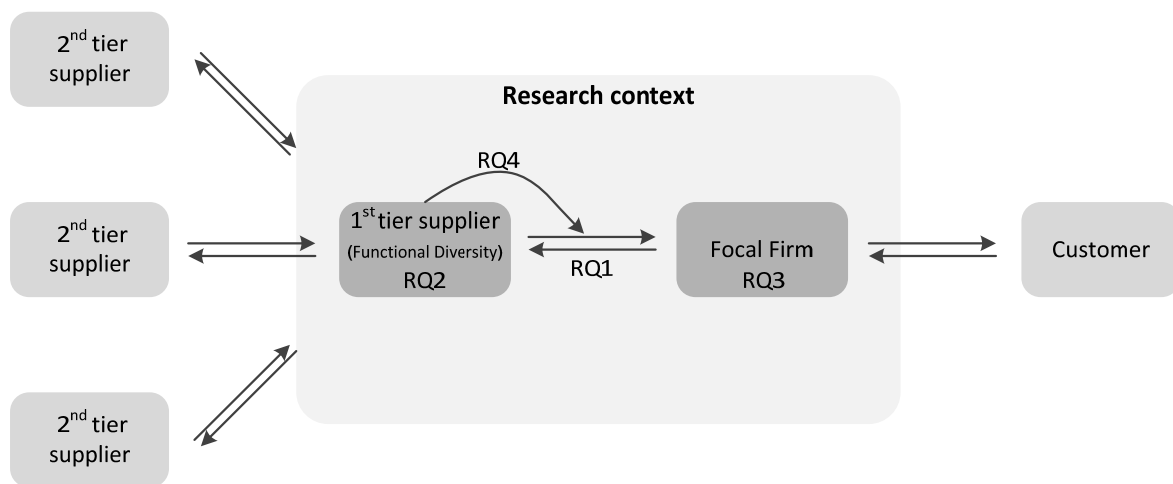
In order to provide an answer to these research questions a large amount of literature, all with an impact factor of 1.5 or higher, is analysed covering three different research fields: 1) knowledge management literature; 2) literature on cross functional teams and 3) new product development literature. Basically, what is done in this study is finding out what is known about knowledge transfer within and between organizations, and how this relates to findings of knowledge transfer in functional diverse teams or cross-functional teams.

The majority of articles is found through scholarly databases (i.e. ABI/Inform, Google Scholar, JSTOR, ScienceDirect and Wiley Online Library), where at least the following key-words were used: “knowledge sharing”, “knowledge management”, “functional diversity”, “knowledge transfer”, “collaboration”, “Inter-organizational”, “intra-organizational”, “supplier involvement”.

The above mentioned desk research strategies resulted in 135 potentially relevant articles. Further, a forward and backward search on article references is performed to enlarge the scope of search.

## FOCUS

The focus of this study lies within knowledge transfer between organizations. In this field, the effect that functional diversity at the supplier’s side of the cooperation can have on knowledge transfer is investigated. In figure 2 a graphical representation of the research context as it is described above is given.



**Figure 2, Research context**

Furthermore, although the first part discusses knowledge transfer between organizations and its antecedents, the discussed characteristics find their impact not only on the organizational level but also on an individual level. In fact, as the personnel is the working force behind organizations, characteristics of the organization and/or relationships with other organizations that influence knowledge transfer has its effect through its personnel.

*In other words: An organization cannot transfer knowledge. It is its personnel that can transfer knowledge. In knowledge transfer from one organization to another, the knowledge owner will assess not only the organization that he or she will transfer the knowledge to, but also the team and/or the person. That because those are the people who receive the knowledge in the end. The characteristics, capabilities, motives, etc. of the individual(s) making up the team influence whether or not knowledge transfer is useful and desired. As their characteristics, capabilities, motives, etc. are partially described by the organization they work for, the organizational characteristics, capabilities, motives, etc. find their way through its personnel.*

Throughout this literature review organizational and relational characteristics are addressed that affect knowledge transfer between organizations. As described above, it is important to bear in mind that these characteristics affect knowledge transfer not only on the organizational level but most importantly on the personal level as well.

The remainder of this section reads as follows, first RQ1 is addressed with an elucidation of knowledge transfer between organizations (S.3.1.). Thereafter, RQ2 is answered by a description of functional diversity on the side of the supplier, and its advantages and disadvantages (S.3.2.). Finally, propositions are made for RQ4 on which aspects of functional diversity on the supplier’s side of the cooperation affects knowledge transfer between the two organizations, and how they affect them (S.3.3.).

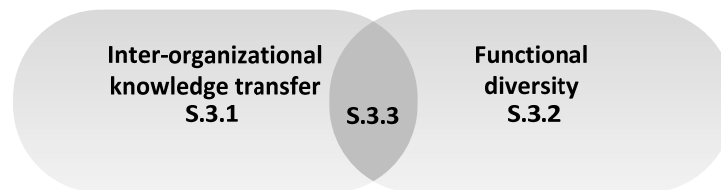


Figure 3, Connection of following sections

### 3.1 INTER-ORGANIZATIONAL KNOWLEDGE TRANSFER

As the importance of organizational learning increased due to the pursuit of competitive advantage, authors focused their studies on the antecedents, barriers and consequences of knowledge transfer. According to van Wijk et al. (2008), who studied knowledge transfer both within and between organizations, *knowledge transfer is referred to as the process by which knowledge is exchanged from one organizational actor to another*. Within this definition organizational actors are described as teams, units or entire organizations (van Wijk, et al., 2008). Although the term knowledge transfer is often used, other studies refer to this concept in an alternative but similar way; *knowledge sharing* (Hansen, 1999; Tsai, 2002). Within this study the term knowledge transfer is used because the main goal is to enable the FEI Company to obtain the knowledge and capabilities of their suppliers.

Term	Authors	Definition
Knowledge transfer	(van Wijk, et al., 2008), (Simonin, 2004), (Inkpen & Tsang, 2005), (Cummings & Teng, 2003) (Easterby-Smith, et al., 2008), (Zhoa & Lavin, 2012), (Emden, et al., 2006)	The process by which knowledge is exchanged from one organizational actor to another.
Knowledge sharing	(Tsai, 2002; Hansen, 1999), (Hansen, 1999), (Mäkelä, et al., 2012), (Riege, 2006)	The process in which knowledge is shared for collective use in order to pursue shared goals.

Table 3, Usage of knowledge transfer versus knowledge sharing in literature

In knowledge transfer literature a distinction is made between knowledge transfer within teams and organizations, and between organizations. The two fields of literature, within and between organizations/teams are in literature often referred to as inter- and intra-organizational knowledge

transfer. Where inter-organizational knowledge transfer describes the dynamics on an organizational level and intra-organizational knowledge transfer deals with both the unit and team level. The focus of the present study lies on the inter-organizational level of knowledge transfer.

The factors affecting inter-organizational knowledge transfer are covered extensively in literature and can be divided in knowledge characteristics, organizational characteristics, and relational characteristics as graphically displayed in figure 4. The following segments elaborate on the aforementioned categories of characteristics.

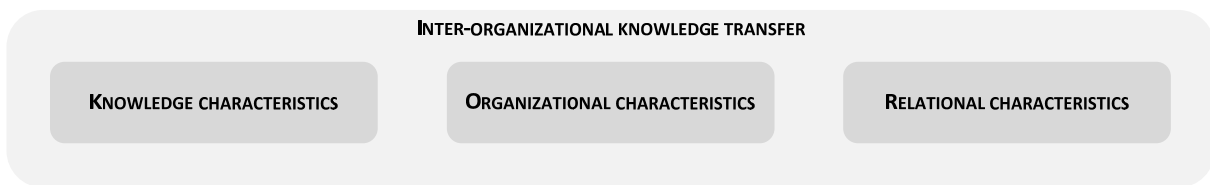


Figure 4, Three categories of characteristics affecting inter-organizational knowledge transfer

### 3.1.1 KNOWLEDGE CHARACTERISTICS

In literature a knowledge categorization exists that differentiates by “tacit” and “explicit” knowledge. *Tacit knowledge* is knowledge that is deeply rooted in experience and concerns the skills and know-how that are embedded in organizational actors (Levin & Cross, 2004; Meier, 2001; Zhoa & Lavin, 2012). Therefore tacit knowledge is considered to be subjective, personal and context specific (Hislop, 2009). Because tacit knowledge is embedded in experience it is difficult to codify, articulate and communicate, which makes it difficult to transfer (Hitt, et al., 2000; Levin & Cross, 2004; Meier, 2001; Zhoa & Lavin, 2012). According to Zhoa & Lavin (2012), who investigated knowledge transfer in working relationships with suppliers, collaborative experiences (i.e. in the form of training or coaching) enable the transfer of tacit knowledge. *Explicit knowledge* on the other hand, can easily be transferred due the fact that it can be formalized, codified and articulated in a systematic language (Hitt, et al., 2000; Meier, 2001; Ramesh & Tiwana, 1999; Zhoa & Lavin, 2012). According to Hislop (2009) explicit knowledge is characterized by being objective, impersonal, context specific. The distinction between tacit and explicit knowledge is used in literature as a spectrum with the two knowledge types as two extremes. Therefore, authors often refer to the tacitness of knowledge when discussing the type of knowledge present (Zhoa & Lavin, 2012).

Knowledge	
<p>Explicit knowledge: Knowledge that can be formalized, codified and articulated in a systematic language</p>	<p>Tacit Knowledge: Knowledge that is deeply rooted in experience and concerns the skills and know-how that are embedded in organizational actors</p>

Table 4, Definitions: two types of knowledge

Besides the tacitness of knowledge, also the ambiguity of knowledge is described in literature as an important factor for knowledge transfer. *Knowledge ambiguity refers to the extent to which the underlying components and sources of knowledge, and the way in which they interact, are inherent and irreducibly uncertain* (Reed & DeFillippi, 1990). According to Reed and Defilippi (1990), who studied the



barriers of imitation and sustainable competitive advantage, the ambiguity of knowledge makes it more difficult to transfer. Further, authors found that the ambiguity of knowledge is closely related to its tacitness (Easterby-Smith, et al., 2008; Reed & DeFillippi, 1990; Simonin, 2004), but also to its complexity (Kogut & Zander, 1992; Reed & DeFillippi, 1990).

Complexity deals with the degree in which knowledge is built from multiple fields and/ or types of knowledge (Reed & DeFillippi, 1990).

*To illustrate, knowledge can build on the fundamentals of mathematics, chemistry and biology (knowledge fields) covered over different sources such as raw data, experience and project reports (types of Knowledge). When more knowledge fields are fundamental to the knowledge to be transferred, it becomes harder to unravel the underlying components. The same goes for the different media. Analysing different types of knowledge in order to get the message hinders its easy transfer.*

Knowledge characteristics			
Factor of impact	Theory	Effect	Authors
Tacitness	Knowledge with a higher degree of tacitness is more difficult to transfer as it is deeply rooted in experience	Negative	(Hitt, et al., 2000) (Meier, 2001) (Levin & Cross, 2004) (Zhoa & Lavin, 2012) (Ramesh & Tiwana, 1999) (Hislop, 2009) (Hirunyawipada, et al., 2010) (Dixon, 2000) (van Wijk, et al., 2008) (Riege, 2006) (Easterby-Smith, et al., 2008)
Ambiguity	Knowledge transfer becomes more difficult when the underlying components and sources of knowledge, and the way in which they interact, are inherent and irreducibly uncertain	Negative	(Easterby-Smith, et al., 2008) (Reed & DeFillippi, 1990) (Simonin, 2004) (Cummings & Teng, 2003) (van Wijk, et al., 2008) (Ko, et al., 2005)

**Table 5, Knowledge characteristics on inter-organizational knowledge transfer**

### 3.1.2 ORGANIZATIONAL CHARACTERISTICS

Organizational characteristics that are commonly found to affect inter-organizational knowledge transfer are the organizational culture, the presence of a “not-invented here syndrome”, and the absorptive capacity.

#### ORGANIZATIONAL CULTURE

*Organizational culture* – The culture present in an organization – is explained by the system of values of an organization and its corporate vision. The system of values determines how people interact and work, and what is perceived as important (Gold, et al., 2001; Leonard, 1995; Miles, et al., 1997). Also

the corporate vision affects the organizational culture as it enables people to work towards a common goal (Gold, et al., 2001; Leonard, 1995) and evokes a sense of involvement and contribution among employees (O'Dell & Grayson, 1998; van Wijk, et al., 2008)

Certain compositions of values and the corporate vision positively affect inter-organizational knowledge transfer. A system of values and a corporate vision in which the delegation of responsibilities is promoted, creative mistakes are tolerated, and time is given to explore new ideas is in literature referred to as a learning culture (Cummings & Teng, 2003). Such vision and values reduce the perceived risk of failure when looking for solutions elsewhere, but also stimulate the exploration of alternatives. A learning culture is perceived by authors to have a strong positive effect on inter-organizational knowledge transfer, as actors search for alternatives outside organizational boundaries (Cummings & Teng, 2003; Davenport & Prusak, 1998; Meier, 2001; Pérez-Nordtvedt, et al., 2008; van Wijk, et al., 2008).

A crucial element in a learning culture is the learning intent of a company, which is part of the corporate vision. According to the study Tsang (2002) on acquiring knowledge in international joint ventures, learning intent was a key factor in knowledge transfer as it describes the desire to learn and acquire the knowledge from the partner firm and commit resources to knowledge transfer activities.

### NOT-INVENTED-HERE SYNDROME (NIH)

In some organizations resistance is given to external knowledge and ideas, especially when it requires abandoning internal knowledge (Cummings & Teng, 2003). This is known as the not-invented-here (NIH) syndrome, which often restricts inter-organizational knowledge transfer (Gupta, et al., 1985). Katz and Allen (1982) studied the group characteristics that facilitate the NIH syndrome and found that confidence in a team/organization's capabilities plays a key role. When a team/organization believes that the problem can be solved with internal resources, the readiness to accept external knowledge decreases (Katz & Allen, 1982). Further, the NIH syndrome can be caused by a lack of or negative experiences with external knowledge (Allen, 1977; Katz & Allen, 1982). The NIH-syndrome hinders inter-organizational knowledge transfer, as organizational actors are demotivated to acquire knowledge from outside organizational boundaries.

### ABSORPTIVE CAPACITY

While the learning culture and the NIH syndrome describe the willingness of organizational actors to acquire external knowledge, the absorptive capacity describes their ability to acquire new knowledge. The degree to which an organization is able to internalize external knowledge is in literature referred to as the absorptive capacity of an organization (Cohen & Levinthal, 1990; Easterby-Smith, et al., 2008; Lane & Lubatkin, 1998; Meier, 2001; van Wijk, et al., 2008). Cohen and Levinthal (1990, p128) defined absorptive capacity as 'the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends'. To what extent an organization is able to learn from external parties is dependent on the similarities in knowledge bases and the way of working (Lane & Lubatkin, 1998; Meier, 2001). These characteristics are discussed in further detail within the following section, "Relational characteristics". Here "similarities in knowledge bases" is referred to a "prior basic knowledge", and way of working is witted within the cognitive dimension.

Organizational characteristics			
Factor of impact	Theory	Effect	Authors
Learning culture	When the delegation of responsibilities is promoted, creative mistakes are tolerated, and time is given to explore new ideas, then the risk of failure when looking for solutions elsewhere is reduced. This stimulates the exploration of alternatives, which includes looking outside organizational boundaries	Positive	(Cummings & Teng, 2003) (Davenport & Prusak, 1998) (Emden, et al., 2006) (Ko, et al., 2005) (Meier, 2001) (Pérez-Nordtvedt, et al., 2008) (Riege, 2006) (Tsang, 2002) (van Wijk, et al., 2008) (Zheng, et al., 2010)
NIH-syndrome	Resistance to external knowledge hinders the adoption of new knowledge from outside organizational boundaries and therefore inter-organizational knowledge transfer	Negative	(Allen, 1977) (Cummings & Teng, 2003) (Gupta, et al., 1985) (Katz & Allen, 1982) (Katz & Allen, 1985) (Ko, et al., 2005)
Absorptive capacity	When an organization is unable to internalize new knowledge, then it becomes useless to transfer knowledge to that organization	Positive	(Cohen & Levinthal, 1990) (Easterby-Smith, et al., 2008) (Emden, et al., 2006) (Gold, et al., 2001) (Ko, et al., 2005) (Lane & Lubatkin, 1998) (Meier, 2001) (van Wijk, et al., 2008)

**Table 6, Influence of organizational characteristics on inter-organizational knowledge transfer**

### 3.1.3 RELATIONAL CHARACTERISTICS

Relational characteristics describe antecedents of knowledge transfer that operate between the two organizational actors. These antecedents encompass several aspects of social context, for example social ties and trust (van Wijk, et al., 2008). The study of Inkpen and Tsang (2005) uses three dimensions to describe the social context: the structural, cognitive and relational dimension. In this study the three dimensions of Inkpen and Tsang (2005) are used to elaborate on the relational characteristics that influence knowledge transfer.

#### 3.1.3.1 STRUCTURAL DIMENSION

The structural dimension deals with configuration and patterns of relationships among partners and can be viewed from a perspective of social ties within a network. Social ties explain how organizational actors (individuals, teams or organizations) within a network are connected and related. They are of key importance as they create opportunities for social exchange, and thus knowledge transfer (Inkpen & Tsang, 2005; Krackhardt, 1992; Tsai & Ghoshal, 1998). A larger amount of social ties increases the probability that relevant knowledge is accessible (Krackhardt, 1992; van Wijk, et al., 2008; Tsai & Ghoshal, 1998).

The way organizational actors interact, the configuration of social ties, is dependent on the structural element of density (Inkpen & Tsang, 2005; Tsai & Ghoshal, 1998). The density of a network is concerned with frequency of interaction and is strongly linked to trust, which is described within the third dimension. Further, in a network one can be in different kinds of positions. When the amount of connections that one has is limited, one probably holds a position on the edges of the network. On the other hand, someone with a large amount of connection is at the centre of the network. A central

position in the network is associated with higher level of knowledge transfer, because central positions may access other actors easily (Burt, 1992; Tsai & Ghoshal, 1998).

### **3.1.3.2 COGNITIVE DIMENSION**

The cognitive dimension deals with the resources that provide network actors with a common meaning and understanding. Inkpen and Tsang (2005) discuss shared goals and a shared organizational culture as two main aspects concerning the cognitive dimension. Concerning common goals within an intra-organizational context, network members usually work towards the same goal that is set by the headquarters. However, they often also pursue certain secondary goals that are related to their own set of responsibilities. Within an inter-organizational context, although it is likely to have some overlap in goals, a common main goal is usually absent (Inkpen & Tsang, 2005).

*To illustrate: People working for different organizations do not share the same company values and goals. Where one company may be a non-value profit organization and focuses on the environment, the other may only value profit. The non-profit organization will, also in collaboration with the other organization, work towards environmental friendly solutions, where the profit organization is more concerned with making a profit out of it. In such collaborations, the non-profit organization will probably withhold more profitable alternative solutions that are less environmental friendly (and vice versa).*

Therefore, collaboration between two organizations can suffer from a lack in goal coherence. This also holds on a personal or team/group level. Shared culture, which relates to the organizational culture as it is described in the organizational characteristics, describes the degree in which relations are governed by norms of behaviour. In inter-organizational relations cultural conflicts may arise when partners rigidly demand their own way of working (Inkpen & Tsang, 2005), which hampers cooperation and thus knowledge transfer (van Wijk, et al., 2008). According to van Wijk, et al. (2008), a shared vision and way of working enhances the mutual understanding, and helps with the transfer of knowledge as trust is more easily built and familiar procedures are in place.

### **3.1.3.3 RELATIONAL DIMENSION**

The relational dimension explains the nature of the relationships themselves, and is in literature mainly described through the strength of relations and trust. The strength of a relationship can be described as the closeness of the relationship among network actors, and is often referred to as tie strength (van Wijk, et al., 2008). Stronger ties are found to stimulate knowledge transfer as they motivate actors to ensure their partner understands the newly acquired knowledge sufficiently (van Wijk, et al., 2008; Zhao & Lavin, 2012).

Trust is, in general, defined as the degree in which one is willing to accept vulnerability based on the belief that another's intentions and/or behaviours are contributing (Mayer, et al., 1995). At an inter-organizational level, authors categorize two distinct forms of trust; competence trust, concerning whether or not one believes that the partner can perform according expectations, and goodwill trust,

concerning the belief that the partner has the right intentions (Nooteboom, 1996). Knowledge transfer is only likely to occur when both types of trust are present on both the organizational level and personal level.

According to Inkpen & Tsang, the structural dimension can have its effect on the trust among new partners. This is due to the fact that the structure of the network determines the social ties among network members.

### PRIOR BASIC KNOWLEDGE

The study of Lane and Lubatkin (1998) described the importance of common knowledge/prior basic knowledge – a general understanding of the fundamentals on which the new knowledge is based –in the field of one’s partner in order to facilitate inter-organizational knowledge transfer. Prior basic knowledge consists of basic skills (e.g. working together with others), shared language (e.g. technical language), and technical knowledge (e.g. how to write software codes) (Dixon, 2000). Prior basic knowledge is essential in order to understand the knowledge to be transferred, and thus make it possible to fully transfer it for future use.

According to Makela et al. (2012), who studied interpersonal similarity and knowledge sharing in multinational organizations, a shared functional background between two people allows individuals to rely on common points of reference and a shared way of thinking. This can have a mediating effect on the conflict provoking effects of lacking goal coherence and the absence of a shared working culture (Makela, et al., 2007).

### SPECIALIZED KNOWLEDGE

Although some similarity in knowledge bases is needed in order to successfully transfer knowledge from one organizational actor to another, some differences should be present at the level of knowledge of both actors as well. When two actors possess the exact same level of knowledge, knowledge transfer becomes irrelevant and impossible (Lane & Lubatkin, 1998). A different level of understanding/specialized knowledge should be present in order to make knowledge transfer possible and relevant.

### COMPETITIVE OVERLAP

In a situation where collaboration between competitors is present, trust issues arise. The extent to which both organizations are active in the same industry and market is in literature described as the competitive overlap among partners. Competitive overlap, besides the negative effect of trust issues, can also enhance knowledge transfer due its positive effect on the absorptive capacity through similarities in basic knowledge (Emden, et al., 2006; Inkpen & Tsang, 2005; Meier, 2001).

Relational characteristics			
Factor of impact	Theory	Effect	Authors
Diverse perspectives	Integrating suppliers into NPD increases the amount and variety of perspectives. A wider variety of perspectives increases the probability that useful knowledge is present	Positive	(Inkpen & Tsang, 2005) (Krackhardt, 1992) (Ngai, et al., 2008) (Tsai & Ghoshal, 1998) (van Wijk, et al., 2008)
Central network position	A central position in the network enables easy access to valuable knowledge	Positive	(Burt, 1992) (Easterby-Smith, et al., 2008) (Tsai & Ghoshal, 1998)
Goal coherence	A lack of goal coherence can increase conflict and thereby reduce knowledge transfer	Negative	(Emden, et al., 2006) (Inkpen & Tsang, 2005) (Gold, et al., 2001) (Ko, et al., 2005) (Nissen, et al., 2014) (van Wijk, et al., 2008)
Common culture	A lack of coherence in organizational culture can hamper cooperation as different ways of working are present	Negative	(Emden, et al., 2006) (Inkpen & Tsang, 2005) (Gold, et al., 2001) (Ko, et al., 2005) (van Wijk, et al., 2008)
Tie strength	When a relationship is stronger knowledge transfer is enhanced as more trust is present and both parties are familiar with each other	Positive	(Cummings & Teng, 2003) (Easterby-Smith, et al., 2008) (Emden, et al., 2006) (Inkpen & Tsang, 2005) (Ngai, et al., 2008) (van Wijk, et al., 2008) (Zhoa & Lavin, 2012)
Trust	Two types of trust; goodwill and capability trust. One would not transfer knowledge to someone of whom they think does not have the right intentions with the knowledge and/or is not capable of understanding and using the transferred knowledge	Positive	(Cummings & Teng, 2003) (Dyer & Chu, 2011) (Easterby-Smith, et al., 2008) (Inkpen & Tsang, 2005) (Meier, 2001) (Morgan & Hunt, 1994) (Nooteboom, 1996) (Regatz, et al., 1997) (van Wijk, et al., 2008) (Zhoa & Lavin, 2012)
Competitive overlap	Competitive overlap leads to more trust issues, however it does have a positive effect on the absorptive capacity	Negative/Positive	(Emden, et al., 2006) (Inkpen & Tsang, 2005) (Meier, 2001)
Prior basic knowledge/Common knowledge	Prior basic knowledge, helps understanding the assumptions at the base of new knowledge. Further, it can help to distinguish valuable from non-valuable new knowledge and integrate it for commercial use	Positive	(Cummings & Teng, 2003) (Daghfos, 2005) (Dixon, 2000) (Emden, et al., 2006) (Gold, et al., 2001) (Grunwald & Kieser, 2007) (Inkpen & Tsang, 2005) (Lane & Lubatkin, 1998) (Nissen, et al., 2014) (Regatz, et al., 1997)
Specialised knowledge	When two parties overlap in specialised knowledge, knowledge transfer becomes useless as both already possess the same knowledge	Negative	(Daghfos, 2005) (Dixon, 2000) (Emden, et al., 2006) (Grunwald & Kieser, 2007) (Inkpen & Tsang, 2005) (Lane & Lubatkin, 1998) (Nissen, et al., 2014)

**Table 7, Influence of organizational characteristics on inter-organizational knowledge transfer**

### 3.2 FUNCTIONAL DIVERSITY

Diversity within teams is in literature described on several different topics. The study of Ancona and Caldwell (1992) for example, investigated the effects of team diversity on NPD performance with respect to the age, gender, tenure, ethnic background, and functional specialty of the team members. Where the age, gender, tenure, and ethnic background are mainly covered under diversity in general, diversity in functional specialties is in literature referred to as *functional diversity*.

In a functional diverse team representatives from different departments, all with their own knowledge field, social network, goals and culture, are brought together (figure 5). On the one hand this gives the potential to enhance the team’s capabilities, and on the other hand it can hinder the collaboration within the team (Ancona & Caldwell, 1992; Brown & Eisenhardt, 1995; Harrison & Klein, 2007; Keller, 2001; McDonough III, 2000; Ratcheva, 2009).

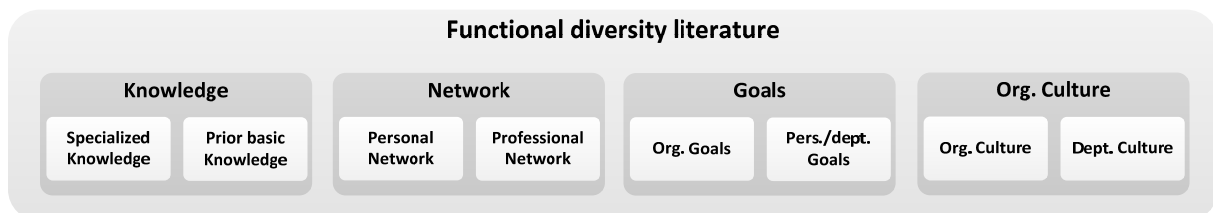


Figure 5, What does functional diversity bring to a team?

#### 3.2.1 KNOWLEDGE

Bringing different functional specialties together in a team increases the variety and the amount of prior basic, and specialized knowledge that becomes available as the different functional specialties all have different knowledge fields and different ways of looking at the world (Ancona & Caldwell, 1992; Brown & Eisenhardt, 1995; Harrison & Klein, 2007; Keller, 2001; McDonough III, 2000; Reagans & Zuckerman, 2014).

The amount of diverse knowledge that functional diversity brings to the table is useless if the team is not able to integrate the knowledge in an effective manner (Dougherty, 1992; Ratcheva, 2009). In order to integrate knowledge in an effective manner a general understanding of the fundamentals on which the new knowledge is based, and thus prior basic knowledge, is needed (Lane & Lubatkin, 1998). Different functional specialties from the same organization do not share the same prior basic knowledge in terms of educational history, but do share a high degree of prior basic knowledge in terms of product understanding.

#### 3.2.2 NETWORK

The social network increases as every person who is added to the team has a different personal and professional network. On the matter of external connection, the heterogeneity has a strong positive influence on diversity and amount of connections (Keller, 2001; Magjuka & Baldwin, 1991). Ancona & Caldwell (1992) also found that a higher degree of functional diversity lead to more frequent communication across team boundaries (external connections).

However, according to Reagans & Zuckerman (2014), who studied the social capital of R&D teams, the social network (set of internal and external connections) tends to become less dense and less homogenous when teams get larger. This means that when the size of the teams increases the amount of social ties increase but also tend to become weaker. That is why, according to Reagans & Zuckerman (2014), larger teams tend to communicate with inferior quality and frequency.

### **3.2.3 GOALS AND CULTURE**

Functional diversity brings more together than just knowledge and external connections, also different ways of working, and goals are brought together when functional diversity increases.

Ratcheva (2009) discussed shared goals within an intra-organizational context. They found that members of the same organization usually work towards the same goal that is set by the headquarters. However, they often also pursue certain secondary goals that are related to their own set of responsibilities. When the goals of team members interfere conflicts can arise, which hampers collaboration (Ancona & Caldwell, 1992; Inkpen & Tsang, 2005; Ratcheva, 2009). As depicted by Reagans & Zuckerman (2014), effective management and collaboration becomes more difficult as the social network increases. As the amount of stakeholders increases, the variety of individual goals enlarges as well. Especially when it comes to cooperation with other organizations, goal coherence can become a problem (Mäkelä, et al., 2012).

Differences in ways of working and expectations about working can hamper with knowledge transfer as it fuels conflicts (Ratcheva, 2009; Dougherty, 1992; Grant, 1996; Gupta, et al., 1985). Ratcheva (2009), and Olso, Walker and Reukert (1995) state that members of functional diverse teams, although part of the same organization, are part of different organizational (departmental) cultures and therefore bring different expectations about work relations and ways of working to the team.

## **3.3 CONCEPTUAL MODEL**

In the previous section (3.2) functional diversity and its effect on a team are described. From this discussion four main categories arise of factors that affect knowledge transfer; knowledge, network, goals, and organizational culture. In this section the findings on these four categories are linked to the in section 3.1 presented antecedents of inter-organizational knowledge transfer. Describing one category at a time, this section builds towards a conceptual model which is presented in 3.3.4.



### 3.3.1 KNOWLEDGE

Functional diversity has a positive effect on the variety and amount of prior basic and specialized knowledge present in a team. The specialized knowledge of the different functional specialists enriches the collaboration with more diverse perspectives. The enlarged amount of knowledge and wide range of perspectives enable knowledge transfer over more content (Ancona & Caldwell, 1992; Brown & Eisenhardt, 1995; Harrison & Klein, 2007; Keller, 2001; McDonough III, 2000; Reagans & Zuckerman, 2014).

**Proposition 1a:** Functional diversity on the supplier's side increases the amount of perspectives and knowledge that is present and available for knowledge transfer.

However, as described within the organizational characteristics (section 3.1.2), absorptive capacity can influence the amount of knowledge that the focal firm is able to obtain from its supplier. It was described how similarities or differences in knowledge bases, later referred to as prior basic knowledge, can affect inter-organizational knowledge transfer (Cohen & Levinthal, 1990; Gold, et al., 2001; Easterby-Smith, et al., 2008; Ko, et al., 2005; Emden, et al., 2006; Lane & Lubatkin, 1998; Meier, 2001; van Wijk, et al., 2008). Also the literature on functional diversity described prior basic knowledge as a key factor in knowledge transfer (Dougherty, 1992; Ratcheva, 2009).

Through functional diversity more specialists will find a counterpart at the supplier's side which connects in terms of prior basic knowledge. This increases the quantity and the quality of knowledge transfer.

**Proposition 1b:** Functional diversity on the supplier's side can overcome barriers of prior basic knowledge thereby stimulating the quantity and the quality of knowledge transfer.

A small part of the absorptive capacity concerns a shared way of thinking, or as referred to by Parkhe (1998); mutual understanding. As described within the relational dimension (section 3.1.3.3), a shared functional background between two individuals allows them to rely on a common point or reference and a shared way of thinking (Makela, et al., 2007). The study of Parkhe (1998) on trust building in international alliances stated that the greater the mutual understanding, the greater the trust building among both partners is. Further, social ties stimulate inter-organizational knowledge transfer. As social tie strength is strongly related to trust, the trust among organizational actors is of key importance in inter-organizational knowledge transfer (Cummings & Teng, 2003; Dyer & Chu, 2011; Dyer & Chu, 2003;

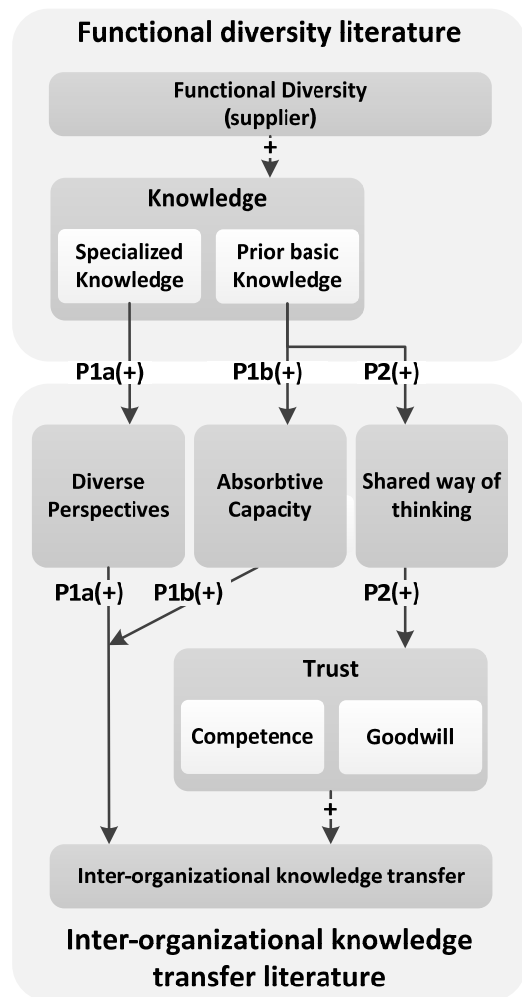


Figure 6, Relational diagram (Knowledge)

Easterby-Smith, et al., 2008; Inkpen & Tsang, 2005; Meier, 2001; Morgan & Hunt, 1994; Nooteboom, 1996; Regatz, et al., 1997; van Wijk, et al., 2008).

**Proposition 2:** Functional diversity on the supplier’s side enables trust building and the strengthening of social ties through mutual understanding, thereby stimulating inter-organizational knowledge transfer.

### 3.3.2 NETWORK

Functional diversity brings a larger and more diverse social network to the table as the personal and professional social networks of the different functional specialists are likely to differ (Keller, 2001; Magjuka & Baldwin, 1991).

As described within the relational dimension (section 3.1.3.3), there are two ways in which the social network could affect inter-organizational knowledge transfer. First, larger networks contain more knowledge. As teams broaden, the number of social ties enlarges. This increases the probability that relevant knowledge is accessible within the network (Krackhardt, 1992; van Wijk, et al., 2008; Tsai & Ghoshal, 1998).

**Proposition 3:** Functional diversity on the supplier’s side increases the amount of knowledge that is present and available for knowledge transfer within the network of the project teams.

Second, as described within the relational dimension (section 3.1.3.3) expanding networks tend to get denser as they enlarge (Inkpen & Tsang, 2005; van Wijk, et al., 2008; Cummings & Teng, 2003; Easterby-Smith, et al., 2008). Inkpen & Tsang (2005) mentioned that the level of trust is affected by the configuration of the network, in which the level of trust is likely to increase in a denser network. This is mainly described among two parties which are already tied to each other. However, whether or not this also affects the level trust in a third party which is only known by one network member, is less documented. Can shared connections in a network facilitate a kick-start in trust between two not directly tied parties, through positive feedback?

To illustrate: *When two parties have a shared connection with whom they both have worked, they can both consult the shared connection on their experience with the other party. If a high level of trust is present between both parties and their shared connection, and the shared*

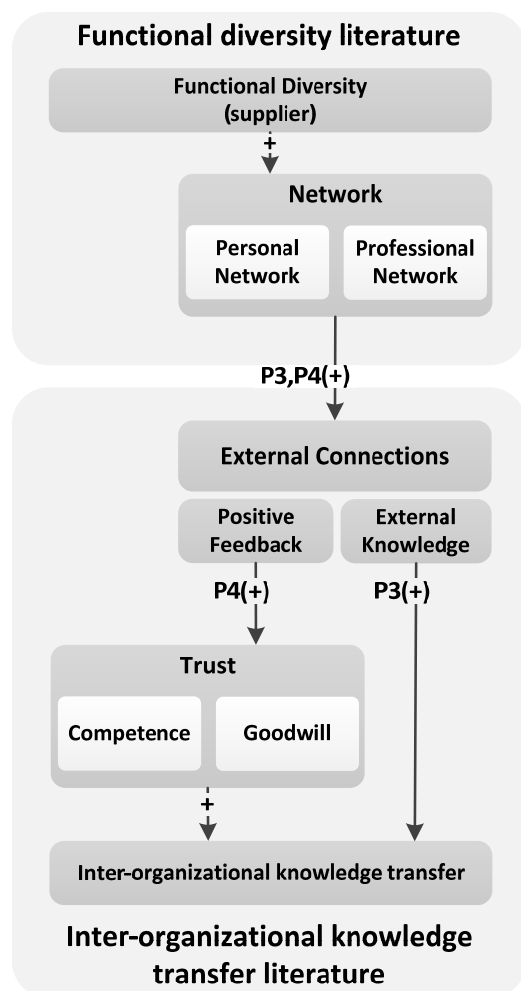


Figure 7, Relational diagram (Network)

connection indeed gives positive feedback for both parties, the level of trust among the two parties will increase.

**Proposition 4:** Functional diversity on the supplier’s side enlarges presence of shared connections/ties. Having shared connections in a network that provide positive feedback enables more trust building, which is key for inter-organizational knowledge transfer.

### 3.3.3 GOALS AND CULTURE

Within the cognitive dimension (section 3.1.3.2), goal coherence was described as a real issue. A lack of goal coherence is fuel for conflicts in an inter-organizational context (Inkpen & Tsang, 2005). Within functional diversity literature (section 3.2.3) it was found that team members pursue both organizational and departmental/personal goals (Mäkelä, et al., 2012). As organizational and departmental/personal goals are not necessarily in line, functional diversity can increase the variety of goals in a team. This variety in goals enables conflicts in for instance priorities or project scope, and can thereby make collaboration more difficult (Ancona & Caldwell, 1992; Inkpen & Tsang, 2005; Ratcheva, 2009).

**Proposition 5:** Functional diversity on the supplier’s side decreases the goal coherence in the supply team as more personal and departmental goals are present. This negatively affects inter-organizational knowledge transfer as more conflicts are present due to the misalignment of stakeholders.

Mismatches in organizational culture can hinder knowledge transfer as conflicts can arise when partners rigidly demand their own way of working (Inkpen & Tsang, 2005). Functional diversity does not affect the organizational culture and ways of working of a company. However, within organizations departments create an own organizational (departmental) cultures which is generally in line with the (entire) organization’s culture, but differs slightly from the culture present in other departments within the company (Ratcheva, 2009; Dougherty, 1992; Grant, 1996; Gupta, et al., 1985).

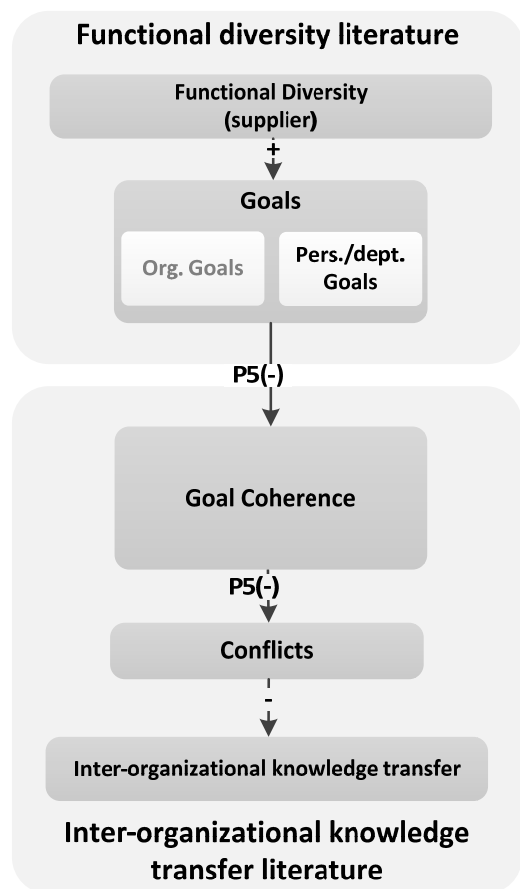


Figure 8, Relational diagram (Goals)

**Proposition 6:** Functional diversity on the supplier’s side amplifies the diversity in organizational (departmental) cultures. This enables more conflict and has a negative effect on knowledge transfer.

### 3.3.4 CONCEPTUAL MODEL

By combining the above presented diagrams (figure 6-9), the conceptual model is constructed. This conceptual model contains all above mentioned propositions, including one extra. Proposition 7 was not included in the previous discussions on the construction of the conceptual model. It finds its effect in the intersection of the functional diversity aspects knowledge, goals, and organizational culture. Before presenting a summarizing table of all propositions and the conceptual model (section 3.3.4.2), proposition 7 is explained (section 3.3.4.1).

#### 3.3.4.1 ADDITIONAL PROPOSITION

Makela et al. (2012), in their study on interpersonal similarity and knowledge sharing in multinational organizations, describe how functional diversity mediates the hindering effect of the cognitive dimension. A shared functional background between two actors of both firms, of which the probability increases when more functional specialties are added, allows individuals to rely on common points of reference and a shared way of thinking. According to their study, this can mediate the hindering effects a lacking goal coherence and shared culture.

**Proposition 7:** Functional diversity on the supplier’s side enables functional specialists of the focal firm to find counterparts at the supplier with a shared way of thinking which mediates the hindering effects of a lack in goal coherence and culture.

#### 3.3.4.2 CONCEPTUAL MODEL

Table 8 summarizes all propositions made in the previous sections, including proposition 7.

Propositions	
1a	Functional diversity on the supplier’s side increases the amount of perspectives and knowledge that is present and available for knowledge transfer.
1b	Functional diversity on the supplier’s side can overcome barriers of prior basic knowledge thereby stimulating the quantity and the quality of knowledge transfer.
2	Functional diversity on the supplier’s side enables trust building and the strengthening of social ties through mutual understanding, thereby stimulating inter-organizational knowledge transfer.
3	Functional diversity on the supplier’s side increases the amount of knowledge that is present and available for

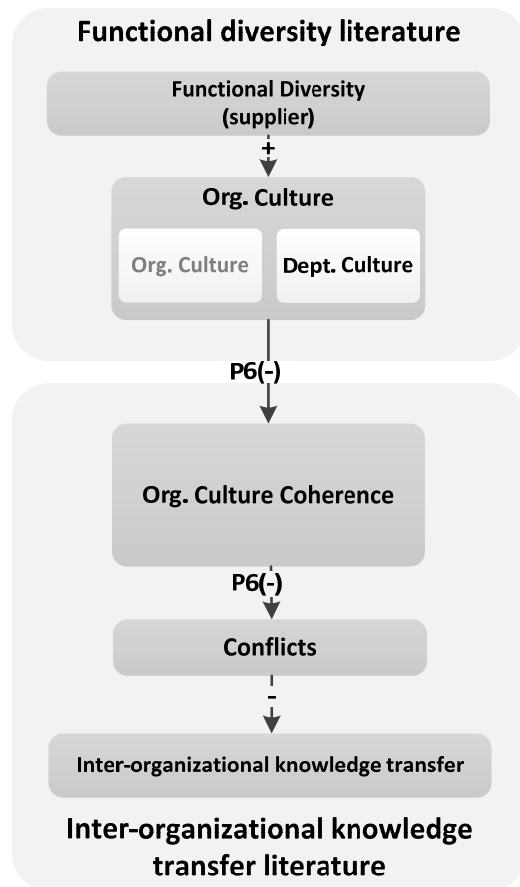
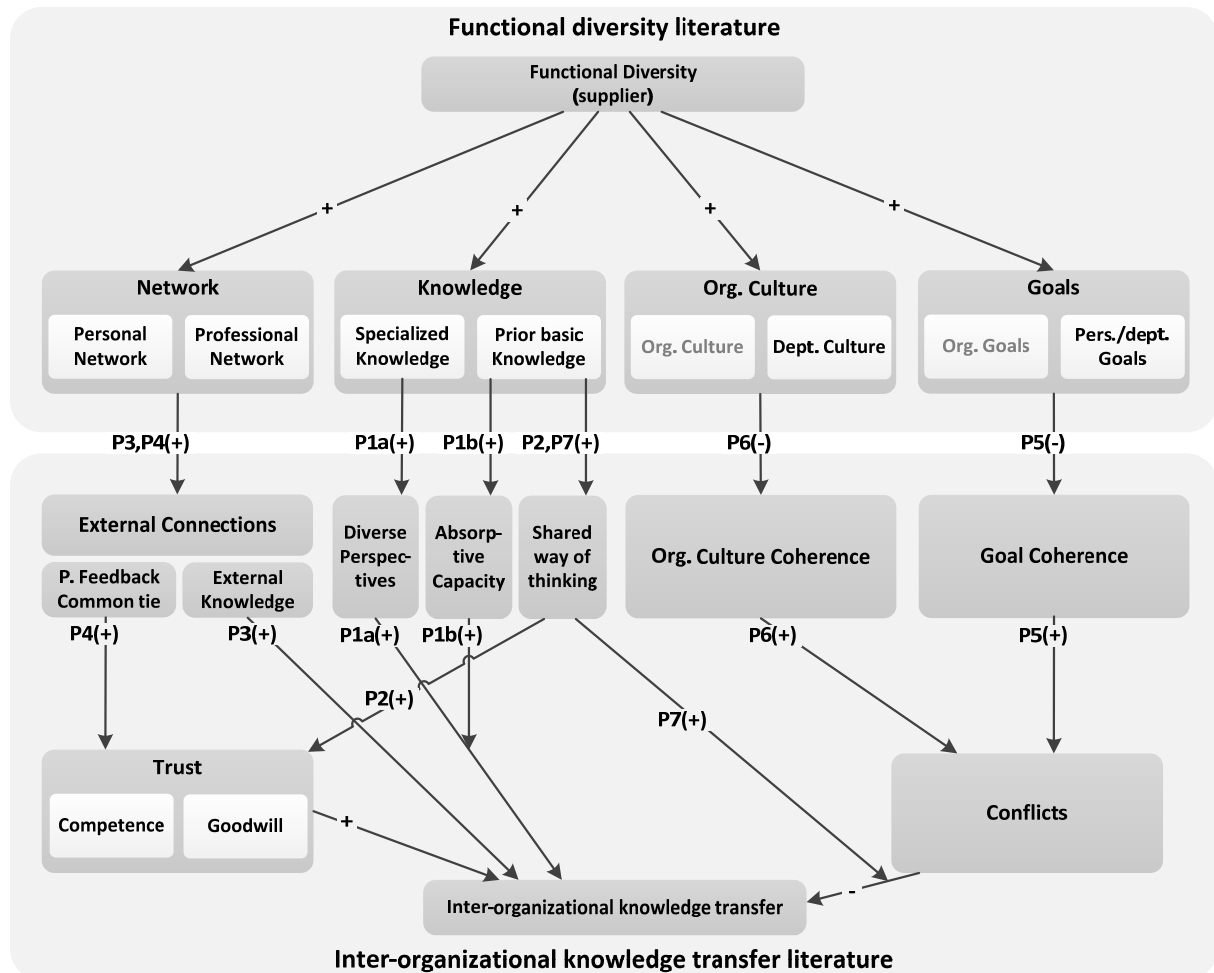


Figure 9, Relational diagram (Org. Culture)

	knowledge transfer in the network of the project teams.
4	Functional diversity on the supplier's side enlarges presence of common connections/ties. Shared connections in a network that provide positive feedback enables more trust building, which is key for inter-organizational knowledge transfer.
5	Functional diversity on the supplier's side decreases the goal coherence in the supply team as more personal and departmental goals are present. This negatively affects inter-organizational knowledge transfer more conflicts are present, due to the misalignment of stakeholders.
6	Functional diversity on the supplier's side amplifies the diversity in organizational (departmental) cultures. This enables more conflict and has a negative effect on knowledge transfer.
7	Functional diversity on the supplier's side enables functional specialists of the focal firm to find counterparts at the supplier with a shared way of thinking and which mediates the hindering effects of a lack in goal coherence and culture.

**Table 8, All propositions**

These propositions form the base of the conceptual model which is presented in figure 10. The layout of the conceptual model is a simple summation of figures 6 to 9, in which the relation of proposition 7 is added.



**Figure 10, Conceptual model**

## 4 EMPIRICAL RESEARCH

This chapter presents the results and findings of the empirical research. The aim of this chapter is to examine and adjust the conceptual model, and answer the following research questions:

- RQ3: How does FEI Company currently manage supplier involvement and how does it enable knowledge transfer with their suppliers?
- RQ4: Which aspects of functional diversity within the supplier's project team affect inter-organizational knowledge transfer, and how?

The findings from the empirical research are discussed in section 4.1 to 4.6. First Section 4.1 describes how FEI collaborates with suppliers on a project level and why (RQ3). Thereafter, sections 4.2 till section 4.4 explain the results of the empirical analysis in line with the conceptual model presented in section 3.3 (RQ4). Subsequently, section 4.5 elaborates on three topics which were only found within the empirical research, are not extensively covered in section 4.1 to 4.5, and mediates the effect of functional diversity of the supplier on inter-organizational knowledge transfer.

*Note: In some circumstances indications are given on the responses of the interviewees presented in the following manner: (5; 7; 3). in this representation of the responses the first number describes the amount positive replies to the prior statement. The second number displays the amount of neutral responses and the third the negative reactions.*

### 4.1 COLLABORATION BETWEEN ORGANIZATIONS

The way in which FEI collaborates with suppliers in NPD projects is derived from empirical data collected from the interviews. On a project level typically three interfaces emerge; *the main interface, a secondary interface and the interface between the organizational teams* (figure 11). The main interface consists of a multidisciplinary project leader, and a representative of the commercial side and occasionally one representing the technical end. Both organizations are preferably represented in the main interface in this way. The organizational teams from each organization entail representatives from the different functional specialties present in the project. These teams determine the organizational alignment in the project. The secondary interface links functional specialists from both organizational teams directly and is used sporadically for cooperation over organizational boundaries. Such cooperation is limited to content that does not affect other disciplines in the collaboration, so no contradicting agreements are made between different functional specialties in the secondary interface. The

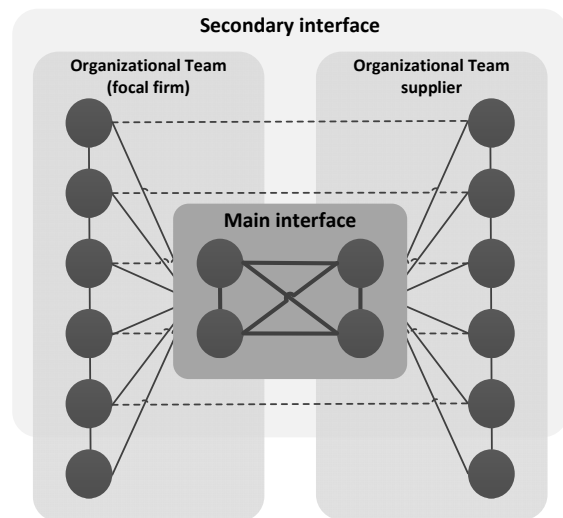


Figure 11, Interfaces between the 2 organizations, FEI and supplier.

responsibility to avoid contradicting agreements lies within the main interface. The main interface is in charge of inter-organizational alignment and controlling the boundaries of the project, and thus responsible for the majority of the communication with the supplier. Representatives of the secondary interface are involved in inter-organizational discussions when more details are needed which cannot be covered by individuals from the main interface. This results in for example a technical meeting where the engineers and the project leaders are brought together to discuss the project. It is of note that not all functional representatives present in the organizational teams are necessarily also part of the secondary interface.

When asked why the collaboration among organizations within projects is structured in such a manner, the answer boils down to *complexity* (8; 0; 0). If one man would have all the relevant knowledge available within the organization, the interface would be rather simple (figure 12.A). However, in organizations knowledge is generally divided over different functional specialist. Therefore, different functional specialties are involved in a collaboration. Involving more functional specialties increases the amount of social ties and interactions between the two organizations. Functional specialists collaborate and make agreements with counterparts (figure 12.C), or with counterparts and other functional specialties (figure 12.B). Although more social ties and interactions enable more knowledge transfer, it also increases the likelihood of miscommunications and contradicting agreements. It may for instance happen that the promises that sales and sourcing specialists made do not correspond with what engineers agreed upon. To avoid this the structure of interfaces can be confined to a limited amount of personnel. They determine the inter-organizational alignment (figure 12.D).

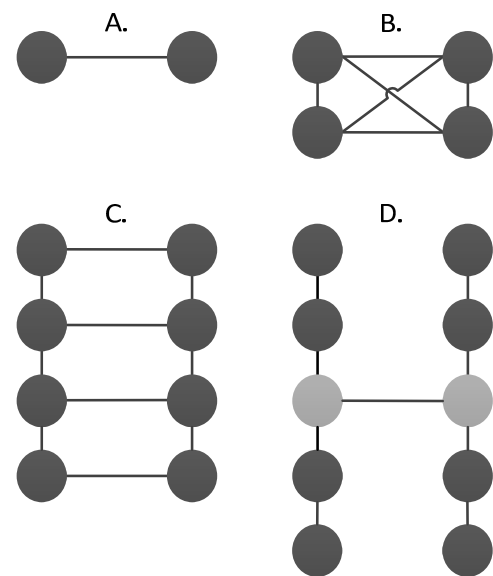


Figure 12, Complexity within the interfaces

## MAIN INTERFACE

As mentioned the main interface consists of project leaders, and a representative from the commercial end. The main interface is responsible for the alignment of both organizations in terms of goals, organizational cultures, and responsibilities throughout the project.

At the start of a project the main interface discusses, in consultation with the secondary interface, the feasibility and boundaries of the project, determines the deliverables, agree upon the responsibilities of both organizations, and talk about what to do in case of conflicts. The agreements are put in the statement of work which functions as a basis and guideline for the collaboration. The statement of work enables the secondary interface to cooperate freely within the boundaries of the project as long as the project leader in the main interface is in the loop of any agreements that are made. Respondents from all cases describe how a poorly executed statement of work, too vague,

hampers the collaboration with suppliers as conflicts (for example due to unclear responsibilities) can rise easily (9; 0; 0). In order to make a statement of work explicit and complete, input from the organizational teams is needed. If all members of the organizational teams are in line with the statement of work and the agreements that are made then conflicts are less likely as everyone is on the same page. When conflicts do occur, both parties can turn to the statement of work and act accordingly.

As the project proceeds the main interface is responsible for the continuous alignment of both organizations. This is done through internal alignment within the organizational team and inter-organizational alignment via the main interface (figure 13). This ensures that a R&D engineer from the supplier does not have to discuss all his/her work with a service expert from FEI, and thus that the goals and organizational culture of the R&D expert do not directly affect the service expert. The degree to which the collaboration among two organizations succeeds depends to a large extent on the experience of the project management/personnel in the main interface, as they facilitate and guard the cooperation (6; 0; 0).

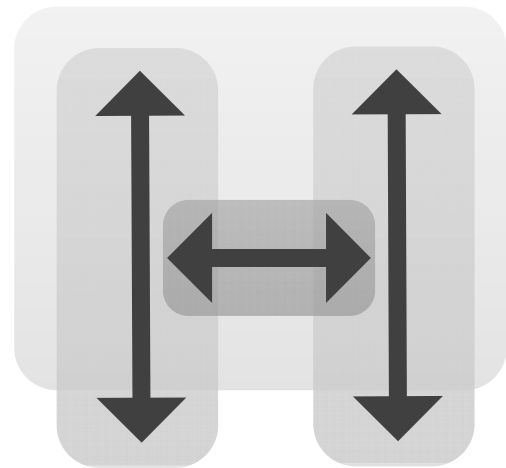


Figure 13, Main interface, internal and external alignment

## SECONDARY INTERFACE AND ORGANIZATIONAL TEAM

The secondary interface describes the collaboration of functional specialties from one organization to another without interference of the main interface. The secondary interface describes the collaboration between the two organizations together with the main interface. The organizational team of the supplier on the other hand concerns which functional specialties work on the project on the side of the supplier, regardless of whether or not they collaborate with the other firm.

As proposed in section 3.3 the functional diversity brings four factors (knowledge, network, goals, and organizational culture) to a team which stimulate or discourage the enlargement of a team with other functional specialties. The following sections elaborate on the four mentioned factors.

## 4.2 KNOWLEDGE

As shown in section 3.3.1, the category of 'Knowledge' and its effects on inter-organizational knowledge transfer is governed by and described through two principles; diverse perspectives and absorptive capacity. The empirical data concerning this category are therefore presented according to this subdivision. However, as will become clear, efficiency plays an important role in the degree of functional diversity and is therefore added to the subdivision.

### DIVERSE PERSPECTIVES



Combining literature on functional diversity and inter-organizational knowledge transfer it was proposed that functional diversity at the supplier's side of a collaboration enables more inter-organizational knowledge transfer as more knowledge is present in the team. The empirical research, in general, shows similar results (14; 6; 0). The most typifying statement concerning this relation was made by one of the sourcing professionals; 'Knowledge that is not involved in the project cannot be transferred'. Although fourteen out of sixteen interviewees (evenly divided over the different functions) directly refer to the positive effect of functional diversity on the amount of knowledge available for transfer, six interviewees also mention mediating factors to this relation. Several interviewees mention that the amount of knowledge that functional diversity makes available for inter-organizational knowledge transfer is dependent on *expertise* and *experience* of the functional specialists. Examples were given of inexperienced and incompetent functional specialists who did not bring any new knowledge to the table due to their frail capabilities. *These results indicate the positive effect of functional diversity on the amount of knowledge available for inter-organizational knowledge transfer (proposition 1a), but also shows that this relation does not stand alone and is influenced by more than just the diversity of functions.*

## EFFICIENCY

Although functional diversity adds more knowledge to the project, the secondary interface of the supplier is rarely extended to the entire organizational team. The explanation given by almost all respondents is *efficiency* (14; 0; 0). Not every functional specialty can add the same amount of and/or equally relevant specialized knowledge to the project. Especially when more functions are involved, the added value of additional functional specialties can decline as functions seem to have a certain overlap in specialized knowledge (7; 0; 0).

For complex projects, in which project success comes with a very detailed and integrated design, overlap in specialized knowledge may not be sufficient to cover certain functional specialties. As a wider variety of capabilities is required, some projects necessitate a more functional diverse team on the side of the supplier functions (9; 0; 0). For less complex projects certain functions, for example manufacturing, can be covered by for instance a project leader that holds enough manufacturing related specialized knowledge to bring the project to a success. In such projects involving a manufacturing specialist does not bring any additional relevant knowledge, will be a waste of human resources,

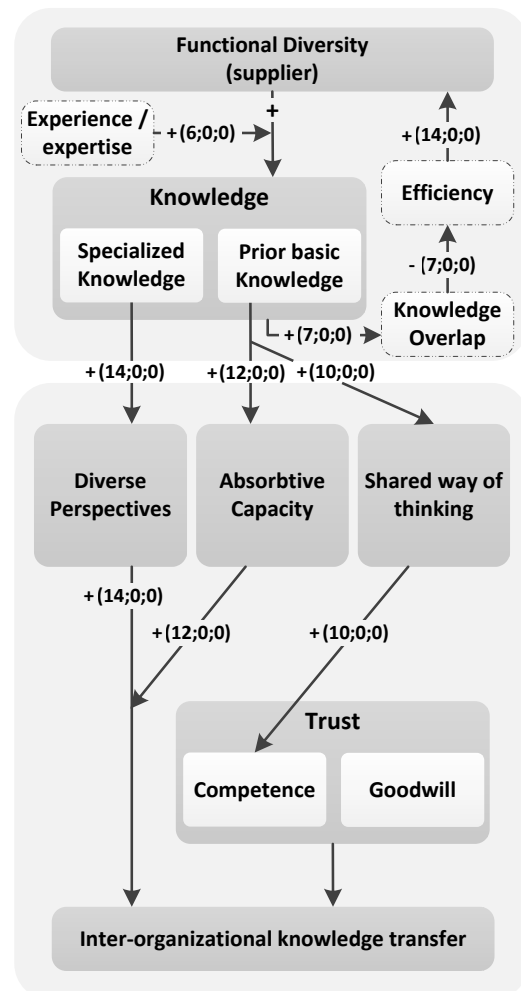


Figure 14, Research diagram (Knowledge)

and is thus inefficient (7; 0; 0).

Also the not-invented-here syndrome plays its part. When the supplier adds functional specialties to the collaboration of which FEI already covers a fair amount of specialized knowledge, then employees of FEI seem to reject the knowledge of that additional functional specialty (3; 0; 0).

Further, a vast majority of interviewees refers to the project phase as decisive phase to determine the appropriate functional diversity (12; 0; 0). At the start of a project, when the concept of the product is still to be tuned and tested, and the boundaries of the project are still vague, different capabilities are important than when the project comes close to production. Therefore, the collaboration with some functions may become important in later phases of the project while their presence is useless in the early stages. As mentioned, the statement of work is an important step in the collaboration with a supplier. To make a high quality statement of work comprehensive involvement of the organizational team is desired. By covering all the bases of the organizational team in these early project discussions a holistic statement of work can be agreed upon which enables a smooth collaboration (10; 0; 0). Further, interviewees mention that the time spent early in the project to align both organizations and to make agreements on the ways of working does without a doubt save more time further down the road as issues are accounted for (6; 0; 0).

*To conclude, although the functional diversity of the supplier does increase the amount of knowledge available for transfer over inter-organization boundaries, the functional diversity of the supplier's team is not always increased as it is not always efficient to do so.*

## ABSORPTIVE CAPACITY

Literature proposed that functional diversity of the supplier enables more inter-organizational knowledge transfer as it allows counterparts, which hold the same prior basic knowledge, to transfer their specialized knowledge. Concerning this relation, the importance of prior basic knowledge for knowledge transfer in an inter-organizational context was unanimously acknowledged by the interviewees (12; 0; 0). Therefore, the empirical data collected from the interviews gives reason to believe that *proposition 1b is realistic*.

Further, prior basic knowledge also seems to affect trust building activities as proposed in proposition 2. However, in this relation, a clear separation should be made between competence trust and trust in the intentions of individuals. Concerning trust building in the competences of individuals only positive connections were made by the interviewees between the presence of prior basic knowledge and shared way of thinking (10; 0; 0). Not only did trust building in the intentions of individuals as a consequence of shared prior basic knowledge come up in just four interviews, the interviewees also held different opinions about the relation. Where two architects mentioned that prior basic knowledge enabled more trust building, two sourcing professionals mentioned that the intentions of someone cannot be fathomed and/or trusted by sharing prior basic knowledge. What is interesting is that one of those sourcing professionals actually mentions the difference in people from sales and sourcing, and R&D. He states that people from R&D are usually straight forward without any political games and/or tricks up their sleeve, while people from sales and sourcing often use such actions. *These*

results give the impression that proposition 2 should be limited to competence trust. Further an alternative proposition for trust in the intentions should be built in which the personalities of functional specialties should be considered.

### 4.3 NETWORK

As shown in section 3.3.1, the category of 'Network' and its effects on inter-organizational knowledge transfer is described through two principles; external knowledge and positive feedback. The empirical data concerning this category are therefore presented according to this subdivision.

#### EXTERNAL KNOWLEDGE

Combining literature on functional diversity and inter-organizational knowledge transfer it was proposed that functional diversity at the supplier's side of a collaboration enables more inter-organizational knowledge transfer as more knowledge is present in the network. *The empirical data collected in the interviews does not provide distinctive indications to support or reject this theory (proposition 3).* In one of the cases two sourcing professionals indicated that a particular supplier was selected as the supplier possessed connections in their network with certain capabilities applicable to and relevant for the project. They pointed out that although the desired capabilities were present in the network the supplier did not use its network to obtain the required knowledge. This does not provide direct evidence for the proposed relation. It does show, however, that knowledge present in the network is not necessarily and automatically used and transferred.

#### POSITIVE FEEDBACK

Literature proposed that functional diversity enlarges the professional and personal network of a project team. In an inter-organizational context this could make the social network denser and provide the opportunity to use feedback from common connections. Data from the interviews were in line with this theory. Respondents confirmed to inquire and ask common connections for information about the people from the supplier that they are about to work with (12; 0; 0). One of the respondents even stated that this is a very natural thing to do. Common connections can provide feedback on both the competences (10; 1; 0), and intentions of people (8; 0; 0) enabling a kick-start in terms of trust. As stated by one of the sourcing professionals; "when positive references are given about a certain person,

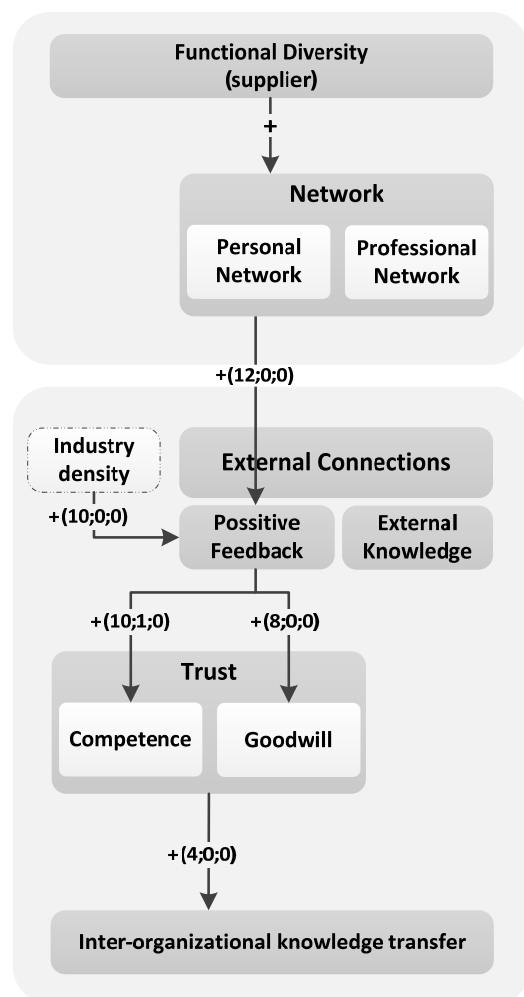


Figure 15, Research diagram (Network)

people tend to give him/her the benefit of the doubt”. One interviewee mentions that shared connections that you actually know is particularly common in their high-tech industry in which all important players are located in the region. That the industry is concentrated in the region is confirmed by other interviewees as well (10; 0; 0). Further, the kick-start in the level of trust is limited to the person of whom references are received (4; 0; 0). *The here presented data, retrieved from the interviews, indicates that the common ties can indeed give a kick-start to the level of trust (proposition 4). However, this does not seem to affect the level of trust in the supplier’s team in general, and might be mediated by the degree in which the industry is concentrated in the region.*

#### 4.4 GOALS AND CULTURE

Section 3.3.3 described how the variety of goals and cultures which comes with functional diversity might affect inter-organizational knowledge transfer. In this section the empirical data from the interviews are compared to those propositions.

##### 4.4.1 GOALS

Combining literature on functional diversity and inter-organizational knowledge transfer it was proposed that functional diversity at the supplier’s side of a collaboration provides a collaboration with a wider variety of goals and therefore may fuel conflicts. Two distinctive sets of goals came forward in the interviews; goals in terms of priorities between projects, and goals in terms of pursuing what the job description prescribes.

##### PRIORITIES

Concerning priority lists, the interviewees mention that prioritizing is natural and happens everywhere (4; 0; 0). Differences in priorities can lead to conflicts. Frustration rises when people notice that not the same amount of effort is put in the project by a counterpart or team member. In such cases also the level and quality of communication drops as one party is not fully devoted to the project (8; 3; 0). Three interviewees (two sourcing professionals and one product engineer) mention that in order to prevent conflicts as a consequence of differences in priorities, tight agreements should be made at the start of the project (in previous sections described as the statement of work) which should be controlled by the project manager. *To conclude, the functional diversity of the supplier does seem to affect the number of conflicts between the two organizations*

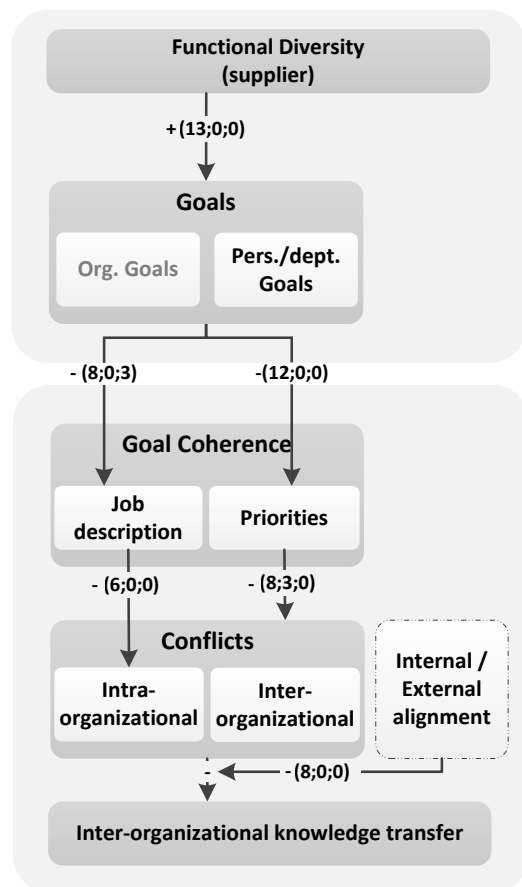


Figure 16, Research diagram (Goals)

*with respect to the priorities pursued by the functional specialties involved (proposition 5).*

## **JOB DESCRIPTION**

In terms of job description, the general consensus is that functional specialties indeed do differ in terms of what they pay attention to and what they find important. This can lead to conflicts (13; 0; 0). However, in an inter-organizational context counterparts are focussed on the same issues (8; 0; 3). R&D professionals focus on a perfectly working design, whether they are from FEI or the supplier. This does not necessarily lead to conflicts, only when counterparts rigidly demand their own way (6; 0; 0). Three sourcing professionals disagreed with the aforementioned statement. They comment that although they work on the same issue as their counterpart, their goals are exactly opposite (making money through lower purchasing prices versus revenues with a big margin). The remark of the sourcing professionals is concerned with differences in organizational goals, which was cited by all twelve respondents as a cause of conflicts. However, the organizational goals are not influenced by the functional diversity of teams and thus not relevant for the present study. Combining more functional specialties of the supplier in the project team does thus not increase the amount of job description related goals in the inter-organizational context, but does on the supplier's side of the secondary interface and/or organizational team. This wider range of job description related goals, although it enables conflicts, is important for the project as it ensures that a more holistic product design is developed (6; 0; 0), which is in line with section 4.2. It is the responsibility of the project leaders and the main interface to align the organizational teams in terms of goals first internally and thereafter between the organizations (8; 0; 0). *To conclude, the functional diversity of the supplier does not seem to affect the number of conflicts between the two organizations with respect to the responsibilities of the functional specialties involved (proposition 5). However, although it was considered essential to the project, it does affect the number of conflicts within the organizational team of the supplier which can negatively affect inter-organizational knowledge transfer.*

### **4.4.2 CULTURE**

Combining literature on functional diversity and inter-organizational knowledge transfer it was proposed that functional diversity at the supplier's side of a collaboration provides a collaboration with a wider variety of departmental cultures and therefore may enable conflicts. Within the interviews organizational culture was mentioned in three distinctive ways; ways of working, personalities, and norms and values.

## **WAYS OF WORKING**

Concerning the ways of working interviewees mention that differences in ways of working can make collaboration among functional specialties more difficult and may cause conflicts (10; 3; 0). This is in line with functional diversity literature. One of the interviewees stated that the ways of working naturally follow from the goals that are pursued on the supplier's side. Similar to the job descriptions of counterparts, the ways of working among counterparts seems to be similar to a large extent (8; 1; 0). When differences do occur, if not too extensive, a shared prior basic knowledge enables counterparts to still be able to communicate (8; 0; 0). The differences in ways of working come with the wide variety of

functional specialties and the presence of two independent organizations (10; 0; 0). Further, the shared prior basic knowledge provides both counterparts with a shared way of thinking which helps to overcome conflicts (7;0;0). Rarely conflicts arise as the ways of working of two counterparts are seldom too different and not compatible (8; 0; 0). In such cases robust agreements and alignment on a shared way of working can provide a smooth collaboration (9; 0; 0).

Combining more functional specialties of the supplier in the project team does thus not necessarily increase the diversity of way of working in the inter-organizational context, but does do that within the supplier's side of the secondary interface and/or organizational team. *Within the inter-organizational context functional diversity of the supplier does not inevitably enable more conflicts in terms of ways of working (proposition 6), or make knowledge transfer more difficult as prior basic knowledge helps to overcome differences (proposition 7).* At the supplier's side of the collaboration the functional diversity does make it more difficult to collaborate internally as ways of working differ per department. In order to develop a holistic product design the project leader should align the project team in terms of ways of working.

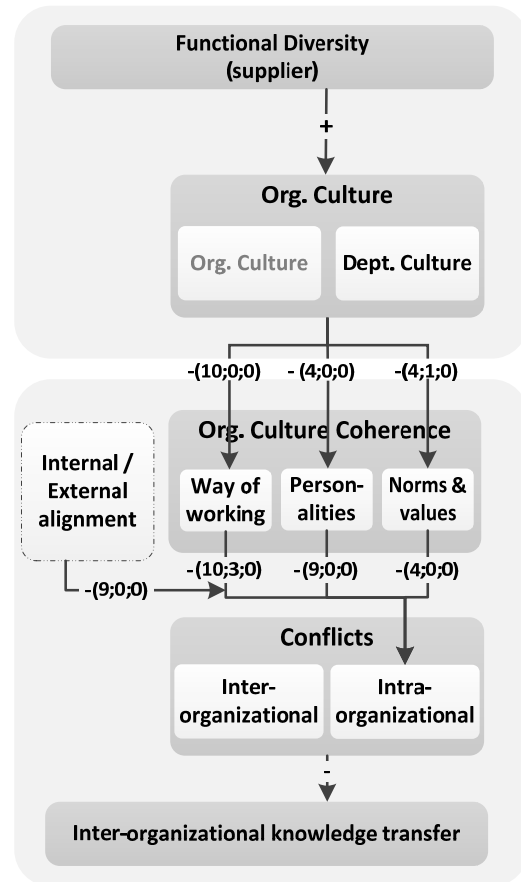


Figure 17, Research diagram (Org. Culture)

## PERSONALITIES

A majority of interviewees indicated the importance of personalities in inter-organizational knowledge transfer. A match in personalities seems to boost knowledge transfer, where a mismatch could have the exact opposite effect and even enable conflicts to occur (9; 0; 0). Only four interviewees link the differences in personalities to functional specialties by stating that R&D departments contain different people than sourcing departments. However, even those four respondents mention that this is not always the case. Meaning: in for instance a R&D department there are more 'blue' people than in a sourcing department. This does not mean that all people in the R&D department are 'blue', but the percentage of 'blue' people in a R&D department is higher. Therefore, functional diversity increases the probability that different and incompatible personalities meet in an organizational team thus enabling conflicts. Counterparts, who are generally part of the same functional specialty, can also find a mismatch in personalities as a distribution of personalities is present within functional departments. The degree in which this would occur is dependent on the distribution of personalities within the departments. *To conclude, matching personalities are important for knowledge transfer and to avoid conflicts. Functional diversity does not necessarily increase the diversity in personalities but does increase the probability of it occurring (proposition 6).*

## NORMS AND VALUES

In terms of norms and values the interviewees mention that different functional specialties pursue different norms and value (4; 1; 0). Differences in norms and values between counterparts are seen as a potential source of conflicts (4; 0; 0). *The limited amount of empirical data collected from the interviews concerning norms and values reveals the same relation as proposed in proposition 6. Due to coherence in the results in terms of norms and values, proposition 6 seems lifelike.*

## 4.5 MEDIATING EFFECTS

The data has shown some variables which were not discussed within the literature review, but mediate the effect of functional diversity on inter-organizational knowledge transfer. The previous sections briefly addressed experience/expertise, the geographical density of the industry, and the statement of work as variables of influence.

### EXPERIENCE / EXPERTISE

Previous sections elaborated on the importance of specialized knowledge. The data shows that in projects, all relevant specialized knowledge should be present within the collaboration (secondary interface + main interface). It came forward that, depending on the complexity of the project and the experience/ knowledge level of the specialists, a certain amount of functional specialties is needed. In some collaborations not all functional specialties were involved as some specialties are already covered by other functions involved in the collaboration.

*For example, in the projects of the Piezo enhanced compu stage, Exsolve stage, and the Thalos some functional specialties were not involved in the secondary interface. Account managers or project leaders guaranteed that they possessed enough specialized knowledge of service and sourcing that those functions could be left out of the collaboration, and that they would have their consultations with the concerning functional specialists.*

The empirical data indicates that if the account manager and/or project leader indeed does possess all required specialized knowledge related to the functional specialty, and consults its functional specialists on a regular basis to stay on top off all specialized knowledge, then covering-up for one functional specialty is no problem. It even reduces the amount of goals and cultures present in the collaboration. However, in some cases it was found that account managers and/or project leaders think they are able to cover certain functions where in fact they do not possess sufficient knowledge.

*For example, in the Exsolve stage project the sourcing function of the supplier was covered by a project leader who did not have the required sourcing related insights. This resulted in an initial lead time of one component which was undesirably long. Only after the involvement of sourcing did the collaboration manage to reduce the lead time to an acceptable level through the incorporation of the knowledge present in the sourcing department.*

Furthermore, the data highlighted that one should be aware that not every supplier possesses all knowledge that FEI's needs. Internally some suppliers are not very functionally diverse. In the case of

the Exsolve stage a supplier was used which is primarily a development group. Their knowledge on supply chain or service is inadequate. Also within the Super x (G2) a supplier was used of which the core competence is development. Their knowledge on for instance supply chain is limited. This boils down to supplier selection procedures in which FEI should look at the core competences of a supplier in order to select a supplier(s) which can cover all required knowledge.

## INDUSTRY DENSITY

Over the six reviewed cases a clear pattern is seen in the density of the industry. With all suppliers face-to-face meetings had taken place on a regular base. The geographically furthest located supplier was only a six hour drive away, where all other suppliers are within an hour away. The connection and network with those suppliers is very dense as people regularly change jobs between organizations within the network. According to the data, the geographical density of the industry showed a positive effect on the amount of common connections within the industry.

## STATEMENT OF WORK

In previous sections the statement of work is described as an important step in the collaboration as it acts as a basis and guideline for the collaboration which enables *internal and external alignment*. According to the interviewees, the statement of work should be of high quality to prevent later disappointments or even conflicts in the project. The data shows that a statement of work needs a clear view of the boundaries of the project and all issues that may arise during the project in order to function as it should. Therefore all aspects of the project should be taken into account and no perspectives should overlooked. Although FEI recognized the importance of a comprehensive statement of work, the company did not always succeed in the establishment of such a statement of work. Through the analysis of the six cases it can be concluded that the statement of work does not always receive the appropriate attention. Within the Thalos and the Super x (G2) projects, for example, the statement of work was not conclusive enough according to the interviewees. Concerning why the statement of work sometimes received insufficient attention the general remark was that at the start of the projects too little is known about the direction of the project which makes it difficult to make set agreements. When the time comes that the direction of the project is clear enough to discuss responsibilities etcetera, this step is often passed with too much ease as both parties are too excited about the new project.

## 4.6 FINAL RESEARCH MODEL

Though the analysis of the empirical data, the propositions constructed in section 3.3 are examined. This resulted in some alterations to the conceptual model presented in section 3.3.4. Figure 18 reveals the end result of those alterations in the final research model. The final research model is constructed through an integration of the figures presented in sections 4.1 to 4.5.



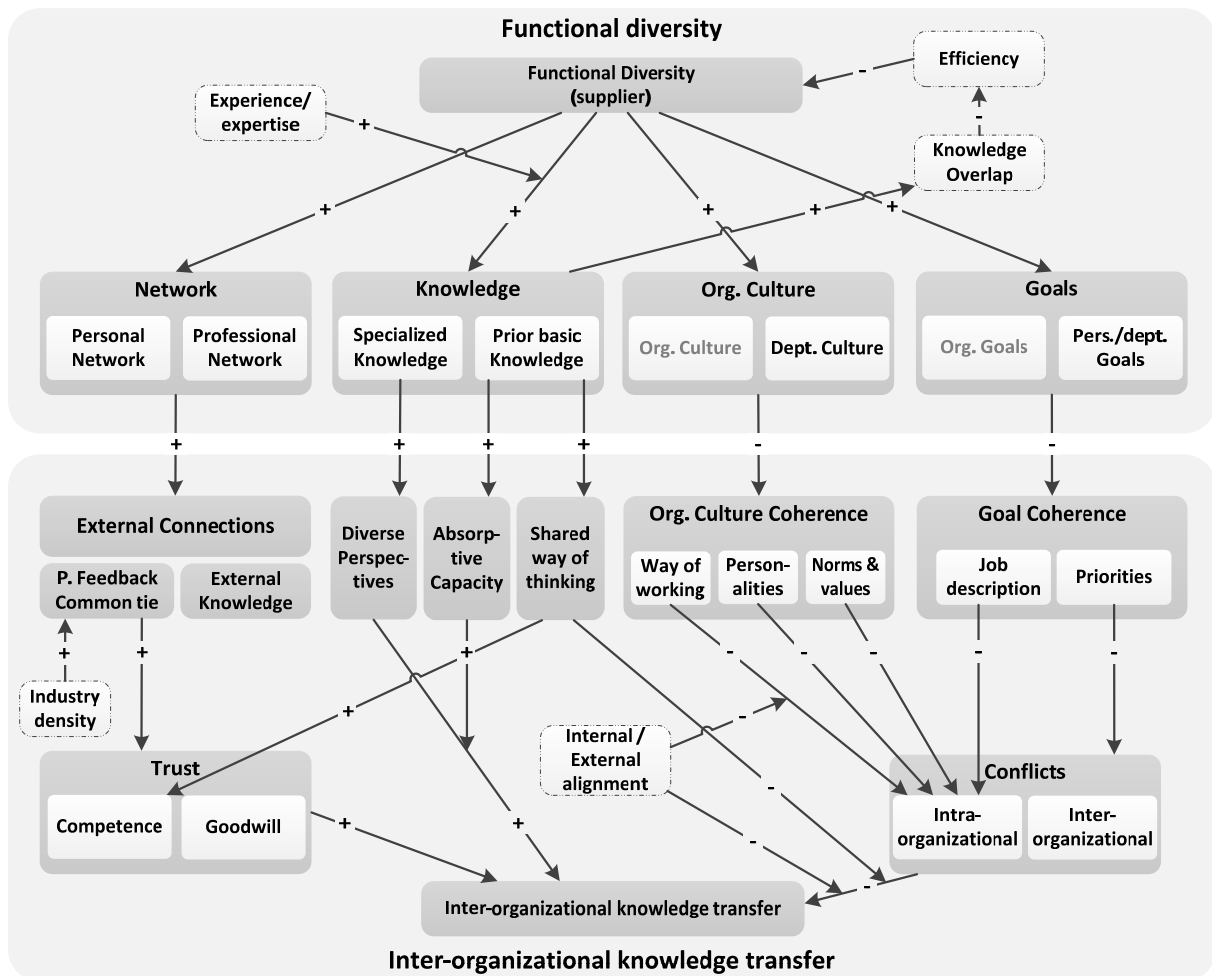


Figure 18, Final research model

## 5 DESIGN PRINCIPLES

As mentioned in section 2.3, the present study used literature to create a theory (section 3), and practice to examine and supplement the theory (section 4). In this section grounded design principles are constructed through a synthesis of both the academic research and empirical data. This has led to four design principles, of which the first is principle is constructed through a direct synthesis of literature and practice. This principle describes the intervention of functional diversity to enhance inter-organizational knowledge transfer. The other three design principles provide a solid base in which the functional diversity intervention can actually be effective. These principles acknowledge the in both literature and practice found consequence of functional diversity, namely a lack of goal and cultural coherence, and provide interventions to overcome those. The input for these principles is mainly the empirical data.

As proposed by literature and confirmed through empirical data, functional diversity can enable inter-organizational knowledge transfer through the presence of a wider variety of knowledge which can be transferred.

*Principle 1: In a new product development project with a supplier, in which both organizations are internally and externally aligned in terms of goals and culture, a wider variety of functional specialties at the supplier's side could enhance inter-organizational knowledge transfer as more knowledge is present.*

However, as found in both literature and in the empirical data, functional diversity increases the amount of goals and organizational cultures in the collaboration which increases the probability of conflicts to occur. Therefore, it is of utmost importance that functional diversity is managed well, so conflicts are prevented and/or solved. Design principles two, three and four are constructed to enable this conflict solving and preventive management.

Section 4.1 elaborated on the collaboration between FEI and its suppliers. In that section it was described how the main interface served an important role in the collaboration between both organizations as it is responsible for the internal and external alignment and determines the boundaries within which the two organizations cooperate.

A central role in the alignment of both organizations is the statement of work. As described in previous sections, the complete and comprehensive statement of work is essential to guide the collaboration of the FEI and its supplier through a new product development project. This means that from both FEI and the supplier all relevant perspectives should be incorporated into the statement of work discussions. As stated in previous sections, this can be done through the involvement of a wider variety of functional specialties, or by including an individual who can cover multiple functional specialties. In the last case, one should make sure that this key-individual indeed has sufficient specialized knowledge in the fields that are required to engage in statement of work discussions, hence the second design principle.

*Principle 2: At the start of a new product development project with a supplier all required specialized knowledge, which is not present in FEI, should be incorporated in the supplier's organizational team so that no issues are overlooked in the discussions on requirements, responsibilities, and feasibility of the project. This offers the collaboration between FEI and the supplier the potential to make a complete and comprehensive high-quality statement of work.*

As the second design principle describes, the involvement of all required functional specialists or representatives of those specialties, only gives the collaboration the potential to formulate a clear and all covering statement of work. The empirical data have shown that in some cases too little time is reserved for the design of the statement of work. Time and efforts invested early in the project to align both companies are crucial. The costs of such efforts are negligible compared to the costs of avoidable potential conflicts later in the process. Therefore it is important to invest early on in the project to obtain a comprehensive high-quality statement of work, hence the third design principle.

*Principle 3: At the start of a new product development project with a supplier enough time and resources should be invested from both sides of the collaboration to generate a comprehensive high-quality statement of work covering all issues. This breeds a clear guideline and basis for a fruitful collaboration and helps to prevent conflicts to occur or to overcome them when they arise.*

Concerning the internal and external alignment, described in section 4.1, the main interface plays a crucial role. The personnel of the main interface is responsible for the alignment of cross-functional goals and cultures within his/her own organization. Further, they facilitate, and control inter-organizational knowledge transfer. Over the project phases, different functional specialties require collaboration with the partner firm. It is the role of the main interface, in particular of the project leaders, to recognize at what time, which functional specialties should collaborate and transfer knowledge. In order for this transfer to go with ease, alignment is a necessity. To conclude, the main interface is responsible for setting the boundaries of the project, enabling and controlling inter-organizational knowledge transfer, prevent inter-organizational and intra-organization conflicts through internal and external alignment of goals and cultures, hence the fourth design principle.

*Principle 4: In a new product development project with a supplier, appointing experienced personnel to the main interface at both sides of the collaboration is crucial and enables adequate internal and external alignment of goals and cultures. This prevents conflicts between and within organizations in terms of goals and organizational cultures.*

## **6 CONCLUSIONS, IMPLICATIONS, LIMITATIONS AND FURTHER RESEARCH**

This section presents the conclusions based on the research questions (section 6.1), formulated in section 2.2. Thereafter, the contributions, limitations and directions for further research are presented.

### **6.1 CONCLUSIONS**

This section presents the conclusions on research questions 1 to 4 (section 6.1.1), the stepping stones to the main research question, and on the main research question (section 6.1.2).

#### **6.1.1 RESEARCH QUESTIONS**

In the introduction of this paper, four research questions were formulated to answer the main research question. This section summarizes the insights gained concerning those four research questions.

*RQ1: What are the key determinants and barriers of Inter-organizational knowledge transfer?*

The key determinants and barriers of inter-organizational knowledge transfer are categorized in knowledge-, organizational-, and relational characteristics. Within the knowledge characteristics a distinction is made between; the degree in which knowledge is rooted in experience and therefore difficult to codify (tacitness); and whether underlying components and sources of knowledge and the

way in which they interact, are inherent and irreducibly uncertain (the ambiguity of knowledge). Concerning organizational characteristics, the main factors to affect inter-organizational knowledge transfer are the degree in which an organization is willing to learn (learning culture), whether or not an organization shows resistance to external knowledge (not-invented-here syndrome), and the extent to which an organization is able to acquire and internalize new knowledge (absorptive capacity). Relational characteristics describe antecedents of knowledge transfer that operate between the two organizational actors, and are divided over three dimensions. First, the structural dimension, which describes how the network of social ties contributes to the partnership in terms of knowledge and connections. Second, the cognitive dimension, which outlines how the coherence and/or differences in organizational goals and cultures affect the amount of conflicts between organizations and thereby knowledge transfer. Third, the relational dimension, which explains the level of trust between two organizations, the strength of the social ties between individuals of both organizations, the degree in which both organizations have enough understanding of each other's business to transfer knowledge (prior basic knowledge), and on the other hand not consist of the exact same knowledge so knowledge transfer becomes irrelevant (specialized knowledge).

*RQ2: How can functional diversity be defined, and what are the advantages and disadvantages?*

Functional diversity can be defined as variety of functional specialties which are grouped together in for instance a project team. Functional diversity has two advantages. First, a wider variety of functional specialties increases the amount of knowledge present in a team as each function has its own perspective on the matter. Second, functional diversity increases the social network of a team, thereby enabling contact with an even wider variety of knowledge bases. As a down-side a group of people with a wider array of functional diversity brings the risk that they will all pursue different personal and departmental goals. This can make collaboration among the functional specialties harder and makes the team conflict-prone. Difficulties in collaboration and even conflicts can also occur due to differences in organizational (departmental) cultures of the functional specialties in the project team.

*RQ3: How does FEI Company currently manage supplier involvement and how does it enable knowledge transfer with their suppliers?*

Supplier involvement is managed through two interfaces; the main and the secondary interface. The main interface consists of a multidisciplinary project leader, a representative of the commercial end and occasionally also of the technical end. The main interface is in charge of inter-organizational alignment and is controlling the boundaries of the project, and thus the majority of the communication with the supplier. Representatives of the secondary interface are involved in inter-organizational discussions when more details are needed which cannot be covered by individuals from the main interface. This results in for example a technical meeting where the engineers and the project leaders are brought together to discuss the project. The secondary interface links functional specialists from both organizational teams directly and is used sporadically for cooperation over organizational boundaries. Such cooperation is limited to content that does not affect other disciplines so no contradicting agreements are made over different functional specialties. In order to keep both organizations on the

same page during the collaboration, a statement of work is made at the start of a project. The statement of work describes the boundaries of the project, the responsibilities and deliverables within the project, and the room and procedure for escalation in case of conflicts. This statement of work functions as a basis and guideline for the collaboration.

*RQ4: Which aspects of functional diversity within the supplier's project team affect inter-organizational knowledge transfer, and how?*

Four aspects of functional diversity are described which can affect inter-organizational knowledge transfer; network, knowledge, goals, and culture. The increasing network through functional diversity of the supplier can affect inter-organizational knowledge transfer in two ways. First, it can enhance the amount of available and relevant external knowledge as more connections are present in the network of the supplier. Second, with a bigger network at the supplier's side, the probability of mutual contacts between both teams increases. Although this is mitigated by the degree in which an industry is concentrated in a certain region, this enhances trust building between both organizations and therefore affects inter-organizational knowledge transfer.

The increased amount of knowledge present in a team as a consequence of functional diversity, although mitigated by the experience and expertise of the functional specialist, affects inter-organizational knowledge transfer in multiple ways. First, functional specialists may find counterparts with the same prior basic knowledge. This has a positive influence on the absorptive capacity. Second, the presence of counterparts speaking the same technical language positively influences the trust building in each other's competences, which leads to more inter-organizational knowledge transfer. Third, the presence of counterparts that share the same way of thinking, enables counterparts to overcome inter-organizational knowledge transfer hindering conflicts more easily.

The increased variety of goals present in a team as a consequence of functional diversity, affects inter-organizational knowledge transfer in two distinctive manners. First, when the priorities within the functional specialties are not in line people get frustrated and conflicts may arise that will negatively influence the inter-organizational knowledge transfer. Regarding job descriptions (meaning: people pursue what they are hired for), differences between the organizations may lead to conflicts. These do not directly occur between organizations but more so within the individual organizations. Conflicts within organizations on their turn negatively affect the inter-organizational knowledge transfer.

The increased variety of organizational (departmental) cultures present in a team as a consequence of functional diversity can make collaboration among functional specialties more difficult and cause conflicts. In terms of the way in which a functional specialty works, it is due to the manner in which FEI constructs its collaboration with suppliers. These conflicts do not play in the inter-organizational context but within the organizations. Conflicts within organizations on their turn negatively affect the inter-organizational knowledge transfer. Matching personalities of functional specialists are important for knowledge transfer and also to avoid conflicts. Functional diversity does not necessarily increase the diversity in personalities but it does increase the probability of it occurring. That could potentially negatively affect inter-organizational knowledge transfer. Different functional specialties often pursue

different norms and values. Differences in norms and values between counterparts are a potential source of conflicts within organizations, and thus indirectly influence the inter-organizational context.

### **6.1.2 MAIN RESEARCH QUESTION**

The present study build four design principles (section 5) as an answer to the main research question which was constructed in section 2, and presented below.

#### **Main research question**

***How should FEI Company adapt its supplier management process based on the functional diversity of the supplier's project team to increase the inter-organizational knowledge transfer?***

In a collaboration which is well aligned, both internally as externally, FEI company should encourage the supplier to enlarge their organizational team and secondary interface with more relevant functional specialties to increase the amount of knowledge available for transfer (design principle 1).

In order to manage this extended involvement of suppliers well and overcome the increased probability of conflicts, FEI Company should take the following three principles into account:

- At the start of a new product development project with a supplier FEI Company should make sure that all required specialized knowledge, which is not present within FEI, is incorporated in the supplier's organizational team so that no issues are overlooked in the discussions on requirements (design principle 2).
- Subsequently, FEI should safeguard that enough time and resources are invested from both sides of the collaboration to generate a comprehensive high-quality statement of work covering all issues. This breeds a clear guideline and basis for a fruitful collaboration and helps to prevent conflicts to occur or to overcome them when they arise (design principle 3).
- Third, FEI should ensure that experienced personnel is appointed to the main interface on both sides of the collaboration. This enables adequate internal and external alignment of goals and cultures, and prevents conflicts between and within organizations in terms of goals and organizational cultures (design principle 4).

When striving for more inter-organizational knowledge transfer it is important to note that other aspects of the project might suffer. Functional diversity is in a constant struggle with efficiency. More people means more alignment and human resources, and thus more effort and costs. Functional diversity and inter-organizational knowledge transfer should therefore be in constant trade-off with efficiency.

### **6.2 THEORETICAL IMPLICATIONS**

Currently, inter-organizational knowledge transfer theories do not account for the functional diversity of both organizations. The present study provides the first step in filling that gap. The result of

the present study suggest that the functional diversity can be a significant antecedent in inter-organizational knowledge transfer. As this study links several key factors of inter-organizational knowledge transfer literature with characteristics described in the research field of functional diversity, it provides many topics for further research. The present study also shows how the management of projects is a crucial factor in inter-organizational knowledge transfer.

### **6.3 MANAGERIAL IMPLICATIONS**

The fast changing technological landscape makes it more difficult for organizations to remain competitive in multiple areas of technology at the same time. In order to be able to produce competitive products, organizations must strive to acquire and internalize new knowledge (Kogut & Zander, 1992; van Wijk, et al., 2008), and make better use of internal knowledge (Ancona & Caldwell, 1992; Brown & Eisenhardt, 1995; Gupta, et al., 1985; McDonough III, 2000; Ratcheva, 2009). The present study combines two mechanisms known in academic research to acquire and internalize new knowledge. One, supplier involvement, concerns the use of external knowledge. The second, functional diversity, mainly focusses on the better use of internal knowledge. The following paragraphs describe how managers can use functional diversity to enhance inter-organizational knowledge transfer, and what they should take into account when doing so.

The present study shows that combining both mechanisms, in which functional diversity is not only used within FEI but also in its suppliers, can bring the transfer of new knowledge to a higher level than both mechanisms independently. When suppliers increase the amount of functional specialties involved in the project, the amount of knowledge available within the project rises. This enables both teams to transfer more knowledge over organizational boundaries, especially as both organizations are able to link counterparts with similar prior basic knowledge. Through an increase in inter-organizational knowledge transfer organizations can come to more competitive and complete products. Managers should therefore, especially at the start of new projects when the requirements and scope of the project are still vague, make sure that the widest variety of specialized knowledge is present (meaning more functional specialties or more experienced personnel). This prevents that important issues are overlooked.

However, as the present study has shown, the implication of functional diversity does require more than just manpower. In order to enhance inter-organizational knowledge transfer, both sides of the collaboration should ensure that enough time and resources are spent to generate a comprehensive high-quality statement of work covering all issues. Aligning both organizations through such a document breeds a clear guideline and basis for a fruitful collaboration, and helps to prevent conflicts to occur or to overcome them when they arise.

The present study has shown that functional diversity at both sides of the collaboration can make the cooperation more difficult as the wider diversity in goals and organizational cultures make internal and external alignment harder. This study concluded that in order to use functional diversity to enhance inter-organizational knowledge transfer, while remaining internal and external alignment, managers should make sure experienced personnel is appointed to central roles between both organizations.

Experienced project leaders know how to balance priorities and goals, and thereby how to align both organizations internally and externally.

When striving for more inter-organizational knowledge transfer it is important to note that other aspects of the project might suffer. Functional diversity is in a constant struggle with efficiency. More people means more alignment and the need of human resources, and thus more effort and costs. Functional diversity and inter-organizational knowledge transfer should therefore be in constant trade-off with efficiency.

## **6.4 LIMITATIONS AND FURTHER RESEARCH**

Although the present study provided an overview of the factors that affect inter-organizational knowledge transfer and the dynamics of functional diversity, the impact of the study is limited in a number of ways. First, the holistic review of inter-organization knowledge transfer provides clear understanding of the different concepts that affect knowledge transfer between organizations. The aim of the present study lies on finding where functional diversity and inter-organizational knowledge transfer meet and in general how they interact. The present study expatiates to a limited extent on the other aspects affecting knowledge transfer. The in this study presented interactions concerning prior basic knowledge, social network, and coherence in goals and working cultures indeed proved to align with reality. This makes an in-depth exploration on the magnitude and precise mechanism of the interactions with these concepts a valuable subject for further research.

A second limitation concerns the focus on knowledge transfer in general. In the present study functional diversity is elaborated upon in the light of knowledge transfer. However, functional diversity does not only affect knowledge transfer between organizations, but might also impact the costs, duration, and success rate of projects. As this is not taken into consideration in the present study, the clarification of the effect of functional diversity is a bit one-sided, and can give a misguided impression on the advantages and disadvantages of functional diversity. Therefore, it would be valuable to further examine how functional diversity affects other concepts than just knowledge transfer. For example, how does the functional diversity affect the project outcome in terms of costs, duration, and success?

Third, the characteristics of the people involved in the transfer of knowledge are not taken into account in the present study. Adding more people with different functional specialties to a team does not only make the team more functionally diverse but also more diverse in general. People from different countries, tenure, age, personality, etc. all collaborate differently. In literature, diversity is found to have a big effect on how people cooperate and communicate. The fact that this is not included in the present study limits the effect and power of the study on literature. In order to get a better understanding on what functional diversity really does to inter-organizational knowledge transfer, further research must go beyond only adding the functions to a team and also look at the characteristics of the people that are behind the function.

A fourth limitation, and important topic for further research, is the perspective of the supplier which is not considered in the present study. Within the present study solely personnel of FEI were



interviewed, which limited the study to only the buying side of the collaboration. By involving the supplying side in further studies, a more complete picture can be drawn on the effects of functional diversity.

## 7 BIBLIOGRAPHY

Allen, T., 1977. *Managing the Flow of Technology*. Cambridge: MIT Press.

Ancona, D. G. & Caldwell, D. F., 1992. Demography and Design: Predictors of New Product Team Performance. *Organization Science*, 3(3), pp. 321-341.

Barney, J., 1991. Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), pp. 99-120.

Brown, S. L. & Eisenhardt, K. M., 1995. Product Development: Past Research, Present Findings, and Future Directions. *Academy of Management Review*, Volume 20, pp. 343-378.

Burt, R., 1992. *Structural Holes: The Social Structure of Competition*. Cambridge: MA: Harvard University Press.

Cohen, W. m. & Levinthal, D. A., 1990. Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, Volume 35, pp. 128-152.

Cummings, J. L. & Teng, B.-S., 2003. Transferring R&D knowledge: the key factors affecting knowledge transfer success. *Journal of Engineering and Technology Management*, Volume 20, pp. 39-68.

Daft, R. L., 1998. Organization Theory and Design. In: 6, ed. *Organization Theory and Design*. Cincinnati : international Thomson Publishing, pp. 201-243.

Daghfos, A., 2005. An Empirical Investigation of the Roles of Prior Knowledge and Learning Activities in Technology Transfer. *Technovation*, Volume 24, pp. 939-953.

Davenport, T. & Prusak, L., 1998. *Working Knowledge: How Organizations Manage What They Know*. Boston: Harvard Business School Press.

Dhanaraj, C., Lyles, M., Steensma, H. & Tihanyi, L., 2004. Managing tacit and explicit knowledge transfer in IJVs: the role of relational embeddedness and the impact on performance. *Journal of International Business Studies*, Volume 35, pp. 428-442.

Dixon, N. M., 2000. Common Knowledge. In: *How Companies Thrive by Sharing What They Know*. Boston: Harvard Business Press, pp. 25-27.

Dougherty, D., 1992. Interpretive Barriers to Successful Innovation in Large Firms. *Organization Science*, 3(2), pp. 179-202.

Dyer, J. & Chu, W., 2003. The role of trustworthiness in reducing transaction costs and improving performance: Empirical evidence from the United States, Japan, and Korea. *Organizational Science*, 14(1), pp. 57-68.

Dyer, J. & Chu, W., 2011. The determinants of trust in supplier-automaker relations in the US, Japan and Korea: A retrospective. *Journal of international Business Studies*, 42(1), pp. 10-27.

Easterby-Smith, M., Lyles, M. A. & Tsang, E. W., 2008. Inter-Organizational Knowledge transfer: Current Themes and Future Prospects. *Journal of Management Studies*, 45(5), pp. 0022-2380.

Emden, Z., Calantone, R. J. & Droge, C., 2006. Collaborating for New Product Development: Selecting the Partner with Maximum Potential to Create Value. *Journal of Product Innovation Management*, Volume 23, pp. 330-341.

Gold, A. H., Malhotra, A. & Segars, A. H., 2001. Knowledge management: An organizational capabilities perspective. *Journal of Management Information Systems*, 18(1), pp. 185-215.

Grant, R. M., 1996. Toward a Knowledge-Based Theory of the Firm. *Strategic Management Journal*, Volume 17, pp. 109-122.

Grunwald, R. & Kieser, A., 2007. Learning to reduce interorganizational learning; an analysis of architectural product innovation in strategic alliances. *Journal of product Innovation Management*, 24(4), pp. 369-391.

Gupta, A. & Goyindarajan, V., 2000. Knowledge Flows within multinational corporations. *Strategic Management Journal*, Volume 21, pp. 473-493.

Gupta, A. K., Raj, S. P. & Wilemon, D., 1985. The R&D-Marketing Interface in High Technology Firms. *Journal of Product Innovation Management*, Volume 2, pp. 12-24.

Hansen, M., 1999. The search-transfer problem: the role of weak ties in sharing knowledge across organization subunits. *Administrative Science Quarterly*, Volume 44, pp. 82-111.

Harrison, D. A. & Klein, K. J., 2007. What's the Difference? Diversity Constructs as Separation, Variety, of Disparity in Organizations. *The Academy of Management Review*, 32(4), pp. 1199-1228.

Hill, G., 1982. Group versus individual performance: Are N+1 heads better than one?. *Psychological Bulletin*, 91(3), pp. 517-539.

Hirunyawipada, T., Beyerlein, M. & Blankson, C., 2010. Cross-functional integration as a knowledge transformation mechanism: implications for new product development. *Industrial Marketing Management*, Volume 39, pp. 650-660.

Hislop, D., 2009. *Knowledge Management in Organizations, a critical introduction*. 2 ed. Oxford: Oxford University Press.

Hitt, M., Ireland, R. & Lee, H., 2000. Technological learning, knowledge management, firm growth and performance: an introductory essay. *Journal of Engineering and Technology management*, 17(3), pp. 231-246.

Hunt, S. D., Lambe, J. C. & Wittmann, M. C., 2002. A theory and model of business alliance succes. *Journal of Relationship Marketing*, 1(1), pp. 17-35.

Inkpen, A. C. & Tsang, E. W., 2005. Social Capital, Networks, and Knowledge Transfer. *The Academy of Management Review*, 30(1), pp. 146-165.

Katz, R. & Allen, T., 1982. Investigating the Not-Invented-Here (NIH) Syndrome: A Look at the Performance, Tenure and Communication Patterns of 50 R&D Project Groups. *R&D Management*, Volume 12, pp. 7-19.

Katz, R. & Allen, T. J., 1985. Project Performance and the locus of Influence in the R&D Matrix. *Academy of Management Journal*, 28(1), pp. 67-87.

Keller, R. T., 2001. Cross-functional project groups in research and new product development: diversity, communications, job stress, and outcomes. *Academy of Management Journal*, 44(3), pp. 547-555.

Ko, D.-G., Kirsch, L. J. & King, W. R., 2005. Antecedents of Knowledge Transfer From Consultants to Clients in Enterprise System Implementations. *MIS Quarterly*, 29(1), pp. 59-85.

Kogut, B. & Zander, U., 1992. Knowledge of the firm, combinative capabilities, and replication of technology. *Organizational Studies*, 3(3), pp. 383-397.

Krackhardt, D., 1992. *The strenght of social ties: The Importance of philos in organizations*. N. Nohria, R. Eccles, eds. *Networks and Organizations: Structures Form and Action*. Boston: Harverd Business School Press.

Lane, P. J. & Lubatkin, M., 1998. Relative Absorptive Capacity and Interorganizational Learning. *Strategic Management Jornal*, Volume 19, pp. 461-477.

Laursen, K. & Salter, A., 2006. 'Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal*, Volume 27, pp. 131-150.

Leonard, D., 1995. *Wellsprings of Knowledge: Building and Sustaining the Source of Innovation*. Boston: Harverd Business School Press.

Levin, D. & Cross, R., 2004. The strenght of weak ties you can trust: the mediating role of trust in effective knowledge management. *Management Science*, 50(11), pp. 1477-1490.

Levinthal, D. & March, J., 1993. The myopia of learning. *Strategic Management Journal*, Volume 14, pp. 95-112.

Lyles, M. & Salk, J., 1996. Knowledge acquisition from foreign parents in international joint ventures. *Journal of international business studies*, Volume 27, pp. 905-927.

Madhok, A., 2002. Reassessing the fundamentals and beyond: Ronald Coase, the transaction cost and resource-based theory of the firm and the institutional structure of production. *Strategic Management Journal*, 23(6), pp. 535-550.

Magjuka, R. & Baldwin, T., 1991. Team-based employee involvement programs: effects of design and administration. *Personnel Psychology*, 44(4), pp. 793-812.

Mäkelä, K., Andersson, U. & Seppälä, T., 2012. Interpersonal similarity and knowledge sharing within multinational organization. *International Business Review*, Volume 21, pp. 439-451.

Makino, S. & Delios, A., 1996. Local knowledge transfer and performance: implications for alliance formation in Asia. *Journal of International Business Studies*, Volume 27, pp. 905-927.

Mayer, R., Davis, J. & Schoorman, F., 1995. An integrative model of organizational trust. *The Academy of Management Review*, 20(3), pp. 709-734.

McDonough III, E. F., 2000. Investigation of Factors Contributing to the Success of Cross-Functional Teams. *Journal of Product Innovation Management*, Volume 12, pp. 221-235.

Meier, M., 2001. Knowledge Management in Strategic Alliances: A Review of Empirical Evidence. *International Journal of Management Reviews*, Volume 13, pp. 1-23.

Miles, R. et al., 1997. Organizing in the knowledge age: anticipating the cellular form. *Academy of Management Executive*, 11(4), pp. 7-24.

Mintzberg, H., 1980. Structure in 5's: A synthesis of the Research on Organization Design. *Management Science*, 26(3), pp. 322-341.

Mintzberg, H., 1981. Organization Design: Fashion or Fit? *Harvard Business Review*, pp. 103-116.

Morgan, R. & Hunt, S., 1994. The commitment-trust theory of relationship marketing. *Journal of Marketing*, Volume 58, pp. 20-38.

Morgan, R. M. & Hunt, S. D., 1994. The commitment-Trust theory of Relationship Marketing. *Journal of Marketing*, Volume 3, pp. 20-38.

Nelson, R. & Winter, S., 1982. *An evolutionary theory of economic change*. Cambridge: MA: Belknap Press.

Ngai, E. W., Jin, C. & Liang, T., 2008. A qualitative study of inter-organizational knowledge management in complex products and systems development. *R&D Management*, 38(4), pp. 421-440.

Nissen, H. A., Evald, M. R. & Clarke, A. H., 2014. Knowledge sharing in heterogeneous teams through collaboration and cooperation: Exemplified through Public-Private-Innovation Partnerships. *Industrial Marketing Management*, 43(3), pp. 473-482.

Nonaka, L. & Takeuchi, H., 1995. *The Knowledge-creating company*. Oxford: Oxford University Press.

Nooteboom, B., 1996. Trust, opportunism and governance: a process and control model. *Organization Studies*, 17(6), pp. 985-1010.

O'Dell, C. & Grayson, C., 1998. If only we knew we know: identification and transfer internal best practices. *California Management Review*, 40(3), pp. 154-174.

Parkhe, A., 1998. Building trust in international alliances. *Journal of World Business*, 33(4), pp. 417-437.

Pérez-Nordtvedt, L., Kedia, B., Datta, D. & Rasheed, A., 2008. Effectiveness and efficiency of cross-border knowledge transfer: an empirical examination. *Journal of Management Studies*, Volume 45, pp. 714-744.

Ramesh, B. & Tiwana, A., 1999. Supporting Collaborative Process Knowledge Management in New Product Development Teams. *Decision Support Systems*, Volume 27, pp. 213-235.

Ratcheva, V., 2009. Integrating diverse knowledge through boundary spanning processes - the case of multidisciplinary project teams. *International Journal of Project Management*, pp. 206-215.

Reagans, R. & Zuckerman, E. W., 2014. Networks, Diversity, and Productivity: The Social Capital of Corporate R&D Teams. *Organization Science*, 12(4), pp. 502-517.

Reed, R. & DeFillippi, R. J., 1990. Casual Ambiguity, Barriers To Imitation, And Sustainable Competitive Advantage. *Academy of Management Review*, 15(1), pp. 88-102.

Regatz, G. L., Handfield, R. B. & Scannell, T. V., 1997. Success Factors for Integrating Suppliers into New Product Development. *Journal of Product Innovation Management*, Volume 14, pp. 190-202.

Riege, A., 2006. Three-dozen knowledge sharing barriers managers must consider. *Journal of Knowledge Management*, 9(3), pp. 18-35.

Rochford, L. & Rudelius, W., 1992. How involving more functional areas within a firm affects the new product process. *Journal of Product Innovation Management*, 9(4), pp. 287-299.

Simonin, B. L., 2004. An Empirical Investigation of the Process of Knowledge Transfer in International Strategic Alliances. *Journal of International Business Studies*, 35(5), pp. 407-427.

Smith, K. et al., 1994. Top Management Team Demography and Process: The role of Social Integration and Communication. *Administrative Science Quarterly*, 39(3), pp. 412-438.

Spender, J. C., 1996. Making Knowledge the Basis of a Dynamic Theory of the Firm. *Strategic Management Journal*, 17(Winter Special Issue), pp. 45-62.

Stewart, G., 2006. A meta-analytic review of relationships between team design features and team performance. *Journal of Management*, 31(1), pp. 29-54.

Teece, D. & Pisano, G., 1994. The Dynamic Capabilities of Firms: an Introduction. *Industrial and Corporate Change*, 3(3), pp. 537-556.

Troy, L. C., Hirunyawopada, T. & Paswan, A. K., 2008. Cross-Functional Integration and New Product Success: An Empirical Investigation of the Findings. *Journal of Marketing*, 72(6), pp. 132-146.

Tsai, W., 2002. Social structure of coepetition within a multiunit organization: coordination, competition, and interorganizational knowledge sharing. *Organization Science*, Volume 13, pp. 179-190.

Tsai, W. & Ghoshal, S., 1998. Social capital and value creation: The role of intrafirm networks. *Acad. Management J.*, Volume 41, pp. 464-476.

Tsang, E., 2002. Acquiring knowledge by foreign partners from international joint ventures in a transition economy: learning-by-doing and learning myopia. *Strategic Management Journal*, Volume 23, pp. 835-845.

van Aken, J. E., Berends, H. & van der Bij, H., 2007. *Problem Solving in Organizations*. Cambridge: Cambridge University Press.

van Wijk, R., Jansen, J. J. & Lyles, M. A., 2008. Inter- and Intra-Organizational Knowledge Transfer: A Meta-Analytic Review and Assessment of its Antecedents and Consequences. *Journal of Management Studies*, 45(4), pp. 0022-2380.

Verschuren, P. & Doorewaard, H., 2010. *Designing a Research Project*. 2nd ed. The Hague: Eleven International Publishing.

Williamson, O., 1985. *The economic institution of capitalism*. New York: Free Press.

Yin, R. K., 2003. *Applications of Case Studie Research*. 2nd ed. London: SAGEpublications.

Yin, R. K., 2009. *Case Study Research; Design and Methods*. 4th ed. Los Angeles: Sage Publications.

Zheng, W., Yang, B. & McLean, G. N., 2010. Linking organizational culture, structure, strategy and organizational effectiveness: Mediating role of knowledge mangement. *Journal of Business Research*, Volume 63, pp. 763-771.

Zhoa, Y. & Lavin, M., 2012. An empirical study of knowledge transfer in working relationships with suppliers in new product development. *International Journal of Innovation Management*, 16(2), pp. 1-26.

## APPENDIX A: CASE DESCRIPTIONS

Supplier	Project	Functional diversity	Functions represented
Technolution	Super X	2	R&D, Project lead
<p>The “Super X” is an x-ray detector for TEM microscopes. Eight years ago the first generation of Super X was started in which the electronics were outsourced to a third party. FEI Company focuses on the mechanical aspects of the design, which is the unique selling point as it is completely integrated with the microscopes of FEI Company. For the second generation of the Super X, the project studied within this case, FEI Company desired to get rid of the third party and implement their own electronics and software. In order to enable this step forward, FEI Company asked Technolution to co-develop. At first Technolution would be responsible for the integration of the system, covering the communication with the front end and the interface to the microscope. However, as the project progressed the responsibilities began to drift and got a bit fuzzy. Within every project meeting representatives from both organizations were present. At later stages of the project Technolution even posted one engineer within the team of FEI Company.</p>			
VDL (industrial modules)	Lithicon enclosure	3	R&D, Sales, Project lead
<p>The Lithicon enclosure project concerns an enclosure and a frame of which a model was available in Australia. In order to get the model to the promo-phase FEI Company approached a supplier, VDL. This project suffered a tight time-schedule as only two months were available before the deadline. Although the initial project would only entail to provide detailed documentation like technical drawings and measures, the final project became a real redesign of the enclosure. This increased the time pressure and made the deadline basically impossible. It came to a redesign as the initial model was in a different state as was expected. Because the project became a complete redesign, the collaboration between FEI Company and VDL turned out to be a lot closer than expected as well.</p>			
Frencken	Exsolve stage	4	R&D, Operations, Sales, Project lead
<p>From the American site of FEI Company, where the Exsolve tool is made, the request came to build a stage for the module. This request was send to the R&amp;D department at FEI Company Acht as they have the most expertise with mechatronics. Designers and engineers constructed a functional model which was tested and communicated to Hillsborough, the American site of the company. FEI Company decided to involve an external party, Frencken, to co-develop the stage. Frencken was assigned to develop, manufacture and own the stage design as FEI Company would only take a supporting role. As the project progressed it became clear that requirements were not going to be reached, which led to discussions and conflicts.</p>			
PI	Piezo enhance compu stage	4	R&D, Engineering Sales, Project lead
<p>The “Piezo enhances compu stage” is an improvement of an old module. It is a sort of four-axis robot which is connected to the column of a TEM microscope. It consists of spindles which can manoeuvre the sample underneath the bundle, and can change its orientation. The previous design originates from the eighties. As competitors are catching up, it was decided that the design should be renewed with Piezo stacks.</p>			

This improvement was made in collaboration with a large German company called “PI”. From PI several functional specialties were involved in the project; R&D, an account manager, a project leader, and an external party which was responsible for their logistics.

The two organizations collaborated via phone, email, and a face to face meeting once in every two weeks. The amount of collaboration, and the functional specialties involved, fluctuated over the project phases. Concerning ways of working there were some differences between the two organizations which had to be discussed. After agreement on the way of working the collaboration was rather smooth.

NTS	Thalos	4	R&D, Operations, Sales, Project lead
	Thalos Enclosure	5	R&D, Architect, Project lead, Engineering, Sales

The Thalos project concerns a microscope which, if we look at the basics, is on the market for thirty years now. Within the Thalos project the main concern was to give the entire microscope a facelift and make it of today’s and tomorrow’s standards. The technologies which dated from thirty years ago had to be replaced by modern technology as current legislation and competition were moving ahead.

In the Thalos project a differentiation can be made between the entire frame and the enclosure. The frame consist of a sub-frame, within that sub-frame there is a floating-frame on wheels. Further, there is the enclosure with the hat. The function of the frame is to hold everything in place and enable a facile transport or replacement. The enclosure is used to protect the column of the microscope and provide the machine with a better look and feel.

Divided over more projects and different project teams, NTS has been responsible for the design of the entire frame and enclosure. The main input from FEI Company consisted of the delivery of the specifications. However, FEI Company also interfered on the design. Thereby not making it a fully outsourced project but more of a co-development.



## APPENDIX B: INTERVIEWEES

The table below lists the characteristics of the interviewees according to the interviewee selection criteria described in section 2.7.

Project	Functional specialty	Counterpart
Thalos	Project Lead	Yes
	Sourcing	Yes
	Product introduction Engineer	No
Super X	Project Lead	Yes
	Sourcing	Yes
	Product engineer	No
Exsolve Stage	Project lead	Yes
	Sourcing	Yes
Lithicon Enclosure	Project lead	Yes
	Sourcing	Yes
	Advanced sourcing	No
Piezo enhanced compustage	Project lead	Yes
	Sourcing	Yes
	Product engineer	No
Thalos Enclosure	Project lead	Yes
	Sourcing	Yes
	System architect	Yes
	Mechanical architect	No

## **APPENDIX C: INTERVIEW PROTOCOL**

All interviews have used the same protocol and open questions about the project content, the supplier relationship and the knowledge transfer.

### **INTRODUCTION**

- Introduce myself, the researcher
- Research motive: I am graduating at the Technical University Eindhoven, where I take part in the master of Innovation Management. I am writing my master thesis on behalf of FEI Company. During an internship of five months within the sourcing department of the company a problem was identified. According to the Global Advanced Sourcing Manager, FEI Company did not learn enough from their suppliers through collaboration. After my analysis of the presented problem, my research focused on how the configuration of the supplier's team that is involved in the NPD activities influences the knowledge transfer between the two firms.
- Research objective: The aim of the study is to increase insight on how the functional diversity on the supplier's side of the NPD-team affects knowledge transfer. With these insights recommendations can be made to sourcing professionals in order to enhance the learning capabilities of the company.
- Interview objective: First, to learn about the way the organization manages supplier involvement and enables knowledge transfer. Secondly, to learn about how functional diversity on the supplier's side will influence inter-organizational knowledge transfer.
- Interview procedure: Ask the interviewee the upfront defined questions about the topic. When needed, additional questions can be asked to elaborate on the topic or seek for alternative explanations.
- Ask permission to record the interview
- Ask interviewee to introduce him-/herself

### **INTERVIEW**

Note: some concepts and the purpose of the research might require some further explanation. Ask Interviewee if he/she understands the purpose and the main concepts used.

#### **Project related questions:**

- Could you describe the (aim of the) project?
- Could you describe the company goals through the project?
- In what way were you involved in the project and what were your responsibilities?
- Could you describe the contribution of the different departments to the project?

#### **Supplier relationship (organizational level)**

- Could you tell me something about the supplier and why they were involved in the project?
- Could you describe how the supplier was involved in the project?

- How?
- How frequent?
- Relationship?
- Which functional specialties?
  - Why?
- Could you tell me about resemblance between FEI and the supplier in terms of the way they approach a project?

### **Supplier relationship**

- Could you elaborate on your relation with the supplier?
  - Connection to own functional specialty
    - How?
    - How frequent?
    - Relationship?
  - Connection with other functional specialties
    - How?
    - How frequent?
    - Relationship?
- Could you elaborate on how you built a relation with the supplier?
- Could you describe how the involvement of the supplier affected the project?

### **Knowledge transfer**

- Could you describe how the involvement of the supplier affected the project?
- Could you describe how the involvement of multiple functional specialties of the supplier affected the project?

### **General Functional diversity**

- What does functional diversity bring to a team?
- How does the functional diversity of a supplier affect the collaboration?
  - What are the difficulties?
  - What are the benefits?

## APPENDIX D: CODING MATRIX

The coding matrix is used to get a feeling of the different responses of the interviewees, and to see differences and similarities over the different cases.

Topic	Level	Content	Measuring questions (3 point-Likert-scale)
Amount of valuable knowledge	Team	Knowledge Amount	To what extent did the supplier transfer knowledge to FEI?
		Knowledge Usefulness	To what extent was the knowledge transferred by the supplier useful?
		Knowledge Novelty	To what extent did the supplier bring new ideas to the table?
	Functional specialty	Knowledge Amount	To what extent did the supplier transfer knowledge to FEI (own functional specialty only)?
		Knowledge Usefulness	To what extent did the supplier bring new ideas to the table (own functional specialty only)?
		Knowledge Novelty	To what extent was the knowledge transferred by the supplier useful (own functional specialty only)?
Way of collaborating	Team	Closeness working relationship	How close was the working relationship between the project team and the supplier?
	Individual	Closeness working relationship	How close was your working relationship with the supplier?
		Relation to other specialties	To what extent did you receive new knowledge from other specialties directly from the supplier?
		Relation to other specialties	To what extent is collaboration of functional specialties of the supplier limited to collaboration with its functional counterpart at FEI?
		Relation to own specialties	To what extent did you receive new knowledge from your own specialty directly from the supplier?
Prior basic knowledge	Team	Mutual understanding	To what extent were you able to discuss project details with supplier's specialists?
		Mutual understanding	To what extent did you understand the new knowledge presented by the supplier?
	Individual	Mutual understanding	To what extent did you understand the new knowledge presented by the supplier (own functional specialty only)?
		Functional overlap	To what extent did you share the same educational/technical background as the individuals of supplier?
Relation Proposition 1			To what extent is collaboration of functional specialties of the supplier limited to collaboration with its functional counterpart at FEI due to the barrier of prior basic knowledge?
Trust	Individual	Competence trust	To what extent is there a trustful relationship with the supplier in terms of, they are fully capable of doing the job?
		Goodwill trust	To what extent is there a trustful relationship with the supplier in terms of, they are here for the right intentions?

Trust building	Individual	trust building – way of working	Trust in the capabilities of the supplier is built by observing their way of working
		trust building – mutual understanding	Trust in the capabilities of the supplier is built by a high degree of mutual understanding in conversation
		trust building – network	Trust in the capabilities of the supplier is built by positive feedback from someone in the network
		trust building – way of working	Trust in the capabilities of the supplier is built by observing their way of working
		trust building – mutual understanding	Trust in the capabilities of the supplier is built by a high degree of mutual understanding in conversation
		trust building – network	Trust in the capabilities of the supplier is built by positive feedback from someone in the network
Social tie strength	Team	Perceived Relationship quality	To what extent is it considered to be a good relationship with the supplier?
		Closeness working relationship	How close was your working relationship between the project team and the supplier?
		Frequency of communication	How frequent has cooperation and communication been during the project with the different functional specialties?
	Individual	Perceived Relationship quality	To what extent is it considered to be a good relationship with the supplier (own functional specialty only)?
		Closeness working relationship	How close was your working relationship between the project team and the supplier (own functional specialty only)?
		Frequency of communication	How frequent has cooperation and communication been during the project (own functional specialty only)?
Common ties	Individual	Familiarity supplier	To what extent did you already know the individuals on the other side of the table?
		Familiarity supplier	To what extent did you know people who worked with them?
Positive feedback	Individual	Network feedback	Trust in the capabilities of the supplier is built by positive feedback from someone in the network
		Credentials	The credentials that were checked were positive
		Network feedback	Trust in the intentions of the supplier is built by positive feedback from someone in the network
Organizational cultures (differences)	Team	Difference way of working	To what extent does the supplier project team work with other procedures?
		Difference way of working	To what extent does the supplier project team has other processes in place?
		Difference way of working	To what extent does the supplier project team have other routines?
		Difference way of working	To what extent does the supplier project team have a different approach to problems that occur?
		Difference norms and values	To what extent does the supplier project team have a different understanding of what is important or not?

		Difference norms and values	To what extent does the supplier project team prioritize differently than FEI?
Conflicts (Cultures)	Team	Conflicts in way of working	The differences in procedures made cooperation more difficult
		Conflicts in way of working	The differences in processes made cooperation more difficult
		Conflicts in way of working	The differences in routines made cooperation more difficult
		Conflicts in way of working	The differences in the way of approaching problems made cooperation more difficult
		Conflicts in norms and values	The differences in norms and values made cooperation more difficult
Goal coherence	Organizational	Differences in goals	To what degree did the supplier have different primary goals?
		Supplier strategy	To what extent is cooperation limited by the strategic positioning of the supplier?
		Differences in goals	To what extent did the supplier have the same intentions through the project?
		Differences in goals	To what extent did the NPD roadmaps of both companies align?
	Individual	Differences in goals	To what extent did the individuals of the supplying team pursue different personal goals?
		Differences in goals	To what extent did the individuals of the supplying team pursue different goals from their own departments?
		Differences in goals	To what extent does the supplier project team have a different understanding of what is important and not?
		Differences in goals	To what extent does the supplier project team prioritize differently than FEI?
Conflicts (goals)		Conflicts in goals	Differences in company goals made cooperation more difficult
		Conflicts in goals	Differences in personal goals made cooperation more difficult
		Conflicts in goals	Differences in goals of the departments made cooperation more difficult
Conflicts (goals and culture – prior basic knowledge)		Prior basic knowledge on cultural conflicts	To what extent are the differences in procedures overcome by prior basic knowledge?
		Prior basic knowledge on cultural conflicts	To what extent are the differences in processes overcome by prior basic knowledge?
		Prior basic knowledge on cultural conflicts	To what extent are the differences in routines overcome by prior basic knowledge?
		Prior basic knowledge on cultural conflicts	To what extent are the differences in way of approaching problems overcome by prior basic knowledge?
		Prior basic knowledge on goal conflicts	To what extent are the differences in goals overcome by prior basic knowledge?