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COMMUNICATION PRACTICES IN INTER-ORGANISATIONAL PRODUCT DEVELOPMENT

Doctoral Dissertation

Maria Paasivaara

Helsinki University of Technology
Department of Computer Science and Engineering
Software Business and Engineering Institute

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Dissertation for the degree of Doctor of Science in Technology to be presented with due permission of the Department of Computer Science and Engineering for public examination and debate in Auditorium T2 at Helsinki University of Technology (Espoo, Finland) on the 25th of November, 2005, at 12 noon.

Helsinki University of Technology
Department of Computer Science and Engineering
Software Business and Engineering Institute

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Abstract

Geographically distributed, inter-organisational product development projects are becoming increasingly common. However, companies face challenges in managing this kind of complicated projects. Most of the challenges are related to communication. This study focused on communication needs, problems and practices in distributed inter-organisational product development projects.

The main objective was to identify and describe successful communication practices. In addition, the study aimed to increase the understanding of the communication needs behind the practices, as well as to identify communication problems and unsuccessful practices. From the methodological point of view, studying daily communication in distributed projects is challenging. In this study we experimented with the usage of social process simulation as a tool to study communication.

Methodologically, the research was a qualitative multiple-case study consisting of 12 case projects. The cases were grouped into two separate studies according to the industry. Study 1 concentrated on distributed inter-organisational projects that developed plastic products, whereas Study 2 examined global software development projects. In Study 1, data was collected using the social process simulation method, which combines several data collection methods, such as semi-structured interviews and simulation sessions. In Study 2, semi-structured interviews were used.

The main contribution of this research is a set of eighteen successful communication practices that were identified in distributed product development projects. The practices include, e.g., frequent deliveries, the creation of role descriptions, problem solving responsible, discussion forums, regular meetings, design and code walkthroughs and giving faces. We also found that most of the case companies had not designed clear organisation-wide communication practices that would have been commonly used in their inter-organisational product development projects. The communication practices encountered were mainly project-specific and created by trial and error. The successful practices were simple, but still they were not broadly used, which easily led to problems. Thus, the state of the practice in companies seemed to be quite low. The suitability of each identified communication practice to different situations and projects needs to be evaluated further.

The research recognized five communication needs of distributed projects: problem solving, informing, monitoring progress and providing transparency, giving feedback, and relationship building. Several communication problems were identified as well. Social process simulation was noticed to be a useful tool in studying communication in distributed projects.

Future research should focus on quantitative studies on the usage of communication practices in distributed projects, the effects of communication practices on project success, the suitability of different communication practices for different project types and phases, accomplishing transparency in distributed projects, and experimenting with the usage of social process simulation in different kinds of research.

Keywords: Communication, communication practice, distributed project, product development, global software development

Acknowledgements

In 1997 I joined TAI Research Center to do my master's thesis about a topic that I found extremely exiting: the networked way of working between companies. This topic was new and interesting at that time. Now, eight years later, the topic is even more important, since companies are increasingly working in a distributed manner and collaborating across distances and company borders. I participated in several research projects around that topic, first in TAI Research Center, and later in SoberIT. During these years there have been many people who have contributed to my research work and to whom I am very grateful.

Professors Jukka Ranta and Eila Järvenpää introduced me to this interesting topic and gave me guidance and advice during the first steps of my research carrier, for which I am thankful to them. After joining SoberIT, Professor Reijo "Shosta" Sulonen has had the most important role as both my supervisor and the coordinator of our research projects. He has given me a lot of support by providing new ideas, guiding my work and giving valuable comments, for which I am grateful to him.

I really enjoyed myself doing this research: interviews, simulation sessions, and finally analysis and writing. Besides having an interesting topic, all the people participating in the research process both in SoberIT and in our case companies made this work enjoyable. Special thanks belong to my co-workers: In the VeTO project Jarkko Pyysiäinen shared with me the workload of data collection by planning and participating in the interviews with me. In the Prodoku project, Kirsi Pelto-Aho and Jukka Borgman helped me in preparing and arranging the simulation sessions. Finally, the whole SPRG research group has provided me support and contributed to this work by reading and commenting on my research papers. I would also like to thank all the case companies that participated this study and provided us an access to interesting data. In particular, I wish to thank all interviewees and simulation participants for the many interesting discussions that formed the empirical data that this research is based on.

I would like to thank the pre-examiners of my thesis, Dr. Peter Gloor and Professor Ilkka Haikala for their valuable comments that helped me improve the text of the final version. My opponent, Professor Roberto Evaristo, I wish to thank for the kind comments and interesting discussions that hopefully will continue in the future. I am also thankful to Leena Arpiainen who corrected my English language.

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Hattula, November 2005

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Contents

1 Introduction

This chapter first discusses the background of this research and then briefly describes the objectives and the scope of the study. Finally, the studied projects are introduced and the structure of the thesis is presented.

1.1 Background

New products are increasingly developed in geographically and organisationally distributed projects. The reasons for this development are numerous; companies are concentrating on their core-competences, and thus they need know-how and resources from subcontractors and partners, or they may have internal departments and offices distributed around the world due to acquisitions or the need to be close to the market. In this study we will concentrate especially on geographically distributed inter-organisational projects. There are a number of benefits arising from collaboration between firms, e.g., speeding up product development; obtaining resources, knowledge or technology; and sharing costs and risks. However, several studies have shown that the objectives of the collaboration are not always met (e.g. Bruce et al, 1995). Many of the problems leading to unsuccessful collaborative projects originate from a lack of communication and trust (Wynstra et al, 2001; Bruce et al, 1995). Moreover, previous communication research studying intra-organisational distributed projects has shown that effective and efficient communication is a prerequisite for the success of a project (Moenaert et al, 2000) and that the better the product development team members are connected to each other and to the external key parties, the more successful the project is going to be (Tushman and Katz, 1980).

Accomplishing effective and efficient communication seems to be even more important for geographically distributed, inter-organisational product development projects than it is for normal collocated projects. These distributed projects face several barriers that complicate communication, such as geographical distances, and differences in organisational cultures and operating procedures. Arranging successful collaboration and communication in spite of these barriers poses new challenges and brings out several questions: What are the needs for communication in distributed inter-organisational product development projects? How should the communication be arranged? When should the communication take place? What kind of information should be communicated? Who should communicate? How could this distributed communication be supported?

Even though intra-organisational communication has received significant research attention, communication in distributed, inter-organisational product development projects has not been studied extensively, as will be shown in the literature review, in Chapter 2. Furthermore, we noticed when starting our research that companies seem to have a lot of communication-related problems in their distributed projects, since this kind of projects are quite new and challenging to many of them. Many companies were very interested in the studies and results about successful communication practices. Clearly, companies experience communication to be so challenging in their geographically distributed projects that they need to search for solutions and successful communication practices. This study aims to add to that knowledge by exploring the field of inter-

organisational communication in product development projects.

This study is based on material collected during two research projects carried out at the Software Business and Engineering Institute at the Helsinki University of Technology. Both research projects, ProDoku (1999-2001) and VeTO (2001-2004), studied geographically distributed inter-organisational product development projects and concentrated especially on communication practices.

1.2 Objectives

The main objective of this research was to collect and describe the communication practices that are currently used in geographically distributed inter-organisational product development projects. We aimed to collect especially successful communication practices, since finding successful practices would be helpful for companies that are planning and executing these challenging projects. In addition to collecting successful communication practices we wanted to understand the communication needs behind the practices and also the communication problems and the less successful practices used.

From the methodological point of view studying daily communication in distributed projects is quite challenging. Even though several data collection methods to study communication exist, such as observations, interviews and collecting communication logs, getting reliable results by using them would require a lot of time and effort both from the researchers and the studied companies. Since the case companies participating this study were not enthusiastic about the usage of these methods, we decided to try something else. A research group from our university had developed a simulation game method (e.g., Ruohomäki, 1995a; Smeds and Haho, 1995; Piispanen et al., 1996), which had been used mainly as a process improvement tool. We decided to attempt the usage of a modified version of this method to study the communication in distributed projects. Thus, the last objective of our research was to experiment whether this method, here referred to as the social process simulation method, can be used as a research method to study the communication in distributed product development projects. Next, all the research questions are listed.

The main research question of our study is:

- RQ1: What kinds of communication practices are used in geographically distributed inter-organisational product development projects?

In addition to the main research question, we have three supporting research questions:

- RQ2: What kinds of communication problems do geographically distributed inter-organisational product development projects have?
- RQ3: What kinds of communication needs do geographically distributed inter-organisational product development projects have?
- RQ4: Is the social process simulation method a useful tool in studying the communication practices inter-organisational product development projects?

All the research questions are further elaborated in Chapter 3.1.

1.3 Scope

In this study we wanted to study the communication needs, practices and problems in

a) product development projects that are

b) inter-organisational, and

c) geographically distributed.

Since there are many different kinds of geographically distributed inter-organisational product development projects, we had to choose only one subset of the projects for this study. To be able to understand the projects better and also to compare the studied projects with each other, we chose our case projects only from two different fields. Most of the new products developed are physical products, whereas some of the products are more intangible in nature. We wanted to study both the development of tangible and intangible products because we expected that the communication practices might have some differences when communicating about the development of tangible products compared to the development of intangible products. We divided this study into two studies, Study 1 and Study 2. In our first study we studied tangible products: two comparable plastic product development projects. In our second study we studied intangible products: 10 software development projects. The scope of this research is thus limited to altogether 12 case projects from two different industries.

Geographical and organisational distribution differed between the case projects. Figure 1. presents a classification of product development project types according to organisational and geographical distances. Organisational distance tells if a project is carried out inside one company or if two or more companies are involved. Geographical distance is divided into three categories, the parties can either work at the same location, e.g., in the same building; they can be situated in the same country, e.g., in different cities; or they can be spread out to two or more different countries. The complexity of the project organisation is assumed to increase when following the axes upward or right, i.e., the organisational distance or the geographical distance increases. The meaning of this picture is to present one classification of distributed projects, which helps to clarify the selection criteria and the differences of the chosen case projects.

Different colors in Figure 1 represent the focus areas of this study. In Study 1 both case projects belonged to the category “locally distributed inter-organisational”, i.e., all the involved parties were situated in the same country, Finland, and at least two different companies were involved in each project. In Study 2, the main focus was on projects from the category “global inter-organisational”, i.e. the participants were located in at least two different countries and two or more companies were involved in the development work. In Study 2 eight out of ten case projects belonged to this category. However, we chose also two projects to this study from category “global intra-organisational. These projects had development sites in at least two countries, but the involved companies belonged to the same group, i.e., instead of hiring outside subcontractors the customer company hired its own subsidiaries to help in the development work. In all other case projects of Studies 1 and 2 the inter-organisational collaboration took place between a customer company and one or more subcontractors.

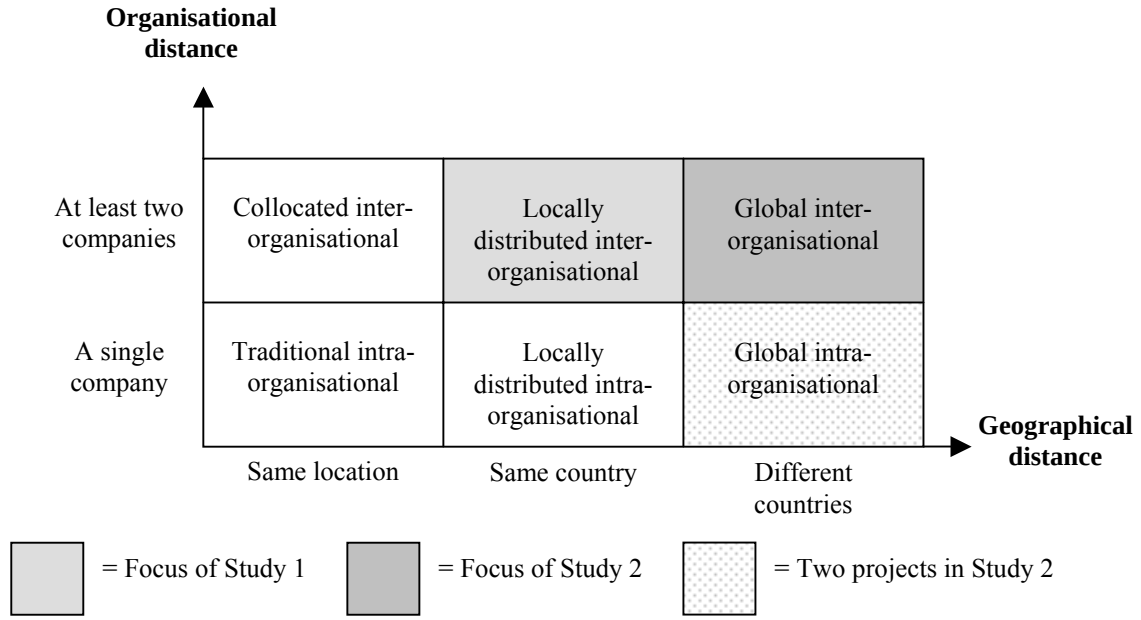


Figure 1. The case projects of our studies situated in a project type classification (modified from Katzy et al. 2000).

Since we studied communication both in locally and globally distributed projects, also cultural aspects came into the picture. Cultural differences have a large effect on the communication especially in globally distributed projects. However, in this study we did not concentrate on the cultural aspects and their effects on the communication. The reason for this was that there are already several studies about cultural issues. Moreover, the effect of cultural differences on communication is a broad area offering interesting opportunities for several studies concentrating only on those issues. Thus, this study excludes more thorough examination of cultural aspects from its scope.

Communication science is an old and broad field of research. The scope of this study is limited to looking at the studied phenomenon, communication in inter-organisational, geographically distributed product development projects, from one specific angle, i.e., from the point of view of product development. Instead of theoretical examination, the phenomenon is studied at a very practical and low level, i.e., the communication practices are explored in a few real-life product development projects. Accordingly, the literature review in Chapter 2 concentrates especially on communication studies made from the product development point of view.

1.4 Product development projects studied

This research is a multiple-case study consisting of 12 case projects grouped into two studies according to the industry of the case projects. Both studies are briefly presented below.

1.4.1 First study – The development of plastic products

Our first study consists of two inter-organisational new product development projects. Both of the projects were carried out by a large Finnish consumer electronics company with the help of its subcontractors. These projects formed a part of larger product programs consisting of many projects developing, e.g. software, electronics and plastic covers for the same consumer electronics products. For this study, we chose one project from each of the two different product programs, the development projects of plastic covers for these products. We limited the scope further to subassemblies of the product front covers. Moreover, the studied time period was limited as explained later on. In both case projects all the sites that participated in the project were located in Finland.

In this study we concentrated on the current communication practices especially between the consumer electronics company and its first tier subcontractors. The consumer electronics industry is characterised by a constant need to shorten project cycle-times, since the environment is changing quite rapidly. Development is increasingly done in parallel, i.e. different parties perform development work at the same time, and the subcontractors are involved in the project at a quite early phase. In the studied projects the subcontractors were involved even earlier than before. Thus, constant communication between the customer designing the product and the subcontractor designing the moulds for manufacturing the plastic covers was needed.

As explained earlier, the main research method used in this study was the social process simulation method, which both enabled access to the case companies and provided several possible ways to collect data. Practically all project team members from each case project participated in the day-long simulation sessions. We also interviewed project team members, 9 persons from the first project and 17 persons from the second one. To deepen our understanding of these projects and their communication we used multiple research methods and concentrated on only two projects in this study.

This study aims to find answers to all four research questions.

1.4.2 Second study – Software development

Our second study consists of 10 globally distributed software development projects. These projects developed either entirely new software (6 projects) or new versions of software (4 projects). Five of the projects developed software products, two projects developed customer-specific systems and three projects were software development subprojects of larger product programs developing products with embedded software. For this study we wanted to choose especially software development projects that are inter-organisational, globally distributed, have uncertainties and where the parties are developing software concurrently. We expected that projects having these qualities would require frequent communication between the parties and would be very challenging from the communication point of view. We believed that these kinds of projects would benefit a lot from functioning communication practices, which is what we searched for during this study. We concentrated especially on studying the communication practices between the customer company and its subcontractor(s).

As a research method we used interviews of both project personnel working in the case projects and managers participating in the projects. Altogether we interviewed 59 persons.

For this second study we chose more case projects than for our first study, since we wanted to get a broad picture of the communication practices used in this industry.

This study aims to answer the first three research questions. Only the last question concerning the social process simulation method is not addressed, since that method was not used in this study.

1.5 The structure of the dissertation

This work has seven chapters: Introduction, Literature Study, Research Design, First Study, Second Study, Cross-Study Summary and Conclusions, and Discussion.

Chapter 2 presents a literature review of past communication research in product development. Earlier studies are divided into four research streams according to the project types: traditional intra-organisational projects, distributed intra-organisational projects, distributed inter-organisational projects and global software development projects. The literature review reveals that communication is one of the biggest problems in distributed projects, but it has not yet received large research attention.

Chapter 3 concentrates on the methodological issues. First, the research questions are presented. Then, the research approach and the research material and methods are described. This research is a qualitative multiple-case study. The main data collection method in Study 1 was process simulation, which has earlier been used mainly for process development purposes. In Study 2, the data was collected by interviews. Finally, the data analysis and research timeline are presented.

Chapter 4 presents the results from Study 1 - the development of plastics products. Firstly, the case projects, research methods and empirical data are described. Then the communication practices are introduced. These include communication through project managers, direct communication between the team members about details, communication through a resident contact person, project meetings for change management and problem solving and meeting memos as the main source of information. Thirdly, the encountered communication problems are described. Finally, the experiences of the usage of social process simulation as a research method are discussed.

Chapter 5 presents the results from Study 2 – software development. Firstly, the case projects, research methods and empirical data are described. Secondly, the subcontracting project types encountered in our case companies: resource hiring, independent subcontractor teams, transparent box and black box are briefly described. Thirdly, the recognized communication needs, problem solving, informing, monitoring progress and providing transparency, giving feedback, and relationship building, are introduced. Fourthly, communication practices, such as frequent deliveries, visiting engineer, problem solving responsible, regular meetings, progress reports, design and code walkthroughs, and giving faces are presented. Finally, the communication problems are reported.

Chapter 6 consists of the cross-study summary and conclusions. Here we summarize and compare the results received from both studies and sum up the answers to the four research questions.

Chapter 7 discusses the results and compares them with earlier research. Moreover, the theoretical and practical contribution of this study is discussed and the limitations are presented. Finally, topics for future research are suggested.

2 Literature study

This chapter discusses first organisational communication in general. The rest of the chapter presents the literature about communication in different types of product development projects.

2.1 Organisational communication

Communication is essential to all organisations. It is self-evident for many, but it can be very challenging at the same time. Several fundamental questions can be asked: What is communication? Why do organisations communicate? Goldhaber (1993) defined organisational communication in the following way: *"Organisational communication is the process of creating and exchanging messages within a network of interdependent relationships to cope with environmental uncertainty."* According to Daft and Lengel (1986) organisations process information to reduce both uncertainty and equivocality. When the uncertainty faced by an organisation is high, acquiring and processing additional information is a solution. However, when the equivocality is high, the field is messy and unclear and new data may even add uncertainty, since it may be confusing. Thus, both Goldhaber, and Daft and Lengel, connect organisational communication to uncertainty. According to them, communication is used in organisations both to cope with uncertainty and to reduce it. Since distributed product development projects normally have many uncertainties, it seems that in the light of these definitions, organisational communication is especially important in such an environment.

2.1.1 The elements of organisational communication

Organisational communication includes many elements. The following ten central elements are collected from literature. The most important is the *message* containing the communicated information. The *reason* for communication expresses why the parties communicate. Communication has at least two parties, a *sender* and a *receiver*, and their communication is based on a *relationship*. Communicators may be part of a communication *network*, and depending on the structure of the organisation or network the communicators are a part of the *direction* of communication can be upward, downward or horizontal (Goldhaber, 1993). The message is transmitted through communication *media*. Communication is affected by the organisational *environment*, and communication can be disturbed by *noise*. All these ten elements are central for the communication in distributed product development projects, as well. Thus, when describing the communication practices later on, at least some of these elements will appear.

2.1.2 Classifying organisational communication

There are several ways to classify organisational communication, e.g. by the forms of communication or by the media used. One division of organisational communication is into formal and informal communication. In formal communication, the message flows through official, prescribed channels, determined by the organisational hierarchy or job

functions (Goldhaber, 1993). Informal communication, on the contrary, is based mainly on personal relationships. Goldhaber (1993) states that all communication that is not formal is informal. According to Krackhardt and Hanson (1993) informal networks can both help accomplish tasks quickly, but also sabotage good plans. Therefore, managers should recognize the existence of informal networks (Krackhardt and Hanson, 1993), know their limitations and learn to use them (Goldhaber, 1993).

Another way to classify organisational communication is by the communication media in use. Nowadays, a lot of organisational communication takes place through electronic communication media. Thus, one division of communication is into electronic and face-to-face communication. When choosing a suitable communication media, media richness theory offers some advises (Daft and Lengel, 1986). According to Daft and Lengel (1986) rich media, such as face-to-face communication is suitable for transmitting messages containing equivocality, whereas written media is better suited for unequivocal messages.

2.2 Literature about communication in product development

To clarify the literature review about communication in product development projects, we grouped the literature according to different product development project types. We got the first three groups from the project type classification presented earlier: 1) traditional intra-organisational projects, 2) distributed intra-organisational projects, and 3) distributed inter-organisational projects. Since Study 2 will concentrate especially on one special type of product development, i.e. global software development, we chose this special field as the fourth area of the literature review: 4) global software development projects. This grouping of the literature is presented in Figure 2.

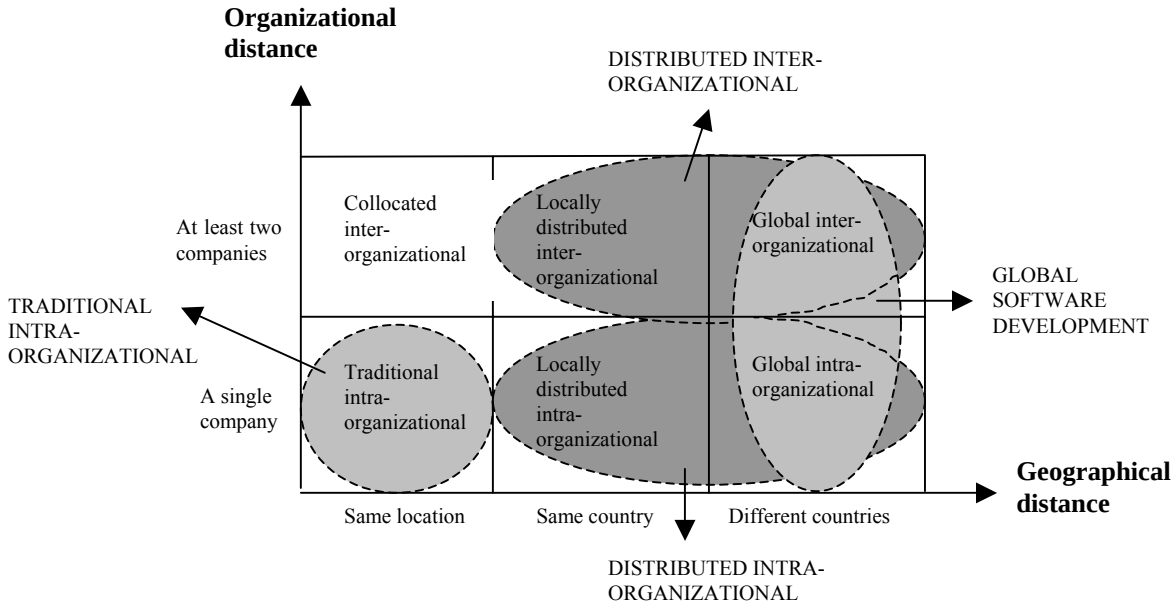


Figure 2. Literature about communication in product development projects.

Communication in traditional product development projects (single firm, one location) has been studied extensively over the years. Both communication between individuals (e.g. Allen, 1984, 2000; Tushman and Katz, 1980) and between functions, such as

marketing, R&D and production, (e.g. Wheelwright and Clark, 1992; Soulder and Moenaert, 1992; Moenaert et al, 1994) have received attention. These studies form the basis for the communication research in product development. The studies report communication practices and problems that could also exist in distributed product development when the departments, e.g. R&D and production, are situated in different companies.

Distributed intra-organisational product development projects are carried out by a single firm, but across various locations. Many studies of such distributed projects have reported how new information and communication technologies can support cooperation across the locations. These studies can be compared to distributed inter-organisational product development projects (e.g. Boutellier et al, 1998; McDonough et al, 1999), because the geographical distance, a factor that hugely reduces communication (Allen, 2000), is always present in these projects as well. Research about communication in intra-organisational projects forms a solid foundation for communication studies in inter-organisational projects. However, compared to cross-functional interaction or intra-organisational distributed projects, communication across company borders poses additional difficulties, e.g., due to factors such as lack of trust, differing ways of working, and legal issues. Communication in distributed, inter-organisational product development projects has not yet been broadly studied (Wynstra and ten Pierick, 2000). We will not include literature about collocated inter-organisational projects into this study since all our case projects are distributed projects.

Finally, the fourth group of literature is global software development. This literature discusses communication in both intra- and inter-organisational software development projects. We did not locate studies concentrating only on communication in this field, but several studies discussed communication as one of their subjects. This special field of product development was chosen to the literature review, since in Study 2, all the studied projects developed software and each project was distributed between two or more countries.

The rest of this chapter will give a more detailed review of the literature on communication in product development projects. It is organized according to the above fields of literature: communication in traditional intra-organisational projects, communication in distributed intra-organisational projects, communication in distributed inter-organisational projects, and communication in global software development projects.

2.3 Communication in traditional intra-organisational projects

Communication studies of traditional, intra-organisational projects have been divided in this literature review into two streams: communication between individuals and communication between functions. The first stream deals with the team member's communication with their colleagues, and the second stream with cross-functional integration and the communication related to that. There is some overlap between these streams, since communication with the colleagues may be directed towards other functional departments as well. Table 1 outlines some of the most interesting studies in each of these streams. Then, both streams are discussed further.

Table 1. Studies about communication in traditional intra-organisational projects.

COMMUNICATION STUDIES IN TRADITIONAL INTRA-ORGANISATIONAL PROJECTS	
Communication between individuals	
Authors	**Main results**
Allen, 1984	A high level of both internal and external communication positively affects team performance. Increasing physical distance between communicating persons decreases the probability of communication almost exponentially.
Tushman & Katz, 1980, Katz & Tushman, 1981	Development projects (product or process) are effectively linked to external areas through gatekeepers, whereas research projects are more effectively linked to external areas through direct member contact.
Katz, 1982	Project groups that have been working for a long time together communicate less internally and externally than newer groups. This reduction in communication may also lead to a decrease in performance
Allen, 1986	There are two types of technical communication in an R&D organisation: communication to coordinate the tasks of the organisation, and communication to keep the engineers abreast of developments in their specialties. Both types need to be managed properly.
Ancona & Caldwell, 1992a	The results indicate that a team's internal diversity affects performance negatively. Diversity brings creativity to problem solving and development, but it impedes implementation by decreasing the capability for teamwork. Greater functional diversity increases team members' external communication.
Ancona & Caldwell, 1992b	Research has identified four strategies that teams used for external communication: ambassadorial, task-co-ordination, scouting and isolationist. The type of external communication a team used determined performance, not the frequency of communication.
Moenaert & Caeldries, 1996	Relocating R&D personnel closer to each other did not increase the quantity of communication, but improved communication quality.
Morelli, Eppinger & Gulati, 1995; Sosa, Eppinger & Rowles, 2000	These studies provide a method to predict coordination-type communication between design groups of a complex product by analysing the architecture of the product to be developed. The ability to predict communication may allow managers to implement suitable organisational structures.
Communication between functions	
Authors	**Main results**
Moenaert & Souder, 1990	**R&D and marketing:** R&D appreciates written communication because of its higher credibility, whereas marketing prefers face-to-face communication due to its higher comprehensibility. To enhance communication between these functions trust, contextual information and formal communication rules are needed.
Souder & Moenaert, 1992	**R&D and marketing:** During the planning stage, R&D and marketing should exchange innovative information using informal channels. During the development stage the importance of coordinative information exchanged between functional supervisors increases.
Moenaert, Souder, DeMeyer & Deschoolmeester, 1994	**R&D and marketing:** Project formalisation and decentralisation, good inter-functional relations and role flexibility increase communication between R&D and marketing.
Griffin & Hauser, 1996	**R&D and marketing:** Based on the literature, the writers conclude that the differences of personality, and cultural, language, organisational and physical barriers between the departments prevent communication. They also suggest methods to achieve integration.
Maltz, Souder & Kumar, 2001	**R&D and marketing:** Inter-functional rivalry between R&D and marketing reduces R&D's use of information supplied by marketing and lowers the perceived quality of information transferred.

Wheelwright & Clark, 1992	**R&D and manufacturing:** Writers present four patterns of communication between upstream and downstream groups: serial mode (downstream group starts when upstream finishes), early start in the dark (downstream starts before getting information from upstream), early involvement (downstream group advices upstream early on) and integrated problem solving (both groups work in parallel and solve problems together).
Nihtilä, 1999	**R&D and manufacturing:** The study identified four key integration mechanisms between these departments: standards, procedures and plans; milestone and design review practice; individual integrator; and cross-functional team.
Rochford & Rudelius, 1992	**R&D, marketing and manufacturing:** Quite often in the product development process only one functional area that has prime responsibility for the stage contributes information to this stage. However, for several stages, obtaining information from more functional areas has a positive effect on new product performance.
Kahn, 1996	**R&D, marketing and manufacturing:** Collaboration between departments has a much stronger positive effect on product development performance than interaction. Actually, meetings and the exchange of documented information seem to have negative effects.
Kahn & McDonough, 1997	**R&D, marketing and manufacturing:** Collocation facilitates collaboration between R&D and marketing, but not between manufacturing and other departments. Collocation does not directly lead to improved performance, instead, collaboration seems to have direct links to performance and satisfaction.
Pinto & Pinto, 1990	**Cross-functional team:** Teams with a high degree of cooperation used much more informal communication than low cooperation teams and their communication also engaged more on task-related issues than on resolving conflicts or other interpersonal difficulties.

2.3.1 Communication between individuals

This research stream deals with the internal and external communication of project teams. Most studies find that increased internal and external communication affect the project performance positively (e.g. Allen, 1984). However, not only the frequency of the communication matters, but also its quality (Moenaert and Caeldries, 1996) and the type of communication (Ancona and Caldwell, 1992b). Internal communication in a project is influenced e.g. by the physical distance between the team members (Allen, 1984), and the cohesiveness (Keller, 1986) and the homogeneity of the team (Ancona and Caldwell, 1992a; Bruce at al, 1995). External communication activities are facilitated by gatekeepers, (Allen, 1984; Tushman and Katz, 1980) and the functional diversity of a team (Ancona and Caldwell, 1992a). Also the type of the external interaction (Ancona and Caldwell, 1992b), and the tenure of a project group (Katz, 1982) should be paid attention.

2.3.1.1 Internal communication

Allen (1984) studied the effect of physical distance on the communication between two persons. His results indicated that the probability to communicate decreases almost exponentially as the distance increases. He discovered that for the probability of weekly communication the first thirty meters matter the most. After that, the probability did not differ much whether the distance was one hundred meters or one hundred kilometres. Allen's studies have affected e.g. the architecture of R&D offices and increased the collocation of project teams. Moenaert and Caeldries (1996) studied collocation and their

findings were somewhat contrasting. Placing R&D professionals in closer proximity did not increase the amount of communication within a project team or between teams; however, the quality of the communication improved.

Ancona and Caldwell (1992a) studied the effects of team diversity on communication. They found that tenure homogeneity within a group increased the communication among the team members, whereas functional diversity increased external communication. However, the overall effect of diversity on project performance was negative. The writers presumed that the reason for the negative performance might have been that the diverse groups bring ideas to problem solving but fail in implementation, since their capability for teamwork is lower than in more homogeneous groups.

Moreover, the tenure of a project group affects communication according to Katz (1982). By project tenure Katz means how long the project members have been working together. His study reveals that project performance is highest in projects with the mean project tenure of the group members between two and four years. Thus, the project performance declines both with shorter and longer member tenures. At least a partial reason for this performance difference seemed to be the communication behaviour. Members of long-tenured groups interacted less often within their group and with external groups and probably became increasingly isolated from critical evaluation and outside knowledge. In the beginning, the performance of a new group started to increase, because of the positive effect of increased internal communication and fresh ideas from new members. The effect of long tenures of individual engineers in the firm did not have a negative effect on the communication if the engineers did not belong to a long-tenured group.

2.3.1.2 External communication

To develop successful products, product development projects need information from outside their team, e.g. from other departments, and from outside their company borders, e.g. market information and competitor information. There are several means to gather the information needed, one way is to use gatekeepers. Product development projects are effectively linked to external areas through gatekeepers, according to Tushman and Katz (1980). Several studies have been made about gatekeepers (e.g. Allen, 1984; Tushman and Katz, 1980; Katz, 1981). Gatekeepers are individuals who are well connected to both internal colleagues and external parties. They gather and understand outside information and translate it into terms which are understandable inside their own organisation. In addition to that, they facilitate the extra-organisational communication of their colleagues. (Tushman and Katz, 1980). Gatekeepers are quite often first level technical supervisors, who have worked in their organisation for approximately six to eight years (Allen, 1984). The existence of gatekeepers had a positive effect on the efficiency of locally defined development projects. However, research projects were more effectively linked to external areas through direct member contacts (Tushman and Katz, 1980).

Ancona and Caldwell (1992b) found that it is not only the amount of external communication that determines the performance of a project, but that the type of the external communication of the teams also plays a part. The most successful teams that they studied used a comprehensive external communication strategy, which combined both ambassador and task-coordination behaviours. By ambassador behaviour they meant that a project group and especially a project leader had to “sell” the project to other persons outside the project, such as managers and other functions. By task-coordination

behaviour Ancona and Caldwell meant the interactions of a project team with other functions, such as getting feedback and information from them and coordinating activities.

2.3.1.3 Predicting communication

The studies about predicting technical communication based on product architecture (Morelli et al, 1995; Sosa et al, 2001) are quite different from the research presented above. These writers have studied especially complex products, such as aircraft engines, that can be divided into subsystems. They suggest that where the subsystems have design interfaces, there should also be communication between the teams designing these different subsystems. The writers presume that the method they present improves the planning of development projects where the product architecture is known in advance.

2.3.2 Communication between organisational functions

In the past products were developed more in a serial mode, one department working at a time and then passing its results to the next department. Tight global competition, however, demanded shorter product development lead-times and better products, in terms of meeting customer requirements and easier manufacturing. Cross-functional integration and cross-functional teams aim to involve several functions more concurrently into the product development to meet these requirements. Also studies about concurrent engineering, i.e., doing different phases of the engineering work in parallel, deal with similar subjects. This new kind of involvement requires also more frequent communication and interaction between the various functions.

The term cross-functional integration is used quite often, but its meaning is not self-evident. According to Kahn (1996) integration is a process including both interaction and collaboration. In another article Kahn and McDonough (1997) explain that collaboration means working together towards collective goals while having mutual understanding and sharing a common vision and resources. Interaction, on the other hand, focuses on communication and information exchange (Kahn and McDonough, 1997). According to these definitions communication seems to have quite a central role in cross-functional integration.

Departments that are involved in the integration efforts are most often either R&D and marketing, or R&D and manufacturing or all three. Integration of R&D and marketing aims to bring R&D closer to the user needs whereas R&D and manufacturing integration helps R&D understand the manufacturing restrictions.

2.3.2.1 Communication between R&D and marketing

Communication between R&D and marketing has received much research attention. The barriers of communication between these functions are high, since these groups often have different educational backgrounds and differing thought frames and they also use different terms (Griffin and Hauser, 1996). Usually there are also physical barriers separating the groups (Griffin and Hauser, 1996). Moreover, Maltz et al. (2001) found inter-functional rivalry, which, of course, reduced trust and the perceived quality of the information transferred. Because of these barriers, trust between the departments can be low preventing efficient communication. Moenaert and Souder (1990) claim that trust can

be developed through interaction and therefore suggest creating a formalized structure for communication that makes interaction mandatory.

R&D prefer to receive written reports from marketing, since R&D perceive that written information requires more thought and is based on facts. Marketers, on the other hand, prefer face-to-face communication, because it allows instantaneous feedback and enhances the comprehensibility of the information (Moenaert and Souder, 1990). Even though the information may have been successfully transferred between the functions it may not be used. To use the information, the person who received it needs to trust the sender, understand why that person gave him or her that piece of information and receive also contextual information to see the relevance of the information to his or her work (e.g., why a particular customer requirement is important) (Moenaert and Souder, 1990).

Communication in different phases of a project seems to differ. During the planning stage more open communication is appreciated, and R&D might accept wild ideas. However, during the development stage more formalised communication is needed, since R&D does not want any unnecessary changes at that phase (Moenaert and Souder, 1990). During planning, emphasis is on innovative information, whereas in the development stage coordinative information is more important (Souder and Moenaert, 1992). Souder and Moenaert even suggest that centralised control is needed and therefore functional supervisors should transfer the coordinative information between the functions.

Means to enhance communication include formal communication structures (Moenaert and Souder, 1990), collocation (Kahn and McDonough, 1997) and role flexibility (Moenaert and Souder, 1994). Formalisation includes, e.g. design review boards, milestone reports and scheduled meetings. In addition to increasing formal communication, these formal structures also enhance informal communication. Role flexibility means that R&D personnel perform activities normally carried out by marketing, or the other way round, and that way understand better the information requirements and information generation of the other party.

2.3.2.2 Communication between R&D and manufacturing

The two major questions that have been studied in connection to cross-functional integration between R&D and manufacturing are: 1) to which extent these activities can be done in parallel, and 2) how parallel work influences the communication patterns. Loch and Terwiesch (1998) state that the gain from overlapping activities has to be weighted against the rework that may result from starting the work with preliminary information. They also propose that communication will reduce the negative effect of the rework.

Wheelwright and Clark (1992) have studied different modes of integration in terms of overlapping activities and communication patterns. According to them only development projects carried out in a dynamic environment require deep, cross-functional integration, whereas projects performed in a more stable environment can succeed with only a modest amount of coordination. To describe the different possibilities for integrating the work and arranging communication between product development and manufacturing, they present four possible modes of interaction: serial mode, early start in the dark, early involvement and integrated problem solving. In the serial mode a downstream group starts working when an upstream group finishes and information is transmitted in one batch. The “early start in the dark” mode means that a downstream group has to start its

work already before it gets information from the upstream group. The information is then transmitted in one batch after the upstream group has finished. In the early involvement mode upstream and downstream groups have intensive communication while the upstream group is still working. However, the downstream group's role is only to give feedback based on their earlier experience and they can start their own work only after the upstream group has finished. The last mode, integrated problem solving, involves the downstream group right from the beginning. The downstream group gets a flying start with their work and the groups can solve problems together based on their experience of really trying to implement the design. According to the authors, each of these modes suits a particular kind of an environment.

Studies by Krishnan et al. (1997) and Loch and Terwiesch (1998) brought out the concepts of evolution and dependence (or sensitivity). These studies deal with overlapping activities in a more general sense, not explicitly stating which are the upstream and downstream groups. However, we believe that these groups can be R&D and manufacturing, as well as two R&D groups. Evolution describes how fast the upstream information stabilises. When evolution is slow, big changes may happen near the end of the upstream phase. Dependence (or sensitivity) describes how big an impact the changes have on downstream activities. When dependence is low, large changes in upstream information can be easily adapted downstream. Loch and Terwiesch (1998) suggest that the expected communication frequency would increase over time when evolution is slow, and decrease with rapid evolution. Moreover, when dependence between the activities is high, the communication levels are also high according to Loch and Terwiesch.

2.3.2.3 The effect of cross-functional communication on performance

Collaboration between departments seems to have a very strong positive effect on project performance according to Kahn (1996). Kahn also expected to find a similar relationship between interaction and performance, but this hypothesis was not supported. Actually, meetings and the exchange of documented information seemed to have a slightly negative effect on performance. Pinto and Pinto (1990) received somewhat contrasting results when studying cross-functional communication in a medical R&D laboratory setting. Their findings indicate that high cooperation teams differed from low cooperation teams in their level of informal communication, i.e., high cooperation teams used the telephone more and had more informal discussions, whereas there were no significant differences in their use of other media. Pinto and Pinto (1990) also found differences in the reasons for communicating. High cooperation teams engaged in task-related communication, such as brainstorming, reviewing the progress and receiving feedback, whereas low cooperation teams spent more time on resolving interpersonal difficulties. The writers suggest that these findings may reflect a higher trust between the members of high cooperation teams. Therefore, they suggest that in the beginning of a project time should be devoted on team building activities to achieve a cohesive project team, and to enhance trust and cooperation.

2.4 Communication in distributed intra-organisational projects

Distributed, intra-organisational projects can take place inside a single country but across locations, or they can be internationally distributed. These international projects are quite often called global projects. All the studies referred to in this chapter deal with global projects. In addition to the geographical dispersion of the team members that all distributed projects have, global projects also face other communication barriers, e.g. cultural and language differences. Table 2 presents studies about communication in distributed intra-organisational projects.

Table 2. Studies about communication in distributed intra-organisational projects.

COMMUNICATION RESEARCH IN DISTRIBUTED INTRA-ORGANISATIONAL PROJECTS	
Authors	**Main results**
McDonough & Kahn, 1996	Higher performing global product development teams use "hard technologies" such as fax, email and phone calls much more than lower performing teams. However, "soft technologies", like encouraging collective goals, and promoting communication, trust and motivation, are seen to be even more important to the success of the project than hard technologies.
Hameri & Nihtilä, 1997	The World Wide Web provides an effective means especially for disseminating data in distributed product development projects. Project milestones play a coordinating role.
Boutellier, Gassmann, Macho & Roux, 1998	Application of information technology is vital for dispersed R&D teams, but is not enough for a project to be successful. Organisational components are needed, as well, e.g. early face-to-face meetings to build trust.
McDonough, Kahn & Griffin, 1999	Differences in country culture, country of origin, and geographic dispersion have an impact on the need for communicating information quickly, communicating rich information and communicating different volumes of information.
Moenaert, Caeldries, Lievens & Wauters, 2000	The requirements for effective and efficient communication in international product development teams are: network transparency, knowledge codification, knowledge credibility, low communication cost and sufficient secrecy.
McDonough, Kahn & Barczak, 2001	Global product development teams experience more behavioural and project management challenges than collocated teams, due to the deterioration in their communications and difficulties in sustaining trust and developing interpersonal relationships.

2.4.1.1 Cultural differences

The importance of cultural differences to communication should be recognised. McDonough and Kahn (1996) state that the biggest problems in global new product development are cultural and social. Cultural differences have a significant effect on the communication patterns in global teams. McDonough et al. (1999) list the following sources of differences arising from a cultural business context that have an impact on communication: approaches used to solve problems, means to communicate with leaders and decision-making practices. A problem-solving approach can be, e.g. a thorough analysis needing a lot of information, or a trial and error technique, which is possible with less information. In some cultures communication across functions may take place directly between engineers whereas some other cultures communicate hierarchically through leaders. Some cultures demand consensus for decision-making, others do not see any need for this. The effects of cultural differences on communication can be huge, however. In-depth discussion of this aspect is left outside the scope of this study.

2.4.1.2 Communication media

Geographical distance decreases the possibilities for the team members to meet face-to-face reducing the spontaneity of communication. It also reduces the amount of real time interactivity, because of the time differences. Travel still plays a major role, since face-to-face meetings cannot be replaced entirely by the use of modern information technology. However, information technology offers increasingly better alternatives to support communication during those time periods when the collaborators are working apart (Boutellier et al, 1998).

McDonough and Kahn (1996) studied the usage of information technology in global teams. They found in their case study that the higher performing teams used fax, email, phone calls, teleconferencing and postal mail to a much greater extent than the lower performing teams. The type of technology used did not have an impact on the performance, only the frequency with which they were used had an impact. The best teams in their study normally used two main communication media frequently and others more seldom. Especially email, individual phone calls and teleconferencing were seen as important technologies for the higher performing teams.

Email and other written media have an advantage when language is a barrier. Written communication is likely to be understood more completely than oral communication, since unknown words or phrases can be looked up (McDonough et al., 1999). McDonough, et al. (1999) found that the frequent use of phone calls was associated with higher performance. However, their results indicate that video conferencing would be negatively associated with performance. This surprising result might arise from difficulties in using the technology. Their study supported the use of several communication media suggesting that different media are suitable for different purposes. They list three communication needs that global product development teams have: speed, (i.e., the need to transfer information quickly) richness (i.e., the need to fully and completely transmit complex information) and volume (i.e., the need for large amounts of information). The authors stress the importance of having different communication mechanisms available that can handle these needs. They suggest that different phases of the project might need different media. Moreover, the needs of different kinds of teams for information immediacy, richness, and volume might differ, requiring the use of a specific set of communication mechanisms.

Even though electronic communication is important for global teams, also face-to-face contacts are needed to maintain a relationship. Electronic communication can prolong the times between face-to-face contacts, but cannot replace them (Boutellier et el, 1998). For electronic communication to be efficient, personal relationships and trust between the employees are essential (Moenaert, et al, 2000). Trust and personal relationships are easier to establish through face-to-face meetings than merely by using electronic media. Face-to-face contacts are also needed to keep the team members interested, because when other team members are out of sight, it is easier to forget them and lose interest in the project (McDonough et al, 1999). Moreover, the only way to effectively deliver highly complex information, particularly across a product development team, is by holding face-to-face meetings, where communication can take place via multiple modes (McDonough, et al, 1999). Face-to-face meetings are especially important in the beginning of a project to develop personal networks and to build up an atmosphere of trust (Boutellier et al, 1998). Some firms even arrange team-building meetings for one to two weeks in the beginning of a project (McDonough et al, 1999). The importance of that kind of a

socialization phase during a start-up has been clearly confirmed (Boutellier et al, 1998). Many interface problems that occur during the development phase may be explained by poor communication during the planning phase, e.g. because of not involving all the functions (Moenaert et al, 2000).

Boutellier et al. (1998) studied also the usage of different IT tools for communication in different phases of distributed R&D projects. In their case study of an organisation they found out that the early project phases require different kinds of IT-tools than the later phases. According to them the early phases, planning and design, can be supported by media that allow quite informal communication, such as videoconferencing, email and phone. The later phases, implementation and testing, require more formal communication as well to ensure e.g. that all problems are pursued further. The authors found that, e.g. online databases are useful tools for those later project phases for sharing technical information, such as designs, and defect reports.

In addition to these studies on communication in distributed product development projects, there are several studies on how different communication media and communication tools can support the work of geographically dispersed groups. This field of research, computer supported cooperative work (CSCW), is quite broad and presents many interesting findings. For example, Andriessen (2003) gives a good presentation on collaboration technologies concentrating especially on interaction in distributed organisations. Since the focus of our study was not on collaboration tools and technologies, but on collaboration practices instead, we will not discuss this field of research further here.

2.4.1.3 Coordination

The coordination of distributed projects is challenging. Boutellier et al. (1998) suggest that project coordination and the exchange of technical information require media characterised by information richness. Weekly telephone or videoconferences were used frequently by all the involved parties in those complex projects Boutellier et al (1998) studied. Hameri and Nihtilä (1997) found that project milestones play an important role in coordinating the work in a distributed project. Their study concentrated on one form of communication, i.e., file transfer activities, which occurred always in bursts around the project milestones, thus emphasizing the role of milestones as an essential coordination mechanism. Also Moenaert et al. (2000) stress the importance of formal coordination mechanisms. They suggest that formal mechanisms, such as project review meetings, might be needed to exchange information at regular time intervals, since a lack of formalisation often creates problems in complex projects.

2.4.1.4 Communication requirements

Moenaert et al. (2000) suggest some requirements for communication in international product development teams. To establish effective communication, transparency of the communication network, knowledge codification and knowledge credibility are needed, whereas the efficiency requirements are low cost of the communication and secrecy. The transparency of the communication network describes how clear and accessible the communication network is to the project participants. Limited transparency may lead to problems in identifying the relevant persons to transfer the information to or to obtain the information from. Moreover, the team members might have motivation problems if they do not know why a particular assignment should be done. The authors found that strong

leadership often increased the transparency of the communication network when the team members used the team leader as the principal means for information diffusion. As the complexity of an international team increases, the transparency has a tendency to decrease. Knowledge codification problems may arise from differences in the language and culture, meaning both company subcultures and their own "languages" as well as national cultures and languages. Knowledge credibility problems, produced by the negative climate in cross-functional interfaces, may lead to the communicated information not being used. Communication costs that can be expressed in both money and time can prohibit communication. Finally, assuring secrecy in a distributed project is difficult, since the prevention of information leaks may lead to a policy of not informing the subsidiaries to a sufficient degree. (Moenaert et al, 2000).

2.5 Communication in distributed inter-organisational projects

Two research streams that have studied communication in distributed inter-organisational projects will be presented next: early supplier involvement and virtual organisations. Table 3. summarizes some of the key findings of these studies.

Table 3. Studies about communication in distributed inter-organisational projects.

COMMUNICATION RESEARCH IN DISTRIBUTED INTER-ORGANISATIONAL PROJECTS	
Early supplier involvement	
Authors	**Main results**
Ragaz, Handfield & Scannell, 1997	The study found that supplier participation in a project team of the buying company was the largest differentiator between the most and the least successful supplier integration efforts, and direct, cross-functional, inter-company communication was the most widely used technique for integrating the suppliers into product development.
Wasti & Liker, 1997	When the design involved technological uncertainties in product development, Japanese firms involved suppliers more and communicated with them more frequently. Low competition in the supplier market and long-term contracts between the parties affected positively both the supplier involvement and the frequency of design-related communication.
Wynstra & ten Pierick, 2000	Four types of supplier involvement were defined: strategic, critical, arms-length and routine. Communication interfaces for these types were defined in terms of direction of the information flow, the communication media used, the amount of communication, the topics discussed and the functions involved. The purpose of this classification is to help companies select a suitable supplier involvement type and understand the communication requirements it poses.
Croom, 2000	In early supplier involvement it is important that both structured and ad-hoc processes for the interaction are developed. A lack of ad-hoc interaction may lead to failure.
Wynstra, van Weele & Weggemann, 2001	Supplier involvement holds great potential, but few companies seem to be able to realise the benefits. Problems resulted, e.g. from the lack of communication and trust.
Virtual organisation	
Author	**Main results**
Wognum & Faber, 2002	The concepts of communication infrastructure and communication behaviour were introduced.

2.5.1 Early supplier involvement

In addition to outsourcing production, it has become popular to outsource also part of the product development to the supplier producing the outsourced component. In these customer-supplier relationships product development can be performed in several different ways: by the customer with early supplier involvement, by the supplier according to the requirements set by the customer, or as a joint development. In early supplier involvement suppliers are involved in the product development project already during the early design phase in order to get their comments from the manufacturing point of view. The degree of early supplier involvement varies from the supplier giving minor design suggestions to cases where the supplier carries a part of the design responsibility. The product development phase where the suppliers are taken in varies as well. Ragatz et al. (1997) found in their survey that companies were planning to involve suppliers at an earlier stage in the future than they had done before, and that they were also expecting deeper integration.

Studies about early supplier involvement cannot be directly categorised as communication studies since they try to find out for example the forms of early supplier involvement, its benefits and weaknesses, how early supplier involvement should be supported, and what kinds of effects it has on the performance. Even so, many of these studies also bring out the communication aspects and point out the importance of communication on the success of the project. A lack of communication or wrong type of communication has often led to problems in early supplier involvement.

2.5.1.1 Benefits of early supplier involvement

Early supplier involvement has brought several benefits, improving both project effectiveness, in terms of product costs and quality, and project efficiency, in terms of development cost and time (Wynstra and ten Pierick, 2000; Wynstra et al. 2001; Ragaz et al, 1997). Most of the product costs are formed during the product development phase. Therefore, during that phase a company should have access to all possible knowledge, also from the supplier's side. Later on, the designs are more difficult and expensive to change. The suppliers can bring their design and manufacturing knowledge into the design phase, resulting in better product designs and easier manufacturing. Moreover, the suppliers can identify potential problems and solutions earlier, reducing both the time and cost of design (Ragaz, et al, 1997). In addition to early problem solving, supplier involvement helps product designers understand the manufacturing restrictions and pay attention to them (Wasti and Liker, 1997).

2.5.1.2 Problems of early supplier involvement

Early supplier involvement does not always lead to success. The results can even be the opposite: increased development and product costs, lower product performance and longer than expected development time. Wynstra, et al. (2001) presume that the lack of positive result suggested by some studies does not imply that early supplier involvement is an inappropriate strategy, but that the expected results cannot be achieved easily. According to Wynstra and ten Pierick (2000), supplier involvement may increase the complexity of managing development projects because of an increased need for communication and coordination, especially in the situation of large projects using several suppliers. Collaborating with the suppliers consumes both money and

management time more than internal development.

Problems can also rise from a resistance to share information. A customer company may not want to share proprietary information with the suppliers, because of the fear that the supplier might reveal it intentionally or unintentionally to competitors. In addition, it might be difficult for the customer's engineers to accept ideas that come from their suppliers. In addition to resistance from the customer's side, also the suppliers may be concerned about revealing their proprietary information or technologies. (Ragatz et al, 1997)

A lack of communication and trust may lead to unclear agreements and differing expectations, which complicate collaboration (Wynstra et al, 2001). Outsourcing the design phase is difficult, because of high technological uncertainty connected with the designing. The writing of an accurate agreement or deciding the correct price pose special challenges as well (Wasti and Liker, 1997). Moreover, problems arise if the customer fails to communicate his requirements and expectations to the supplier correctly. In addition, if a clear project plan and work-packages are missing or the basic principles of collaboration have not been decided, differing interpretations may develop. If the customer does not have a well-defined product development process it can be difficult to decide when and how the suppliers should be involved. (Wynstra et al. 2001)

2.5.1.3 Management practices to overcome problems

Managerial integration practices are needed to overcome many of the problems mentioned above. Ragatz et al. (1997) report that the membership of the supplier in a customer company's project team was the largest differentiator between the most and the least successful supplier integration efforts. According to the results by Ragatz et al. (1997), this membership can be facilitated by direct cross-functional inter-company communication, shared education and training, common and linked information systems and selective collocation. These results suggest that open and direct communication helps identify and solve problems rapidly, whereas shared training allows suppliers to get an insight into the customer company's internal processes. Linking information systems meant in that study mainly the use of EDI, email and CAD/CAM systems, whereas real-time linkages were not in widespread use yet, even though some respondents could see the implementation of these linkages in the near future. Selective collocation means short-term collocation that takes place during specific efforts, such as prototype testing or problem solving. According to Ragatz et al. (1997) formal trust development practices were not used much, because trust is best fostered by performing according to expectations over longer time periods. Therefore, also all other management practices mentioned above help build trust between the companies.

Croom (2000) made a distinction between two competencies: operational and relational competence. Operational capabilities were task-related, like design and manufacturing know-how, whereas relational capabilities included softer issues, such as communication, problem solving and relationship development. Croom stressed that both these capabilities were important for product development performance, and that especially relational capabilities should not be forgotten.

2.5.1.4 Communication patterns and requirements identified

The forms of supplier involvement differ, sometimes deep collaboration with frequent communication is needed, whereas at other times more distant relationship with minimal communication requirements may be sufficient. Wynstra and ten Pierick (2000) suggested a classification of supplier involvement according to the dimensions of the development risk and the degree of development responsibility held by the supplier. The authors presumed that also communication needs differ according to these dimensions. The suggested involvement types were strategic, critical, arm's-length and routine development. In strategic involvement the development risk is high and the supplier has high development responsibility. Frequent, interactive communication through rich media, such as face-to-face communication, is recommended. In critical development, the development risk is still high, but the supplier's development responsibility is low. Limited communication is sufficient, because the supplier needs mainly to comment on what is possible to manufacture and what is not. In arm's-length development, the development risk is low and the supplier takes care of the development quite independently. Since the supplier needs to know exactly what the customer wants, the use of rich media is recommended. Finally, routine development carries low development risk and low design responsibility for the supplier. Minimal communication using media of low richness is enough. Wynstra and ten Pierick (2000) suggest that companies can select an involvement type best suitable for their purposes from this classification and determine what kind of communication requirements the chosen collaboration type involves.

Communication may also differ in the different phases of a product development project. The early project phases carry a high level of uncertainty and the supplier cannot be given all the details at once. Moreover, designs may change during the project when new information becomes available. To reduce any uncertainties that the supplier faces, Wynstra and ten Pierick (2000) suggested that communication in the early phases of the product development should be frequent and interactive. Regular verbal communication is best suited for this situation. Furthermore, face-to-face meetings are, according to these authors, the easiest way to check whether both parties have understood each other correctly, since both parties can explain what they mean, if necessary. Wynstra and ten Pierick also stressed the importance of rapid communication lines, so that product development would not be delayed because of communication. By rapid lines they meant direct contacts e.g. between the development engineers from both sides.

Croom (2000) has categorised the interaction processes between the supplier and the customer. He discovered that interaction between companies contained both formal and ad-hoc communication. Ad-hoc communication is a less formal and reactive form of interaction. It appears e.g. when there are problems to solve or at social events. Croom stressed the importance of ad-hoc communication, since he found that ad-hoc interaction was crucial for effective supplier relationships, and a lack of it led quite often to problems and failures. Formal, more predetermined communication, uses channels such as team meetings and resident engineers. These formal communication channels can be described through standard operating procedures, whereas ad-hoc communication poses a challenge. Officially, ad-hoc communication is quite often handled as if it did not exist, and therefore it is not supported either. Since ad-hoc communication seems to be beneficial, it should be supported as well, according to Croom (2000).

2.5.2 Virtual organisations

The term virtual organisation has many definitions. All the definitions have at least some of the following elements: Virtual organisations are geographically, and possibly also culturally, dispersed, working across space, time and organisational boundaries. They communicate and coordinate work through information technology, or electronic networks. The structure of virtual organisations is flat: they are non-hierarchical and decentralised. They are temporary in nature, consisting of a group of people working towards common goals, and dispersing when the task has been completed. Moreover, they are very flexible, and can react quickly whenever the environment changes. A virtual organisation is like an amorphous web of connections changing constantly according to needs.

Different studies emphasise different qualities of virtual organisations, and none of the studies has defined them with all the presented qualities. Actually, a definition with all these elements sounds more like an imaginary picture of the future and not the present reality. Do these kinds of organisations really exist? Kraut et al. (1999) stated that they had had difficulties in finding virtual organisations that would fulfil their definition, leading them to reconsider the definition. Therefore, they suggested that virtuality would actually be a matter of degree. It can be viewed as a continuum, with almost all organisations having at least some qualities of virtual organisations. Moreover, virtual organisations do not normally come into existence as perfect virtual organisations, instead, they slowly develop and grow from more traditional organisations (Kraut et al, 1999). In addition, some studies expect virtual organisations to be established between different companies or organisations, whereas other studies allow them to be intra-organisational, as well.

We believe that all distributed product development projects, discussed in this study, could be called virtual projects as well. However, this study does not use the term virtual organisation, since that term does not have any established definition or use, and thus can be misunderstood.

As mentioned above, it can be difficult to find actual virtual organisations. Consequently, it is even more difficult to find studies about these actual virtual organisations. This study could locate only one article (Wognum and Faber, 2002) about communication in virtual product development projects. The rest of the articles, referred to here, study communication in different kinds of virtual organisations.

2.5.2.1 The structure of virtual organisations

Virtual organisations are expected to be more effective and efficient than traditional organisations, since they are very flexible and quick to respond. This flexibility is believed to result from their loose structure. The cohesion that holds a virtual organisation together is communication and personal relationships, not formal structures. However, there is not much empirical evidence about the structures of virtual organisations (Ahuja and Carley, 1999). Actually, Ahuja and Carley found, in their study of a research organisation, that even though the authority structure was very flat, the communication structure was somewhat hierarchical. The writers suggest that the communication structure should be aligned to the task characteristics: routine tasks need more hierarchical structure, whereas complex tasks involving uncertainties should be managed by promoting discussion and decentralised decision-making.

2.5.2.2 Coordination in virtual organisations

The coordination of a virtual organisation poses a challenge. Traditional, more hierarchical organisations base their coordination on standardisation and direct supervision. In a virtual context, supervision is expected to be costly, difficult and ineffective, since employees are dispersed and the coordination should take place between firms. Yet, virtual organisations probably need coordination more than traditional organisations to function effectively. Katzy et al. (2000) state that a team member in a virtual project needs to know when, what and how something is being done by the various members of the organisation. Wiesenfeld et al. (1999) add that coordination should help a team member formulate reliable expectations about the behaviour of other team members. Even though the importance of coordination in virtual projects is recognised, very little is known about successful coordination practices (Katzy et al, 2000).

Earlier research according to Wiesenfeld et al. (1999) suggested that virtual organisations should replace external controls with internal controls, such as motivation, trust and shared goals, and coordinate less through hierarchy and more through transaction (DeSanctis and Monge, 1999). Moreover, personal relationships, not only electronic networks, might be needed (Kraut et al, 1999). Wiesenfeld, et al. (1999) found that organisational identification may help to ensure coordination. Organisational identification represents the social and psychological ties that bind employees and an organisation. Wiesenfeld et al. stressed that communication would be needed to create and maintain organisational identification in a virtual context. Communication would strengthen member identification by helping to build a shared context and social presence. They suggested that face-to-face communication should be preferred over email and phone calls to create organisational identification, since face-to-face communication can also transmit social context cues. The created organisational identification could then be maintained through less rich communication media, e.g. using electronic communication. Wiesenfeld et al. also stressed the importance of creating an organisational culture that encourages the use of on-line media to share information.

Kraut et al. (1999) studied the role of electronic networks and personal relationships in coordination. They found that when interpersonal relationships were used for coordination also the use of electronic coordination activities rose. These results indicate that electronic and personal coordination are not alternatives, but supportive means for coordination. Kraut et al. suggested that personal relationships are especially valuable when coordinating a complex process with non-routine transactions.

2.5.2.3 Communication in virtual organisations

DeSanctis and Monge (1999) state that empirical research about communication in virtual organisations is almost non-existent, only a few studies exist. Thus, the suggestions about efficient and effective communication principles in virtual organisations are based more on expectations than on empirical facts. Communication in virtual organisations is expected to be rapid, customised and based on personal relationships and informal contacts (DeSanctis and Monge, 1999). The volume of communication in virtual organisations is presumed to be greater than in hierarchical organisations, since the structure is actually formed by two-way communication links between a great number of persons forming the organisation (Ahuja and Carley, 1999; DeSanctis and Monge, 1999).

Electronic communication is often seen not only as an important enabler of virtual organisations, but also as a necessity. However, electronic communication has also its negative sides: problem solving may be difficult and electronic communication may also affect negatively the understanding of a message, if contextual information is missing. Therefore, DeSanctis and Monge (1999) suggested that the communicating parties should be provided rich contextual information in order to better understand the message and to create a firmer contact. Electronic communication never seems to be able to replace traditional communication; instead, it complements other forms of communication and actually increases the total amount of communication. Face-to-face contacts, on the other hand, seem to be a good and quick way to solve conflicts and create mutual understanding. Moreover, as Wiesenfeld et al. (1999) suggested, face-to-face communication might help establish a relationship that can then be maintained by electronic communication.

It is also possible to work virtually using only electronic media, as in the study by Jarvenpaa and Leidner (1998). These writers studied trust in global virtual teams. The teams, consisting of students, never met face-to-face and the only reasonable communication media they had were electronic. The results of their study suggested that the most successful teams created quite a lot of transparency around each other's tasks through communication: they told the other team members what they were doing, or going to do, and forewarned others about when they would be absent in the future. In addition, providing thorough feedback was important. Social communication that complemented task communication helped these teams build trust. Moreover, the results indicated that it was not only the quantity, but especially the quality and predictability of the communication that were critical for success. Therefore, it might be useful to provide guidelines on how often to communicate and enforce the regular pattern of communication. Even though the electronic media cannot easily transmit social context cues, this was not perceived only as being negative, since electronic media actually seemed to increase the perceived similarity among the members, thus making cultural differences less noticeable.

2.6 Communication in global software development projects

Global software development literature discusses both intra- and inter-organisational software development projects. These project types are rarely separated in the literature and the same term, global software development, is often used when referring to both project types. This special field of product development was chosen to the literature review, since in Study 2, all the studied projects developed software.

Compared to the communication studies presented earlier, the field of research studying global software development is still quite new. One reason for this is that the phenomenon of establishing highly distributed software development projects is quite new, as well. We did not find studies concentrating only on communication in the global software development literature. However, several studies discussed about communication as one of their topics. Some of those studies are listed in Table 4 and discussed later on.

The software development literature studying more traditional project contains some communication studies, as well. One of the early studies about communication in software development projects was done by Hauptman (1986). He studied the influence of task type on the relationship between communication and project performance. In his

study he aimed to compare whether the results received by Allen et al. (1980) from a somewhat similar study of R&D projects would apply also for software development projects. Namely, earlier software development literature regarded the time a team spends on communication as non-productive, and communication as merely a costly overhead. Some of the software development literature goes even further than that by emphasizing information hiding (Parnas, 1972), which means that software modules should hide some design decisions from the rest of the system, and thus make it easier to make changes and at the same time decrease the need for the developers to communicate with each other. Hauptman expected that if other types of R&D projects benefited from informal communication, as Allen's studies had showed (e.g. Allen et al, 1980; Allen, 1984), software development cannot be entirely different from them. Instead, he expected that the innovative activities of software development would probably benefit from informal communication as well. Based on his study, Hauptman presented a hypothesis, which he hoped future research could test further: "Software engineering and design will probably benefit from informal communication which will be the familiar vehicle of technological innovation, similarly to non-software R&D". This article showed clearly that the communication differences between different types of product development projects was and still is an interesting area to study. Thus, it is not self-evident that the advice the literature presented earlier about communication in distributed product development projects suggested will apply to distributed software development projects. However, many similarities between these different project types and suitable communication practices will certainly exist.

Next, we will present the communication-related findings in the global software development literature. Since this literature quite often presents the results in the form of advice to managers, we will use the same format in our subtitles. Table 4 outlines the results from the most interesting studies.

2.6.1.1 Recognize and utilize communication patters

The work on patterns and pattern languages by the famous architect Christopher Alexander (Alexander et al., 1977; Alexander, 1979) has been very influential in the software engineering community. Alexander described patterns that occur in buildings and towns. According to Alexander a pattern "describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice" (Alexander et al., 1977). Alexander shows that although every building is unique, each may be created by following a collection of general patterns. This means that a pattern gives a general solution to a common problem, a solution from which a more specific solution can be derived. Even though Alexander was talking about problems related to architecture and solutions that occur in buildings and towns, his work has inspired many in the software development community.

Gamma et al. (1995) were among the first ones to introduce patterns to software development in the form of design patterns. Their famous book catalogues 23 specific solutions to common software design problems. Coplien (1994, 1995) applied Alexander's thoughts when describing organisational and process patterns, which he thinks will help both in understanding the existing software development organisations and in building new ones. Ambler (1998) presents process patterns that are especially

Table 4. Studies about global software development involving communication aspects.

RESEARCH ABOUT GLOBAL SOFTWARE DEVELOPMENT INVOLVING COMMUNICATION ASPECTS	
Authors	**Main results**
Gloor & Zhao, 2004; Kidane & Gloor, 2005	To better understand communication in distributed settings the authors have built a software tool to uncover and visualize real communication patterns of distributed organisations on the basis of email messages.
Mockus & Herbsleb, 2001	Authors suggest that communication across sites is potentially the largest source of problems in global software development. They list communication-related problems such as: lack of unplanned face-to-face discussions; difficulties to locate experts, initiate contact and express one's meaning clearly; difficulties to share documents and applications; and lack of trust and willingness to communicate openly across sites.
Herbsleb & Grinter, 1999a; 1999b	To minimize the need for communication and coordination between distributed groups, the product structure should mirror the organisation design, i.e. the work assigned to different sites should be designed to be as modular as possible.
Carmel, 1999	Presents advice for supporting communication in distributed projects, such as: arrange kick-off and milestone meetings, encourage lateral communication between developers, give everyone a 360° view, create team communication protocols, build personal bridges between sites, assign cultural liaisons, and rotate team members between sites.
Battin, Crocker & Kreidler, 2001	Sums up practical advice from a case study. Emphasizes continuous communication across sites, which can be established, e.g. by arranging liaison visits, publishing documents in the intranet, and communicating in real-time using teleconferences.
Ebert and De Neve, 2001	Sums up practical advice from a case study: agree and communicate project targets at the start-up, set up a project home page, provide sufficient communication means such as videoconferencing or shared workspaces, and rotate management across locations and cultures.

intended for object-oriented software development. He defines an organisational pattern as "a pattern that describes a common management technique or a potential organisational structure" and a process pattern as "a pattern that describes a proven, successful approach and/or series of actions for developing software". Both Coplien and Ambler present patterns that are proven or at least expected to be successful.

Some organisational patterns that Coplien (1994, 1995) and Coplien and Harrison (2005) present describe communication-related problems and solutions. One of them is a pattern called "gatekeeper", which is actually very close to Allen's (1984) findings. In the gatekeeper pattern the problem is both the communication overhead created by the collaboration with many external collaborators and also the introvert engineering personality types. The solution could be to have a suitable project member in the role of gatekeeper. This person would disseminate information from the outside to the project members and translate it into terms relevant to the project. Coplien's patterns are carefully described: every pattern has a name, describes the problem, gives the context of the problem, explains the forces or trade-offs affecting it, gives a solution to the problems, and explains the resulting context and design rationale. Coplien's work aims to recognize and describe useful organisational patterns for software development projects.

Other collaboration and communication patterns especially meant for distributed use, can

be found, e.g., from the Dispersed Agile Software Development web site (Anomymous, 2003). These pages present patterns many of which are related to communication, such as TravellingDevelopers, DailyConferenceCall and GoldfishPhoneCalls. Some of these patterns are 'protoPatterns', i.e. they may only be suggestions for useful patterns that are not yet used as such in real life. These patterns seem to include quite practical low-level advice on how to communicate in distributed projects that use agile methods. For example, DailyConferenceCall means that all the distributed team members participate in a telephone meeting and tell briefly what they did yesterday, what they plan to do tomorrow and what the problems are. In case the group is too large to do this in twenty minutes, another practice, GoldfishPhoneCall, can be used instead. Then each group names one member to summarize that group's achievements, plans and problems, but the whole group can participate in the teleconference and hear what is going on.

Gloor et al. (2003) have also studied communication patterns in distributed software development projects, but from a different point of view. They have built a software tool to uncover and visualize communication patterns on the basis of email messages exchanged in a network **(**Gloor and Zhao, 2004). With help of this tool they have visualized how communication changes and develops over time, e.g. in open source software development communities. Their studies about the connection between productivity and communication patterns showed that in the Eclipse open source community the development groups with high communication density seemed to be better performers than those with low density (Kidane and Gloor, 2005). The aim of this work has been to reveal the real communication patterns in organisations and in that way to better understand and to be able to improve the communication in a distributed setting.

2.6.1.2 Agree on communication practices

Global software development literature brings up many challenges related to communication and collaboration practices (e.g., Mockus and Herbsleb, 2001). Also, some solutions and advice regarding 'the best practices' are presented (e.g., Carmel 1999; Ebert and De Neve, 2001). Communication is in a central position in almost all of these collaboration practices. However, communication is often mentioned as the biggest problem in distributed software development projects, since, e.g., geographical distance limits face-to-face communication, time-zone differences prohibit synchronous communication, and language and cultural differences cause misunderstandings. The literature has proposed several low-level communication practices for globally distributed projects, e.g. the use of liaisons (Battin et al. 2001), cultural liaisons (Carmel and Agarwal 2001) or straddlers (Heeks et al. 2001) for sharing information and facilitating contacts; conference calls to resolve problems (Battin et al. 2001); the rotation of management to cope with cultural diversity (Ebert and De Neve 2001); and setting up a project home page to distribute information to the project participants (Ebert and De Neve 2001). All these practices aim at increasing and facilitating communication across distances. Agreeing about these kinds of practices also encourages people to communicate and initiate contacts.

Most of these collaboration and communication practices or patterns suggested by the literature are based on case studies made inside one organisation. Thus, the experiences of using these practices in distributed projects are still scarce. More detailed descriptions of the practices, a broader selection of the practices and experiences of their usage in several projects are required.

2.6.1.3 Divide work effectively

The division of work across distributed sites is challenging. When the work items distributed to different sites are interlinked, the communication need increases. Arranging communication efficiently across distances is challenging. Therefore, planning how to divide the work effectively between different sites is an alternative. Already Conway (1968) said: "…organisations which design systems are constrained to produce designs which are copies of the communication structures of these organisations". He suggested: "a design effort should be organized according to the need for communication". These statements became later known as Conway's law. Herbsleb and Grinter (1999a) suggest that the same principles should be applied to distributed software development projects. Hence, according to them, the product structure should mirror the organisational design in order to minimize the need for communication and coordination between distributed groups. This means that the work assigned to different sites should be architecturally separate and as modular as possible. Herbsleb and Grinter (1999b) suggest designing clearly separate modules that could be used as the basis for assigning the work to different sites. Thus, there is an alternative either to minimize the need for communication between the sites by designing a modular product structure, or to improve the communication when modularization is difficult. Herbsleb and Grinter suggest doing both. However, it might not always be easy to divide the product into modules, especially when the software to be developed is new and not well understood.

2.6.1.4 Agree about the process

In software development the chosen development process model affects the working practices and especially the communication practices in distributed projects. Therefore we will next discuss briefly process-related issues.

Regarding collaboration processes, Battin et al. (2001) identify the challenge that collaborating sites can have differing development processes even within one company, a fact that can be very problematic when collaborating closely. Differing change-management processes between the sites have also caused problems, especially in the integration phase, according to Herbsleb and Grinter (1999). One solution to these process compatibility problems could be to make all sites use the same process. Another solution that provides a quicker way to start a project, is to let everybody use his or her own processes. However, in this case it is necessary to clearly divide and specify the work (Battin et al. 2001). Synchronization of the work (Herbsleb and Moitra 2001) and integrating the work products (Battin et al. 2001) are other process-related challenges. As a solution, Battin et al. (2001) suggest an incremental integration plan based on clusters and shared milestones to avoid 'a big bang' integration. Incremental integration and frequent deliveries is a core practice in agile methodologies for collocated projects (Larman and Basili 2003), but its use in distributed development has not yet received much attention. Fowler (2004) and Simons (2002) recently reported their experiences in using agile methods in offshore development projects. According to Simons (2002), an iterative model seems to work well in these distributed projects, and it benefits the project also by providing increased visibility into the project status. There are different kinds of processes and practices to choose from. However, it seems to be important to at least think about the process issues and agree on what kind of process the distributed project is using.

2.6.1.5 Reduce time-zone difference

Time-zone difference is a problem that is known to people working in globally distributed projects. For example, Battin et al. (2001) report that a software development project having no common overlapping work hours for all the development sites experienced communication problems due to that. Their solution was to "share the pain" meaning that when having a common conference call it was not always the same site that had to work in the middle of the night. Also Carmel and Agarwal (2001) bring up the need for synchronous communication in distributed projects. Problem solving takes time when using only asynchronous communication. For example, solving a problem by sending emails can take days, whereas by using the telephone problems may possibly be solved in a few minutes. Carmel and Agarwal (2001) suggest that companies should choose partners within the same time-zone or at least minimize the time-zone difference to guarantee a possibility for synchronous communication.

2.6.1.6 Reduce cultural distance

Cultural differences often make communication problems even worse (Herbsleb and Moitra, 2001). Carmel and Agarwal (2001) suggest that companies should reduce both the national cultural distance and the organisational cultural distance between the different collaborating sites. The means they suggest are the use of cultural liaisons, bridgehead arrangements, internalising foreign entities and language training. Cultural liaisons are persons who travel often between the key projects sites. They might be e.g. managers who during their trips facilitate communication and mediate conflicts between the sites. Bridgehead arrangement is a suitable alternative for companies working with offshore centres. It means the division of the workforce between onshore and offshore sites, so that e.g. 25 % of the personnel are situated onshore, close to the customers to take care of the communication with them, while the rest are working offshore. Internalising foreign entities is a solution to organisational culture problems, suggesting that instead of using subcontractors, the company could build its own foreign organisations or buy suitable organisations. This could reduce at least the problems related to the company culture. Finally, Carmel and Agarwal (2001) suggest arranging language training for the staff as one of the solutions to language-related communication problems. Ebert and De Neve (2001) propose that the rotation of management across the locations would increase the understanding of different cultures. They also suggest that companies could build mixed teams with several nationalities to increase the integration.

2.6.1.7 Arrange face-to-face meetings

The best way to build trust in the beginning of a project is to meet face-to-face. Carmel (1999) suggests arranging face-to-face kick-off meetings in the beginning of a project and re-establishing trust by personal face-to-face communication later on, e.g. in the form of milestone meetings. He also claims that "personal face-to-face bridges are the glue that hold distant sites together". These personal bridges can be created, by assigning cultural liaisons, rotating staff or sending expatriates, for example. Moreover, the project manager should travel to all the distributed sites several times a year to meet his distributed team members. Since travelling is expensive, face-to-face meetings are quite an expensive way to communicate. This may be the reason why the case studies presented earlier did not emphasize face-to-face meetings, but suggested arranging, e.g. videoconferences (Ebert and De Neve, 2001) and teleconferences (Battin et al., 2001). These case studies had

observed face-to-face contacts as well, but on a somewhat smaller scale, e.g. in the form of liaison visits (Battin at al., 2001) and management rotation (Ebert and De Neve, 2001).

2.7 Comparing and discussing the literature

2.7.1 Comparison of the research streams

The communication research streams presented earlier are compared in Table 5 in terms of the key research interests, communication needs, communication requirements, communication barriers, communication enablers and communication media.

Table 5. Comparison of the research streams.

	TRADITIONAL INTRA-ORGANISATIONAL		DISTRIBUTED INTRA-ORGANIZA-TIONAL	DISTRIBUTED INTER-ORGANISATIONAL		GLOBAL SOFTWARE DEVELOP-MENT
	Between individuals	**Between functions**		**Early supplier involvement**	**Virtual organisations**	
Key research interests on communication	Frequency of communication. Physical distance. Gatekeepers.	Cross-functional integration mechanisms.	Overcoming barriers of communication. Electronic communication media.	Coordination of a complex project Overcoming barriers.	Coordination of virtual work. Electronic communication. Communication structure.	Overcoming communication problems.
Communication needs	To get external information, ideas and feedback.	To get input from other functions. To enable concurrency. To coordinate work.	To coordinate work.	To explain requirements to supplier. To coordinate work.	To build personal networks and trust. To coordinate work.	To coordinate work.
Communication requirements	Informal contacts.	Understanding information, credibility and timing of information.	Transparency of network, understanding cultural context.	Understanding received information.	Transparency of network, quick communication, informal contacts.	Either support communication or minimize it by modular product structure.
Communication barriers	Physical distance.	Physical distance, functional borders, different terminology and education, lack of trust.	Geographical distance, differences in culture, language and information systems, lack of transparency.	Resistance to sharing information across company borders, complexity of network.	A lack of trust, a lack of face-to-face contacts.	Geographical distance and time-zone differences limiting synchronous and face-to-face communication.
Communication enablers	Short distance, cohesive and homogeneous team.	Co-location, trust, formal structures for communication, role flexibility.	Face-to-face meetings in the beginning, transparency of network.	Direct contacts, frequent communication, linked information systems.	Frequent communication using both face-to-face and electronic media, personal networks.	Communication patterns and practices.
Communication media	Face-to-face, phone calls.	Face-to-face for comprehensibili-ty, written for credibility.	Face-to-face in the beginning, then electronic.	Face-to-face to explain requirements.	Electronic mainly. Face-to-face to build trust and create contacts.	Electronic mainly. Face-to-face occasionally if possible.

2.7.2 Motivation for this research

The literature review showed that the number of communication studies about inter-organisational product development projects is still rather few, even though communication is often seen as the biggest problem in distributed projects. Moreover, most of the studies gave only quite general-level instructions for arranging communication in distributed projects. Since distributed product development projects are becoming increasingly common and companies are experiencing problems with communication in these projects, descriptions of low-level communication practices could be useful. Global software development literature presented several low-level communication practices as advice to managers planning distributed projects. Unfortunately, many of the descriptions were short and based only on experiences in one case organisation.

To be able to create and describe useful low-level communication practices for distributed, inter-organisational product development projects we need first to understand the communication problems and communication needs of these projects. Secondly we need to find out what kind of communication practices are currently used. The aim of this research is to gather more information about these topics.

2.8 Summary

This chapter presented a literature review about communication in distributed product development projects. The communication literature was grouped into four research streams according to the project types: traditional intra-organisational projects, distributed intra-organisational projects, distributed inter-organisational projects, and global software development projects. The early studies mainly concentrated on intra-organisational communication, either between individuals or between functions. These studies identified e.g. correlation between the communication efficiency and the lead-time for new product development. Communication in distributed intra-organisational projects has received some research attention with many studies concentrating especially on the use of new electronic communication tools. However, inter-organisational communication has not yet received large research attention. The existing studies brought out the importance and difficulty of communication in inter-organisationally distributed projects. Moreover, recent studies about collaboration in virtual organisations state that the communication needs of these new forms of collaboration are not yet fully understood and thus more research is needed. Finally, the literature about global software development is a special field discussing, among other things, the communication problems and practices encountered in these projects.

There is evidence that insufficient or bad communication in a distributed project may lead to poor project performance. However, very little is known about successful communication practices suitable for distributed projects. Therefore, further information about communication in distributed projects is needed.

3 Research design

This chapter concentrates on the methodological issues. The research questions are stated and the research approach of this study is described. Then, the data collection methods and data analysis are shortly described. A more thorough description of the research methods, the data collected and the analysis made is presented in chapters 4 and 5 in connection with the description of the case studies and their results. Finally, the research process is presented at the end of this chapter.

3.1 Research questions

3.1.1 The main research question

The main research question of our study is:

RQ1: What kinds of communication practices are used in geographically distributed inter-organisational product development projects?

Most of this research explores the current communication practices used in our case projects. Next, we will elaborate on this research question by looking at its different parts.

First, we need to define what we mean by the term *communication practice*. In this study we define it as a practice, in which communication has a central role, and which is used at least a few time times in a quite similar form either in one project or in several different projects. In the literature, some authors have also used the term pattern in a similar meaning, however, in this study we chose the term practice instead. This choice is discussed in more detail in Section 7.1.1.

The ten elements of organisational communication presented in the literature review (Section 2.1.1) give a basis for describing a communication practice. These elements include the exchanged *message*, the *reasons* for communication, the parties of communication: the *sender* and the *receiver*, the *relationship* the communication is based on, the communication *network* the communicators may be part of, the *direction* of communication, the communication *media*, the organisational *environment,* and *noise* that can disturb communication. Based on these elements we formed sub-questions that give further information about each communication practice:

- Who communicates with whom between the companies? (Parties / sender and receiver)
- What is the direction of the communication? (Direction)
- What type of information is exchanged? (Message)
- What type of communication media is used? (Media)
- Why does the communication occur? (Reason)
- In what type of circumstances does the communication occur? (Environment)

Finding answers to these questions regarding each communication practice in our case projects will already give a good idea of each practice.

Both Study 1 and Study 2 concentrate on communication practices. In Study 1 our aim was to document all the communication practices used. In Study 2 we were especially looking for good or successful communication practices. Of course, different communication practices are successful in different circumstances, therefore we did not want to name the identified practices as "best practices". We did not measure the successfulness of the practices in either study, e.g. by measuring how the use of the practices affects the project performance. That kind of measuring would have been almost impossible, since all product development projects are different and use a different combination of practices. This makes it difficult to distinguish how each one of the practices affects the project performance. Instead, in this study we documented the current communication practices, and also asked our interviewees, who had used the practices, their opinion on the practices and their usefulness. Moreover, by choosing successful companies to our study, we wanted to ensure that the practices they use are at least not entirely off the mark.

Secondly, the verb *exists* means that we wanted to find out the current state in Finnish companies regarding their communication practices. We wanted to choose on-going projects and interview people about the current practices.

Thirdly, we wanted to study communication especially in *geographically distributed, inter-organisational* projects, i.e. in projects where at least two different organisations are involved and that have sites distributed at least to two locations. Since the main interest is in inter-organisational communication, very little attention is paid to intra-organisational communication unless it relates closely to inter-organisational communication, e.g. disseminating of information received from a partner inside one's own organisation. The collaborating organisations we chose to this study were mainly separate companies, normally a customer and a subcontractor. However, we chose also a few case projects, where collaboration was established between a company and its subsidiary. Geographical distribution means that the collaborating organisations are not situated in one location or site, but preferably all these organisations are situated at different sites and one organisation can even have several sites participating in the same product development project. According to the studies of Allen (e.g., Allen, 1984) already the distance of 20 meters reduces communication significantly. Therefore, all geographical distance makes communication more challenging and the communication practices probably differ compared to collocated projects.

Fourthly, we concentrated on *product development projects*, which are quite a challenging project type. All product development projects are normally different from each other and have a degree of uncertainties and unexpected changes. Therefore, the communication practices probably differ at least to a certain degree in every project. Therefore, it may not be possible to create generally applicable communication practices.

3.1.2 Supporting research questions

In addition to the main research question we had three supporting research questions.

The second research question is:

RQ2: What kinds of communication problems do geographically distributed inter-organisational product development projects have?

The aim was to find out what is problematic in communication especially when compared to intra-organisational and collocated projects. Both Study 1 and Study 2 will provide material to answer this research question.

The third research question is:

RQ3: What kinds of communication needs do geographically distributed inter-organisational product development projects have?

We aimed to identify the most important communication needs between the participants in geographically distributed inter-organisational product development projects. The goal was not to record all the details, but instead to identify the main communication needs to be able to group the collected communication practices according to the communication needs they satisfy. This research question was considered especially during Study 2.

The fourth research question is:

RQ4: Is the social process simulation method a useful tool in studying communication practices in inter-organisational product development projects?

When choosing the methods for collecting data about the communication practices, communication problems and communication needs in our case projects, we first considered traditional communication study methods, such as communication diaries (e.g., Allen, 1984) and interviews. However, we faced resistance when suggesting the usage of this kind of methods to our case companies. The companies thought that these methods would only disturb their work and give them almost nothing. The companies hoped that they could get direct benefits from our research already for their on-going projects that we would study, instead of only receiving the results afterwards.

At the same time we came across an interesting simulation game method, that had been developed at our university (e.g., Ruohomäki, 1995a; Smeds and Haho, 1995; Piispanen et al., 1996), and had been used mainly as a process improvement tool. It seemed that the usage of the simulation method could be interesting to our case companies for several reasons described later on in Section 4.4.3. Moreover, we believed that in addition to benefiting the case companies, this method could be used to collect rich data about the communication practices, problems and needs, and thus benefit our research. Even though it had not been used earlier as a data collection method, we thought that in addition to providing information about the communication, this study could also test whether this simulation method was usable as a research method to study communication in distributed product development projects.

When we suggested the usage of a simulation method to our case companies, the first reaction was positive. Thus, we decided to test the usage of a modified version of this method, named here as social process simulation method, to study communication in distributed projects and include it as one of the research questions, as well. The method

was used in Study 1, therefore only that study will provide answers to this last research question.

3.2 Research approach

This research is a qualitative multiple-case study that aims to understand and describe the communication practices, problems and needs in inter-organisational product development projects. For the data collection we used qualitative semi-structured interviews in all our case projects, a well as the social process simulation method in parts of the case projects. In this chapter we will concentrate on the case study approach used in this study and we will describe the background of the simulation method used.

3.2.1 Case study approach

Case studies are used for many purposes, e.g. to provide a description, to test a theory or to generate a theory. Case studies can be exploratory, descriptive, explanatory or confirmatory, they can consist of one (single case study) or several cases (multiple-case study) and they can be based on qualitative or quantitative data collection. Usually, they combine several data collection methods. Actually, a major strength of the case study method is the opportunity to use many sources of evidence (data triangulation), and many data collection methods (methodological triangulation). Multiple sources of evidence and multiple methods provide a better validity for the findings. (Eisenhardt, 1989; Jick, 1979; Robson, 1997; Yin, 1994)

The main purpose of this study was to explore and describe inter-organisational communication practices in geographically distributed product development projects, an area not yet well understood. The case study method was chosen because it offers a possibility to gain a deeper understanding of the phenomenon. Addressing highly specific questions that would have been needed e.g. for doing a survey, would have been difficult, since this phenomenon is quite new and the theoretical background in this specific area is weak. Instead, by asking quite general questions this study aims to describe and understand the communication practices and problems in distributed inter-organisational product development projects. The case study method also gives a possibility to combine several data collection methods and thus it provides a better validity for the results. In this study we applied both methodological triangulation by combining several data collection methods, and triangulation of the data sources by comparing the perspectives of people from different points of view (Patton, 2002). The main data collection method used in Study 1 was social process simulation, which actually comprises a set of data collection methods. In Study 2, the data was collected by interviews. The use of these methods will be described in more detail later on.

This case study consists of twelve product development projects, or cases, therefore it can be called a multiple-case study (Yin, 1994). We used purposeful sampling for choosing the cases, which means selecting information-rich cases for in-depth study (Patton, 2002). Information-rich cases are those from which we can learn a lot about the issues that are important to the purpose of our research. From that kind of cases we can get in-depth understanding of a phenomenon rather than empirical generalisations. Patton (2002) presents fifteen different strategies for purposefully selecting information-rich cases. Our

sampling strategy is closest to a strategy that Patton calls “intensity sampling”, which according to him means choosing cases that “manifest the phenomenon of interest intensely”. In other words, it means searching for cases that are rich examples of the studied phenomenon, but are not extreme or highly unusual cases. This strategy was used when selecting the cases for both of our studies. More details about case selection will be given in connection to each study.

The research approach used in Study 1 was quite close to action research. Action research can be a special kind of a case study, most often a single case study, but also a multiple-case study is possible. In action research the researcher and a client organisation collaborate to solve a problem set by the client and at the same time contribute to the research. The goal of action research is to generate findings that can be applied in organisations. Action research is often called participatory, since the researcher almost becomes a part of the setting he or she is studying and quite often also several members of the studied organisation are involved both in the research design and the research process. The phases of action research include setting a problem, investigating the problem, giving recommendations, implementing them and finally evaluating the results and making a contribution to the body of knowledge. (Bryman, 1989)

In Study 1 both the researcher and the case project team members participated quite actively in designing the study and setting its goals, which is common for action research. Moreover, one purpose of that study was to identify the problems and suggest improvements that could be implemented in the participating organisations. However, the goals of the researcher and the goals of the participating companies differed somewhat. The research goal was to study the communication practices whereas the goals of the companies were to solve problems and shorten the product development project lead-time by enhancing collaboration and communication. Study 1 differed somewhat from action research, because the last phases of action research, implementing the suggested improvements and evaluating the resulting situation, were left out.

In Study 2 the case study design and the data collection method used were more traditional. The researchers designed the study on their own before contacting the participating companies. The data collection method used in this study was open-ended interviews. Patton (2002) presents three approaches for collecting data through open-ended interviews. From these three approaches “the general interview guide approach” (Patton, 2002) is closest to our approach. An interview guide is a list of questions or issues that are planned in advance to be explored during an interview. The purpose of this guide is to provide the basic guidelines for an interview by listing the topics or subject areas, within which the interviewer is free to build a conversation. These guides can be more or less detailed depending on how well the interviewer can specify the important topics in advance. The interview guide makes it possible for an interviewer to be flexible and study in greater depth the issues that come up during the interview. On the other hand, it makes interviewing several people systematic and comprehensive by delimiting in advance the issues to be explored. In addition to using this approach in Study 2, it was also used in Study 1, since in that study one of the preparations for process simulation sessions was open-ended interviews.

3.2.2 Simulation method

According to systems thinking, organisations can be seen as complex systems (Berends and Romme, 1999). Systems are composed of many elements or actors that are linked to each other by different kinds of relationship links, feedback loops and communication links. Such systems can be studied by dividing them into sections and studying the sections. However, that approach misses information about the interaction between the elements. Berends and Romme (1999) suggest that simulation could be a useful tool when studying industrial or corporate systems as a whole. Since the objective of our research was especially to study the interaction between the companies and project team members, process simulation seemed to be a suitable method. Furthermore, because simulation aims to describe the whole system and its interaction, we believed that it could help us understand the complexity of distributed product development projects and communication practices in numerous interlinked cause and effect situations.

The basic types of simulation are physical and mathematical simulation. One form of the physical simulation used in social sciences is role-playing. We chose social process simulation as our research method (Forssen-Nyberg and Luhtala, 1996; Pankakoski, 1998; Ruohomäki, 1994). It can been seen as one kind of "role-play". In this simulation, the project team members are the players "playing" their own roles while simulating a real project. In other words, a process simulation session is a structured discussion during which the participants simulate their own real work activities based on a simplified model of the work process (Ruohomäki, 1994).

The social process simulation method used in this study is very similar to the simulation games described e.g. in the article by Forssén-Nyberg and Hakamäki (1998). Even though the earlier studies have used the term simulation game, we chose to use social process simulation instead, because it describes better the method we used and its purpose. This naming choice will be discussed more in Section 4.4.1 below.

Earlier research has mainly studied the use of simulation games for process development purposes and simulated real work processes in organisations. These kinds of simulation games have been used e.g. for education and training (Ruohomäki, 1995a), analysing the present situation and its development needs (Forssén-Nyberg and Hakamäki, 1998), facilitating the implementation of a new information system (Ruohomäki, 1995b), developing office work (Piispanen et al, 1996), developing (Forssén-Nyberg and Hakamäki, 1998) and redesigning production processes (Smeds and Haho, 1995), and testing new ways of working before implementation (Ruohomäki, 1995b; Forssén-Nyberg and Hakamäki, 1998).

Simulation games have proved to be beneficial for the participating companies. Several benefits are listed in each study. Firstly, simulation of a broader work process gives the participants an overview of the whole process and increases the common understanding of the process (Piispanen et al, 1996; Forssén-Nyberg and Hakamäki, 1998; Ruohomäki, 1995a). It also helps understand the cause-effects (Forssén-Nyberg and Luhtala, 1996), when all the actions and their consequences can be seen at the same time (Piispanen et al, 1996). Secondly, problems and ideas for improvement come out in simulation games (Forssén-Nyberg and Hakamäki, 1998; Smeds and Haho, 1995; Piispanen et al, 1996; Ruohomäki, 1995a). Thirdly, simulation increases the participants' motivation to implement changes and decreases their resistance to them (Forssén-Nyberg and Luhtala, 1996; Ruohomäki, 1995a; Piispanen et al, 1996). Finally, simulation facilitates

cooperation and communication between the participants (Forssén-Nyberg and Luhtala, 1996; Piispanen et al, 1996).

We had several reasons for choosing to use the social process simulation method in this study. First of all, it allows us to get a big picture of the interaction relationships in a product development project. Secondly, the process simulation works as a process intervention with direct benefits for the involved parties (Forssen-Nyberg and Luhtala, 1996). Thirdly, it is an economic way of collecting large amounts of rich data that can be partly validated during the data collection since all stakeholders are present at the simulation session. Fourthly, we wanted to experiment with using the process simulation as a method for data collection – earlier studies have mainly focused on the use of the process simulation for process intervention purposes.

3.3 Material and methods

In Study 1 we wanted to gain a deep understanding of quite complex product development projects. Therefore, we chose to that study only two projects from the same industry and used multiple data collection methods. The main method was social process simulation, which actually comprises several data collection methods, e.g. interviews, document collection, and a process description session, which are all preparations for a simulation session during which the data collection is complemented with questionnaires.

In Study 1 we got a preliminary understanding of the communication practices and problems in distributed inter-organisational projects. In Study 2, we wanted to broaden that understanding by collecting more data from several projects. Thus, we preferred collecting data from many different projects in Study 2 instead of aiming to get a deep understanding of only a few projects. Simulation sessions were not used in Study 2 since they are more suitable for thorough analysis of single projects. In Study 2 we chose to collect data only by interviewing, using semi-structured open-ended interviews. In that study all case projects were from the same industry, software development. To get a preliminary picture of these kinds of projects we conducted one broader case study, Case 3 (Omega), where we interviewed almost all project personnel. After that experience the rest of the projects in Study 2 were easier to understand and less interviews were required.

In Table 6 we have listed the cases in each study and the names we have given to each case. We had to rename the cases for confidentiality reasons. The naming style of the cases and the case companies differ between Studies 1 and 2. The reason for this is that we wrote first separate research reports and papers on both studies, where these same names were used (see e.g. Paasivaara and Lassenius, 2001; Paasivaara and Lassenius, 2003). Even though the studies were combined here, we did not want to change the case names, since that could have confused those readers who were to read also the earlier reports and papers. In addition, Table 6 summarises the methods used and the forms of data collected. Since the data collection methods in both studies differed the methods used and the data collected are described in more detail in Chapters 4 and 5. Each of these chapters presents one study, the methods used in it, the analysis done and the results achieved. We hope that reading this dissertation will be easier when each study and its methods are presented as a whole in a separate chapter.

Table 6. Cases and methods used

	Study 1	**Study 2**
Cases	Case projects 1-2 - PlastCo and PartCo	Case projects 3-12 - Omega, Alpha1, Alpha2, Beta, Gamma, Delta, Epsilon, Zêta, Êta, and Thêta
Methods and material	Multiple methods - Social process simulation method comprising: • Planning meetings (notes) • Interviews (recorded, notes, documents) • Process description session (process description, notes) • Simulation session (videotaped, notes) • Questionnaire	Single method - Interviews (recorded, notes)

3.4 Data analysis

In this study, the data collection and data analysis took place partly in parallel, and partly in sequence. In the literature, qualitative data analysis is often recommended to be done in parallel with the data collection. For example, Miles and Huberman (1994) prefer ongoing analysis that drives the data collection. According to them it is a serious mistake in qualitative research to leave all analysis to the end of the data collection, since early analysis typically reshapes a researcher's perspective and guides the next steps of the data collection.

The principle of ongoing data analysis was used throughout this study. Part of the analysis was done already during the data collection of each case study. This analysis guided the next data collection steps for the same case study. For example, in Case 1 the process description session shaped the interview questions and they both affected on the planning of the simulation session.

We studied the first three case projects in-depth (Cases 1-2 in Study 1 and Case 3 in Study 2). In these studies within-case analysis was done directly after completing the data collection of that case. Feedback was given to the case companies and research papers were written based on this analysis. Moreover, the results from earlier case studies guided the selection of next case projects and their data collection. The rest of the case projects (cases 4-10 and 11-12) were selected and analysed in two groups. Ongoing analysis took place also during the data collection from these projects.

During the data collection in Study 1 the ongoing analysis included e.g. reading interview and meeting notes that we had written, and arranging that material into categories using the copy-paste technique. We wrote case descriptions and gave feedback to the participating companies both in the form of written reports and oral presentations based on that early analysis. In addition, we discussed the results with the participating companies.

The early analysis during the data collection for Study 2 included all the same steps as in Study 1. Moreover, we started to use a qualitative data analysis software called ATLAS.ti for coding and grouping the data.

A more thorough analysis was done at the end of Study 2. At that point all written material from both studies, e.g. interview transcriptions were coded once again. The codes emerged from the data. The first codes were based on our earlier data analysis. During the coding more codes were added and earlier codes improved. This final coding was done by hand, with pen and paper. We marked the main codes with different colour strike out pens and subcodes by text in the margin. The final results of this study arose from this coding.

A more thorough description of the data analysis in each of the studies is given in Chapters 4 and 5.

3.5 Research timeline

This research started by selecting Case 1 (PlastCo) as the first case project. Data collection and analysis followed, and a research report and a scientific article were written based on the first analysis. Case 2 (PartCo) was selected after that, since we wanted to get more data from a similar type of project. After the data collection, within case analysis was made and a research report written. Then cross-case comparison between Cases 1 (PlastCo) and 2 (PartCo) took place. These results were published as a licentiate thesis (Paasivaara, 2001).

Case 3 (Omega) was selected as the first software development project. Also this case project was studied in-depth and the results from the analysis were presented to the case companies. Even though Case 3 (Omega) was very interesting, the project had problems because the participating companies were still quite inexperienced in distributed working. Therefore we wanted to find more experienced companies next. Based on these results Cases 4-10 (Alpha1, Alpha2, Beta, Gamma, Delta, Epsilon and Zêta) were selected. The data collection effort from six projects was quite strenuous and it was followed by a longer period of analysis and writing of scientific articles. Finally, we decided to select two more case projects (Êta and Thêta) to provide some more data. The selected projects differed from all previous case projects by being intra-organisational, instead of inter-organisational, like the rest of the projects. After this final data collection phase, all data was analyzed once more and cross-case and cross-study comparisons were made. During these last analyses, the writing of this dissertation could start. The research timeline is presented in Figure 3.

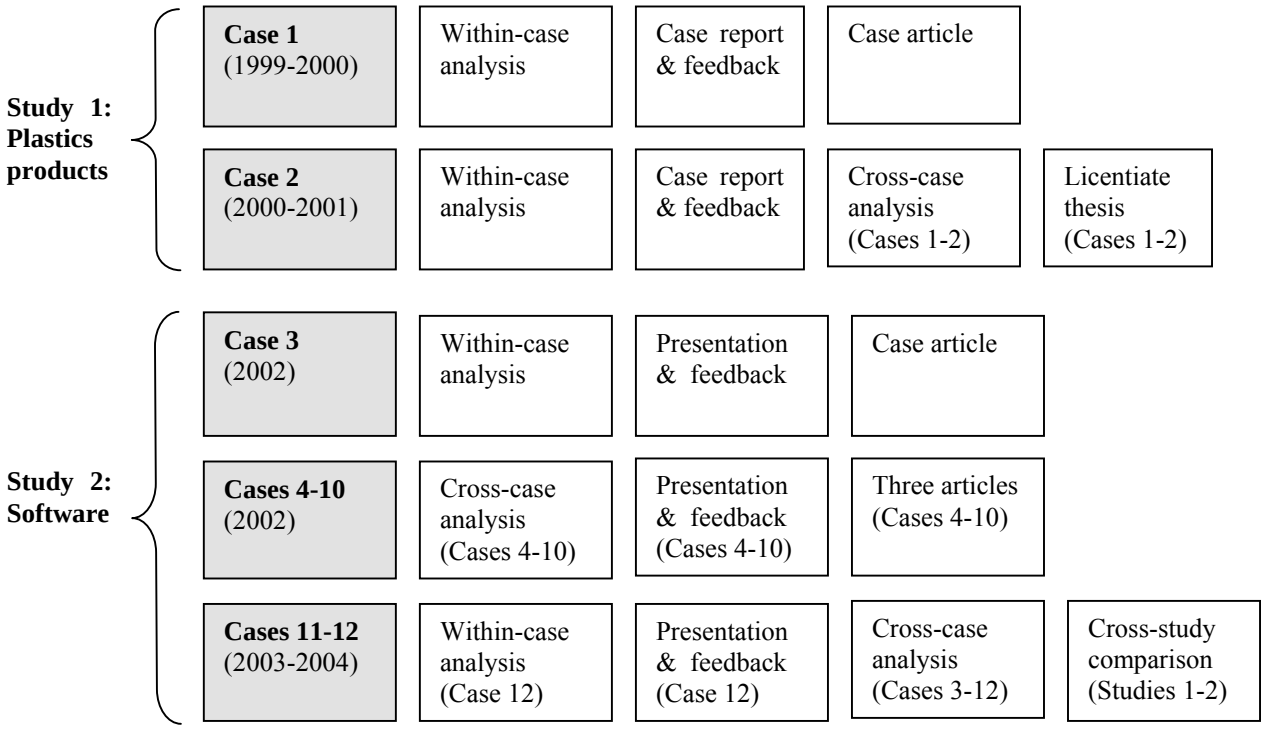


Figure 3. Research timeline.

3.6 Summary

This chapter presented the research design of this study. First, the research questions were stated. The main research question is: "What kinds of communication practices are used in inter-organisational geographically distributed product development projects?" The three supporting research questions concentrate on the communication problems, the communication needs, and the usage of social process simulation methods in studying communication. Secondly, the research approach of this study was described. This is a qualitative multiple-case study with twelve case projects that are grouped into two studies. Thirdly, the data collection methods and data analysis were shortly described. The main research method in Study 1 was the social process simulation method, which actually consists of several data collection methods, such as interviews and simulation session. In Study 2 the data was collected by interviews only. The principle of ongoing data analysis was used throughout this study, thus part of the qualitative data analysis was done already during the data collection of each case study. A more thorough description of the research methods, the data collected and the analysis made will be presented in Chapters 4 and 5, in connection with the description of the case studies and their results. Finally, the research process was presented.

4 First study – The development of plastic products

This chapter presents Study 1. The applied research method will be described first, and the achieved results will be presented next. The results include the identified communication practices and problems, and a discussion about the usage of social process simulation as a research method.

4.1 Research methods and empirical data

4.1.1 Case projects

We used purposeful sampling when choosing the case projects for this study (Patton, 2002). Our research project was built around an interesting company network that operates in the Finnish consumer electronics industry and develops challenging new products. The consumer electronics industry is characterised by a constant need to shorten the product development project cycles, and by a rapidly changing environment. The work is increasingly done in parallel and the subcontractors are involved early. In the studied network, every new project involved the subcontractors earlier than before: in recent projects the subcontractors were involved already in the concept design phase. This seemed to be an interesting and a very challenging environment from the inter-organisational communication point of view, and thus suitable for our study. With the help of company representatives we chose first one case project, and later on a second case project for this study, based on the criteria presented below:

1) **Inter-organisational development:** At least two different companies, a customer and a subcontractor or subcontractors are involved in the project.

   → Collaboration across company borders.

   Our research project had five company participants. All participants were at least somehow connected and working in the same network. Thus, from these company participants we chose first a customer company and a subcontractor company for our first case study and later on a second pair of companies.

2) **Concurrent development:** Both the customer and the subcontractor(s) participate in the product development phase at the same time.

   → Communication and collaboration needed.

   Involving the subcontractors in the development at a very early phase was a new trend in this industry. It was still quite challenging especially from the communication and collaboration point of view.

3) **Ongoing or recently finished project:** The project is ongoing or recently finished.

   → Easier for the participants to remember the communication practices used.

This requirement was posed by both the companies and the researchers. For the researchers it was important that the interviewees would remember the events and the used practices easily. In addition, the companies hoped that the projects would be ongoing, because then our research results and the usage of the research method, social process simulation, might benefit already the ongoing projects involved in the study.

4) **Distribution inside Finland:** If possible, all the main project participants are situated in Finland, or at least can speak Finnish.

   → No language problems.

   This requirement was posed by our company participants after we had chosen social process simulation as a research method. The reason for this was that the companies were afraid that having simulation sessions in English, instead of in Finnish, would limit the discussions because not all Finnish simulation participants were used to speaking English.

One of the company participants in our research project was a company that we call ElectroCo, a global consumer electronics company. ElectroCo develops products in collaboration with its subcontractors and is the main partner in the studied company network. Two of ElectroCo's plastic part subcontractors, PlastCo and PartCo, were also participants in our research project. Thus, these companies were easy to select for our study. However, the subcontractors, PlastCo and PartCo, are competitors, thus they do not work in the same projects. Together with the companies we chose two case projects, one with each of these subcontractors.

As the first case project we selected a network, which consisted of ElectroCo, its 1st tier subcontractor, PlastCo, and its two 2nd tier subcontractors, i.e., PlastCo's subcontractors AutoCo and PaintCo. In our second case project, ElectroCo co-operated with its 1st tier subcontractor PartCo. From now on these case projects will be called the *PlastCo case* and the *PartCo case* according to the main subcontractors in these projects. The structure of this network is shown in Figure 4.

Because of the changing requirements, none of the projects ElectroCo does with its subcontractors is the same. The two projects selected were similar in the sense that the designed part was meant for the same use. Both of these projects where parts of a larger development programme that included several plastic parts, software and electronics. For our simulations we chose only one plastic cover assembly from each project, the most important one.

In both case projects, ElectroCo was responsible for the product development, the final assembly, and the sales and marketing. ElectroCo's subcontractors, PlastCo and PartCo, are plastics firms, both of which built the manufacturing tools for the plastic parts, as well as manufactured and assembled the plastic components. PartCo did even more than this, it designed and manufactured its own automation lines for the part assembly and it also painted the ready-made plastic parts. PlastCo bought these services from its subcontractors AutoCo and PaintCo. AutoCo was responsible for designing and delivering the assembly automation lines, and PaintCo painted the plastic parts before assembly.

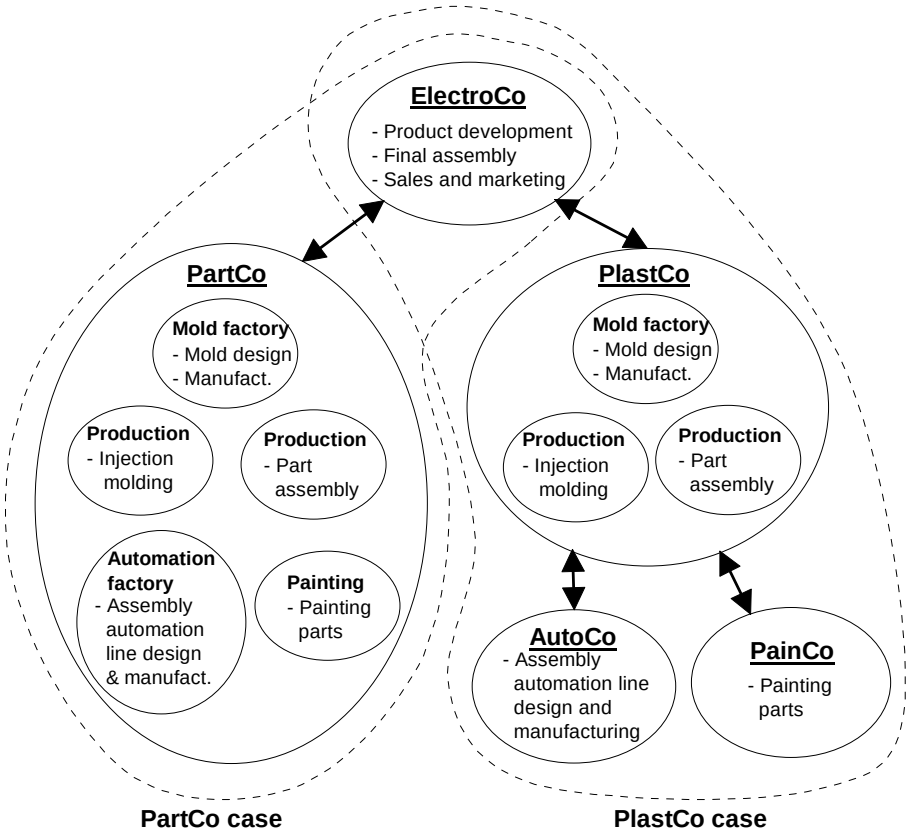


Figure 4. Companies and their tasks in the case projects. Arrows in the picture illustrate both subcontractor relationships and main communication links.

PlastCo and PartCo are competitors. Both have done several projects with ElectroCo. They have worked with ElectroCo since the early 80s. It is not uncommon for ElectroCo to have several simultaneous projects with each of these subcontractors. In each single project, only one of the two subcontractor companies is involved. PlastCo has started its internationalisation, but is still quite small on the global scale, with most of its activities in Finland. PartCo is a somewhat larger firm with more global activities. Both 2nd tier subcontrators, AutoCo and PaintCo, are small local companies, who had worked with PlastCo for about two years at the time of the study.

In both case projects all the sites were located in Finland, with the largest inter-site distance of about 500 km. PlastCo's internal activities; sales, mould factory and production, were all at the same location. PartCo's activities, on the contrary, were more distributed: sales, mould factory, production and automation factory had 10 km as the largest inter-site distance, whereas painting was situated almost 400 km apart from the other sites.

The biggest difference in the PlastCo case project, compared to what is "normal", was that this was the first project between these companies in which the subcontractors were involved before making the first injection-moulded prototype. This increased the

subcontractors' possibilities to influence the design of the final product. The distinguishing feature in the PartCo case project was the tighter than normal schedule set by ElectroCo. Table 7 summarizes the information about both case projects.

Table 7. Summary of the case projects in Study 1.

	PlastCo Case	**PartCo Case**
Basic project data		
- Project members and their activities	- ElectroCo: design, marketing and final assembly of consumer electronics products. - PlastCo: designing and building moulds, injection moulding and part assembly. - AutoCo: designing and manufacturing assembly automation lines for PlastCo. - PaintCo: Painting plastic parts for PlastCo.	- ElectroCo: design, marketing and final assembly of consumer electronics products. - PartCo: designing and building moulds, injection moulding, designing and manufacturing assembly automation lines, painting plastic parts.
- Size of the companies	- ElectroCo is a big global company. - PlastCo is a rather small globalising company with most of the activities in Finland. -AutoCo and PaintCo are small local companies.	- ElectroCo is a big global company. - PartCo is a somewhat larger company than PlastCo and has more global activities.
- Travelling between companies	- A few hours by car between ElectroCo and PlastCo.	- Requires a short aeroplane trip.
The relationship between the customer and its 1st tier subcontractors		
- Length of the relationship	- Approximately 20 years between ElectroCo and PlastCo. (Two years between PlastCo and its suppliers.)	- Approximately 20 years.
- Depth of the relationship	- Not very deep yet. - Subcontractor selection was based on the speed of producing the first prototypes.	- Close, can almost be called a partnership. - Common process development activities.
- Customer's importance to subcontractor	- Very important customer, buys more that half of the production.	- One of the most important customers.
- Project hierarchy	- Quite hierarchical structure, subcontractor does what customer says.	- Hierarchical, but already a more equal situation than in the PlastCo case. Subcontractor feels confident to present its own demands.
- Trust	- Some lack of trust on both sides: the customer was afraid that product design knowledge would leak out and the subcontractor was afraid to lose its know-how to the customer.	- More confidential atmosphere than in the PlastCo case even though PartCo was not ready to discuss its internal mistakes with the customer during the simulation session.
Case project		
- Project chosen	- A totally new product design project. - One plastic part and its part assembly. - Simulated phase of the project: from subcontractor involvement to specification freeze.	- An entirely new product design project. - One plastic part and its part assembly. (For similar use as in the PlastCo case.) - Simulated phase of the project: from specification freeze to mass production release.

- Project speciality	- Subcontractors involved earlier than before, already before the first injection moulded prototypes were produced.	- Very tight schedule: project was to be done much more quickly than normally.
- Project team members	- Only a few team members had worked together across company borders before, but most of them had worked together inside their own organisations.	- Less than half of the team members had worked together across company borders before, but most of them had worked together inside their own organisations.

4.1.2 Summary of data collection

The main research method was social process simulation, which comprised several data collection methods, e.g. process description session and interviews. Before each simulation day a lot of advance preparations were required: planning the simulation with the companies, arranging a process description session, interviewing the project team members and informing the participants about the simulation. After the simulation the participants were invited to a feedback session. Table 8 presents the timeline of the data collection.

Table 8. Timeline of the data collection in Study 1.

Activities	**Timeline, PlastCo case**	**Timeline, PartCo case**
Planning the simulation with the companies	11 / 1999	10 / 2000
Process description	12 / 1999	1 / 2001
Interviews	12 / 1999 – 1 / 2000	1 / 2001
Informing session at the companies	1 / 2000	1 / 2001
Simulation session	1 / 2000	1 / 2001
Feedback session at the companies	3 / 2000	4 / 2001

In both case projects the simulations involved the same kind of preparation. We planned each case study together with the company representatives, and then started the data collection by doing a process description of the chosen case project. Interviews were used to validate the process model, to ask the interviewees about the communication practices and problems and to collect documentation for the simulation session. One week before each simulation session one-hour long information sessions were held in the participating companies. After these preparations a simulation session could take place. The simulation sessions were documented both by videotaping them and by taking detailed notes. During the simulation sessions the participants were encouraged to write down problems and development ideas on Post-it notes. At the end of each simulation day all participants filled in a questionnaire. Finally, the results of each case study were reported to the participating companies both in the form of written reports and as feedback sessions that all the simulation participants could attend.

Table 9 reports the number of persons who participated in the planning meeting, the process description meetings, the interviews and the simulation sessions. It also presents the number of questionnaires and Post-it notes received in the simulation sessions. The next sections describe the methods used and the data collected in more detail.

Table 9. Summary of the data collection.

Abbreviations: tm =project team member, ob = observer (e.g. personnel from other projects, process developers and managers.)

	PlastCo Case					**PartCo case**		
	Electro-Co	**Plast-Co**	**Auto-Co**	**Paint-Co**	**In total**	**Electro-Co**	**Part-Co**	**In total**
The number of persons at the planning meeting	4	3	0	0	**7**	No common planning meeting.		
The number of persons at the process description meetings	4	3	0	0	**7**	2	6	**8**
The number of persons interviewed	4	4	0	1	**9**	10	7	**17**
The number of participants at the simulation sessions	8 tm 14 ob	10 tm 8 ob	1 tm 0	0 0	**41**	7 tm 5 ob	11 tm 2 ob	**25**
The number of questionnaires received	20	18	1	0	**39**	10	12	**22**
The number of Post-it notes received	Not coded according to companies.				**89**	11	15	**26**

4.1.3 Planning meeting

First, the idea of simulation had to be sold to the companies. Then, the planning of the simulation could be started. The purpose of the planning meeting was to set the goals for the simulation, to find a suitable case project, and to set the dates and choose the participants for the process description, the interviews and the simulation session. In the PlastCo case a joint planning meeting was arranged with ElectroCo and PlastCo. In the PartCo case it was too difficult to find a suitable date for both parties, thus the planning was done by telephone calls and by exchanging emails.

In addition to selecting the case projects, we also needed to define the scope for the simulations. Both case projects were so broad that we could not go through an entire project in detail during only a one-day long simulation session. Thus, we chose only a limited time period from both projects to the simulations.

In both projects the product development phase lasted for approximately two years. The PlastCo-simulation session took place when the project was approximately halfway through the product development phase. The simulation covered the period from the first prototyping stage when PlastCo joined the project, to the specification freeze (Stage 1 in Figure 5). The PartCo-simulation was held one year after the mass production release. In this simulation the later stages, i.e. detailed design and manufacturing integration and verification were examined (Stages 2 and 3 in Figure 5). By choosing successive

development periods to the simulations, it was possible to cover a larger part of the whole process. Figure 5 presents the development process and the stages chosen for each simulation.

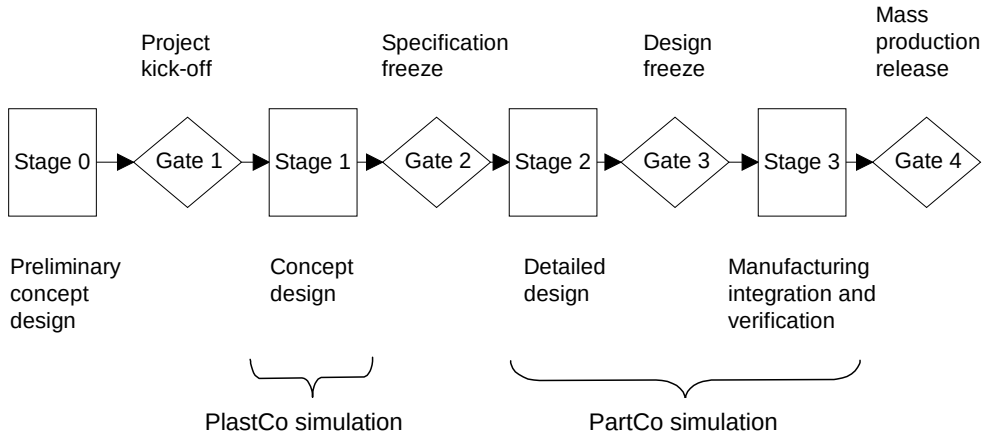


Figure 5. The main stages and gates of the product development process and the phases chosen for the simulation sessions.

During the planning also the goals for the simulation were set. The aim was to concentrate especially on the communication and information exchange between the companies. The research goals were to study the communication practices and problems. The goals of the participating companies differed somewhat from the research goals. The companies hoped that the simulations would give all participants a good picture of the development process and its challenges. Moreover, they expected to get information about possible problems and to collect ideas for process improvement.

4.1.4 Process description

The next step after the planning was to make a process description of the chosen case project. We made the process descriptions with the help of a few project team members from each company. The process description session for each case project lasted approximately four hours. A simple modelling process, sticking Post-it notes to the walls of a meeting room, was used. Both the process stages and the information flow between the different stakeholders were modelled. In both case projects actually three concurrent processes were modelled: ElectroCo's process, its subcontractor's process and a joint process including, e.g. joint project meetings. Information was included in the model by adding the documents and the information needed above each task, and the information or the documents generated under each task. Other information that was exchanged between the companies but not related to any tasks was included as well.

We did not want to use any ready-made process descriptions, instead, our goal was to describe a real project with all its problems and iteration loops. The reason for this is self-evident: projects very seldom follow the process models made in advance. In the simulations we wanted to present the reality that can be otherwise difficult to see in its entirety. After the initial process modelling sessions, the models were validated and refined in interviews.

4.1.5 Interviews

The interviews were semi-structured and open-ended. They typically lasted from one to two hours. The interviews were used both to refine and validate the process descriptions, and to ask questions about the communication practices and problems in the case projects. In addition to this, some interviewees also presented their process improvement ideas. These interviews provided good background information for the simulation facilitator. This person should know quite a lot about the project in advance to be able to lead the discussion into the right direction.

In the PlastCo case the interviewees were selected in the planning meeting, and in the PartCo case the project managers provided a list of suitable persons for the interviews. These interviewees consisted of project team members, i.e. project managers, designers, engineers, quality engineers, material experts and salespersons. In the PlastCo case nine persons and in the PartCo case seventeen persons were interviewed. During the PlastCo case we noticed that the interviews provided useful information for the simulation sessions and interesting data for our research. Therefore, we wanted to increase the number of interviewees in the PartCo case.

In both cases the interviewer took very detailed notes. In the PartCo case the interviews were tape-recorded and transcribed, as well. The discussion topics of the interviews can be found in Appendix 1.

4.1.6 Project documents

The plan was to collect the most important project documents during the interviews and show them in the simulation sessions to complement the process description in which these documents were mentioned. However, in the PlastCo case the documents were deemed to be so confidential that copies of them could not be given to the researchers. The reason for this was that the project had not ended yet and the product had not been introduced to the market. Therefore, the project managers brought the documents to the simulation session and showed them either using an overhead projector or their own computers and a projector. In the PartCo case the documents were collected during the interviews as planned. In addition to that, the project managers and a few other participants showed the documents with their computers when needed during the simulation session. The documents included e.g. offers, orders, change information, measurement reports, acceptance reports, meeting memos and short email messages.

4.1.7 Simulation sessions

Both case projects had a one-day long (about eight hours including breaks) simulation session. The PlastCo-simulation session had 41 participants and the PartCo-simulation 25 participants. Approximately half of the participants were members of the case project team, e.g. project managers, designers, engineers, quality engineers, material experts, production personnel and salespersons. The rest of the participants were observers. These included designers from other projects, process developers and managers. The simulation session setting is shown in Figure 6.

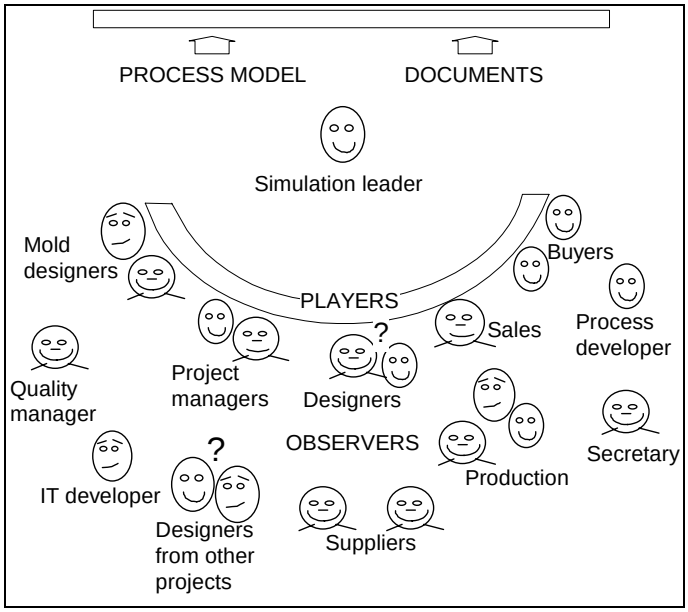


Figure 6. A model of the simulation session set-up and participants (modified from Forssén-Nyberg and Luhtala, 1996).

The agenda of the first simulation day consisted of four parts: presentations, simulation, group work and filling in a questionnaire. The presentations included all participants presenting themselves and the process developers presenting the main process steps in each company. The simulation was conducted under the leadership of one of the researchers and it followed the process description that was projected on the wall. The most important documents were projected with an overhead projector. Using the process description, the project team members and project managers described their work activities, the communication flows and the problems encountered. Each item in the process description was described and discussed. The person who knew the most about a particular item briefly explained it and others elaborated as needed, described the related problems and communication, asked questions or suggested improvements. Several improvement ideas were suggested and discussed during the simulation. The observers were encouraged to comment, to suggest new ideas and to contribute their experiences from other projects. A researcher, in the role of simulation leader, led the discussion and asked clarifying questions whenever needed.

To collect all improvement ideas and problems, the participants were given Post-it notes, on which they could write down their thoughts. These notes were then collected on the walls. The whole session was videotaped and a scribe took notes of all the comments; these were synchronised with the videotape. Thus, afterwards it would be easy to find the most interesting discussions from the videotape.

After the simulation, the participants selected and presented the most important development ideas as a group exercise. Finally, all participants filled in a questionnaire with both structured and open-ended questions about the simulation and process improvement needs. The PartCo simulation was conducted in the same way, with the exception that the group exercise was left out to have more time for the actual simulation.

4.1.8 Questionnaires

At the end of both simulation sessions all the simulation participants that were present filled in a questionnaire. Only a few participants had to leave early in each simulation. Somewhat different questionnaires were used in each of the simulations. In the PlastCo simulation the questionnaire concentrated mainly on the participants' opinions about the simulation. The respondents were also probed about process development ideas and needs, and problems in a distributed project. The questionnaire in the PartCo simulation was very similar to the first one, but somewhat shorter. Moreover, some questions about the simulation where left out and more detailed questions about communication were asked. Both questionnaires consisted of both structured and open-ended questions. The scale of the structured questions ranged from one to five, one being "I completely disagree", and five being "I completely agree". The questions asked can be found in Appendix 2.

4.1.9 Data analysis

The principle of ongoing data analysis was used throughout this study (Miles and Huberman, 1994). The analysis was divided into three steps: preparations for the analysis, analysis during the data collection, and analysis and reporting after the data collection. These steps are presented next.

4.1.9.1 Preparations for analysis

All verbal information, interview notes, open-ended questions from the questionnaire, Post-it notes, and notes from the simulation sessions were computerised.

In the PartCo case the interviews were also tape-recorded. These recordings were transcribed by a student who did not otherwise participate in the study. We listened to all the tapes and made corrections to the transcriptions when needed.

4.1.9.2 Analysis during the data collection

Early analysis of the data was done during the data collection for each case study. This included e.g. reading and writing up the notes right after the meetings, interviews and simulation sessions, and grouping this data into categories. This analysis guided the next data collection steps of that study. For example, in each case study the process description shaped the interview questions and they both affected the planning of the simulation session.

4.1.9.3 Analysis and reporting after the data collection

Within-case analysis was done directly after completing the data collection for each case. The data from each case was analysed by grouping all verbal information into categories using copy-paste technique. Quantitative information from the questionnaires was analysed using the SPSS program.

In PartCo we analysed the transcriptions by coding them (Miles and Huberman, 1994; Patton, 2002). Coding was based on the results from earlier analysis and thus the codes arose from the data. In addition, the codes were improved during the coding.

Based on the analysis, we wrote case descriptions of both cases and gave feedback to the participating companies both in written and oral format after each case study. The findings from each case study were presented in feedback sessions to the simulation participants. We also discussed the results with the participants. The final conclusions and cross-case comparison were made after these discussions.

4.2 Communication practices

4.2.1 Background

Since the subcontractors were involved in our case projects earlier than in the previous projects, continuous communication was required. This caused a need for new communication practices. In the early days of cooperation, our case companies had used the "over-the-wall approach" (Wheelwright and Clark, 1992), giving information to the next development step only after the completion of the previous one. The subcontractors, PlastCo and PartCo, had first received the designs from ElectroCo and then produced the moulds and products according to them. However, in the projects under the study, the interaction between the companies resembled what Wheelwright and Clark (1992) call integrated problem solving. In this mode of communication, the downstream group is involved from the moment the upstream group starts working, thus getting a flying start for their own work. Figure 7 illustrates the direction of change in our case companies.

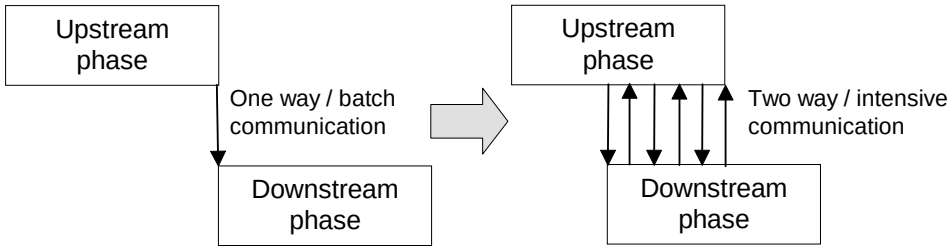


Figure 7. The direction of change in our case network is from a serial mode of working to parallel product development.

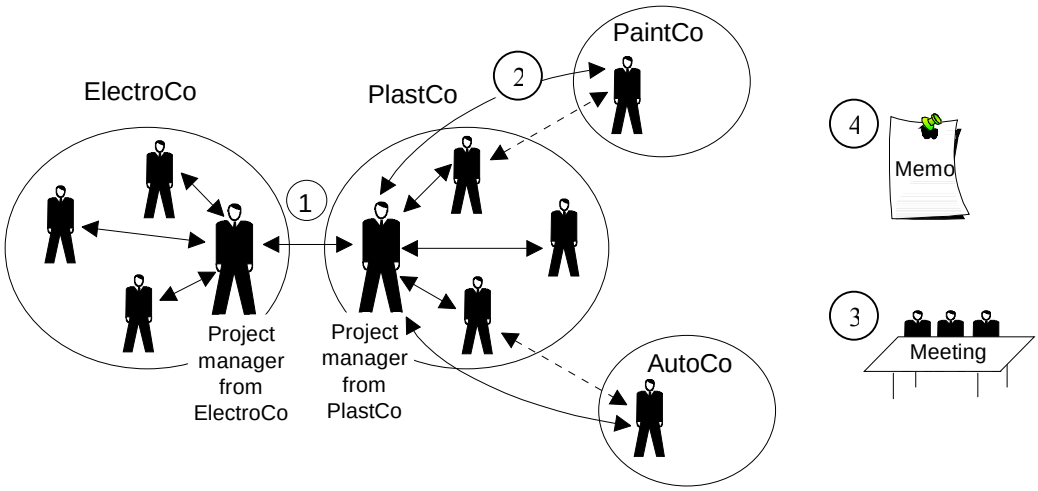
4.2.2 Recognised communication practices

We recognized a few main communication practices between the participating companies in both case projects. In the PlastCo case we found three practices that describe the communication in the project:

1) **"Project managers as gatekeepers between the companies":** Communication through ElectroCo's and PlastCo's project managers, who distribute information further inside their companies and communication between PlastCo's project manager and their subcontractors.

2) **"Weekly project meetings for change management":** Weekly project meetings between the companies for change management.

3) **"Meeting memos as the main source of project status and change information to team members"**



1. Communication through project managers who distribute information further
2. PlastoCo's project manager communicates with supplier, excluding commercial documents
3. Meetings
4. Meeting memos

Figure 8. Communication practices in case PlastCo.

Figure 8 illustrates these communication practices. In case PartCo, the communication practices encountered resembled the practices found in case PlastCo. This result is not surprising, since in both cases the customer is the same and has quite a powerful role. The five main communication practices used between the two companies were:

1) **"Project managers as information distributors and decision makers":** Communication through ElectroCo's and PartCo's project managers, who distributed information further inside their companies

2) **"Communication through direct contacts about details":** Direct communication between team members from ElectroCo and PartCo about details.

3) **"Resident engineer to facilitate contacts and relay information":** Communication between the companies through PartCo's resident contact person located in at ElectroCo's premises.

4) "**Project meetings for problem solving":** Project meetings between companies for problem solving.

5) **"Meeting memos as the main source of project status and change information to team members"**

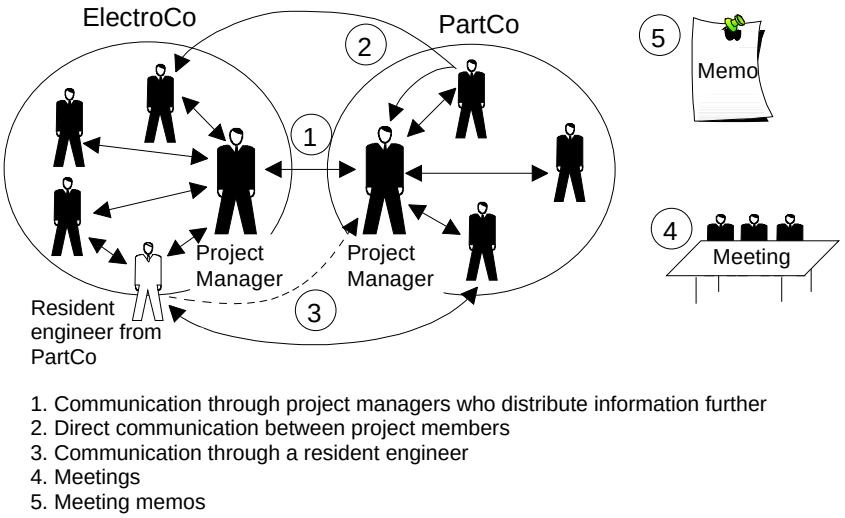


Figure 9. Communication practices in case PartCo

Figure 9 illustrates these communication practices. Next, the communication practices found in each case project are described in more detail, and a cross-case comparison of the communication practices is presented.

4.2.3 Communication through project managers

Clearly, most of the information flow between the companies was channelled through the project managers in both case projects. In addition to discussing and making decisions together, they conveyed information to their intra-organizational teams.

4.2.3.1 PlastCo case

"Project managers as gatekeepers between companies". The information flow between the companies, especially between ElectroCo and PlastCo, was mainly channelled through the project managers. The main part of the documentation and other information was first delivered to the project manager of the employee's own firm, who then sent it to the project manager in the partner firm, who finally distributed the information inside his or her own firm. This pattern was especially strong between ElectroCo and PlastCo.

The communication between PlastCo and its subcontractors mainly conformed to the same pattern, however, commercial communication, such as orders and invoices were not sent through the project manager (the dashed arrows in Figure 8.).

In addition to the documentation, also all other kinds of communication mainly used this pattern. Direct communication between the project members from the different firms was not explicitly forbidden, but it was not encouraged either. It was considered important that the project managers knew everything that was happening and that nothing, not even small things, were agreed directly, behind the backs of the project managers. In addition to this "rule", direct communication would have been difficult because the project members did not know all the relevant names and responsibilities of other project staff across the company borders. In the questionnaire that was filled in at the end of the process simulation session, we got comments such as: "In the simulation I met for the first

time several persons that I have been working with."

The term gatekeeper is used in this study in a somewhat different context than in earlier studies (e.g., Allen, 1984; Tushman and Katz, 1980). These earlier studies have defined gatekeepers as individuals who are closely connected to internal and external colleagues and who translate and distribute external information to the colleagues inside their projects and also facilitate the outside contacts of these colleagues. This was actually quite true also in this case study, with the exception that in this project the gatekeepers worked as messengers mainly inside a project, between two co-operating companies. Earlier studies have concentrated only on internal projects and the gatekeepers have maintained contacts to the external environment. In this case project the gatekeepers were not so interested in the external environment, but only in the partner companies. In this case, the gatekeepers also had a slightly negative effect, since they did not always facilitate the contacts between the co-operating companies, but could even hinder the contacts somewhat, when directing almost all communication through themselves. In that sense they were really watching the "gate" between the companies, and controlling the information transmitted between them.

4.2.3.2 PartCo case

"Project managers as information distributors and decision makers." In the PartCo case the main information flow between the customer and the subcontractor was also channelled through the project managers. In this case, however, PartCo had its automation line factory and painting facilities as separate departments inside the company, whereas PlastCo had bought these services from the outside. This helped communication somewhat in the PartCo case, since it was easier for PartCo's project manager to understand what kind of information these internal departments would need, than what it had been for PlastCo's project manager to understand the information requirements of the outside subcontractors. In spite of this, especially the personnel in the automation factory felt that they did not get information early enough and had wasted energy working with old information. Any change decisions involving adjustments in terms of money or time were always channelled through the project managers.

4.2.3.3 Comparison

In both cases the project managers took care of most of the communication between the companies. Almost all decisions were channelled through them, in the PartCo case some responsibility over small detail decisions was given to lower level employees, the project manager was only informed about these decisions. This practice of channelling everything through the key persons had both its benefits and drawbacks. The project managers knew everything that was happening in the project, and they really took care of the project coordination inside their own companies. Coordination responsibility was actually divided between the project managers from both companies, both coordinated the work inside their own companies, and of course ElectroCo's project managers monitored the work of their subcontractors, as well. However, especially at PlastCo, some project members felt that if the project manager was not available, e.g. she was on a business trip, working was difficult, since the project manager had all the contacts and even most of the documents, which were not easy to find while she was away. In addition to co-ordinating the work inside their companies, the project managers also delivered a lot of project-related information to their project team members. The main information delivery channel

in both cases was the meeting memos that the project managers distributed by email. In the PlastCo case these memos were sent to all meeting participants and also to those team members the project managers thought might need the information. In the PartCo case, however, the meeting memos were normally sent to all project team members. The practice used in the PartCo case seemed to be better, since several team members in the PlastCo case complained that they had not received all the meeting memos, whereas in the PartCo case, the team members were very satisfied with the practice and thought that the project managers were sending them all the necessary information. This successful practice could be observed even in connection to our study: especially the project manager of PartCo sent all the information about the simulation also to his project team members. Thus, when we contacted the interviewees in this company for the first time, we found that they all knew our study and what it was about, and their reaction was very positive.

4.2.4 Direct communication between project team members

Direct communication between the project team members coming from different companies was not very frequent in the case projects. Here, we will discuss only the inter-company communication, intra-company communication between the team members was, of course, more frequent, but it is beyond the scope of this study.

4.2.4.1 PlastCo case

Direct contacts between the team members from the different companies were quite rare in the PlastCo case, since most of the inter-company communication was channelled through the project managers. The team members were not encouraged to communicate directly, because quite often that kind of communication would have concerned changes and changes may affect the prices and the work in the rest of the project. In addition, direct communication could have been difficult since many of the team members from different companies did not know each other, their roles or the contact information. Thus, it seemed to be the safest way to direct the communication through the project managers.

4.2.4.2 PartCo case

"Communication through direct contacts about details". In contrast to the PlastCo case, also the key project members had a few direct contacts between the companies, in addition to the project managers. For example, ElectroCo's designers communicated with PlastCo's mould and automation line designers and quality personnel. These contacts involved mostly small detail decisions. The project managers in both companies were informed about all the decisions that were made during these contacts. Many team members thought that direct contacts are an easier way to communicate than through the project managers, especially because it is quicker. Nevertheless, direct contacts are not possible when the team members do not know whom to contact, which was sometimes the case. Moreover, the barrier to contact someone directly is higher, when one does not know the person one should contact beforehand, as some of our interviewees commented.

4.2.4.3 Comparison

Direct contacts between the companies were quite rare in the PlastCo case, whereas in the PartCo case they were more common. Actually, in both projects many team members

would have welcomed this quicker way of communicating as a common practice. However, in order to arrange direct communication some rules would have been needed, e.g. what kind of decisions can be made through these contacts, who should communicate with whom and who should be informed. In addition to the rules, direct contacts would have required that the would-be contactors first knew the persons who should be contacted.

4.2.5 Communication through a resident engineer

In both case projects a resident engineer from the subcontractor company had been located at the premises of the customer company. He worked as a communication link between the companies.

4.2.5.1 PlastCo case

During this project PlastCo hired a contact person, who would be located at the premises of ElectroCo. However, this happened only in the end phase of our interviews, thus during the interviews or the simulation session the project personnel still did not have much experience of how useful this kind of an arrangement would be. The aim was that this resident engineer would work with the customer's personnel and help them design products that would be easy to manufacture. At the same time this person would facilitate the communication between the customer and the subcontractor.

4.2.5.2 PartCo case

"Resident engineer to facilitate contacts and relay information". In the beginning of the case project PartCo hired a contact person to be located at ElectroCo's premises. This contact person had a long experience in the field and a good knowledge of mould design. The objective was that this person would facilitate the communication between the firms, and help ElectroCo's designers design products that would be easy to manufacture. The contact person stayed in close contact with PartCo's personnel. He visited PartCo at least once a month and was almost in daily contact with PartCo's project manager, whom he informed about all the decisions made.

The team members from both companies found the contact person to be of great help. They also felt that the existence of that kind of a person sped up the whole project. First of all, he helped ElectroCo's designers make better product designs from PartCo's point of view, since he knew what kind of an effect the design changes would have on a mould. This removed the need to send product files many times back and forth between the companies for commenting, leading to a time saving of approximately two days with every change. Secondly, he knew the team members and their expertise fields inside both companies, and thus he could facilitate contacts. He was needed, for example, when a team member from either one of the companies had a problem and wanted to contact someone in the other company, but did not know whom to contact. Moreover, the team members from PartCo felt that it was easier to turn to a familiar person, when they had a "small" problem. Earlier they would have waited until the problem was a "bigger" one before disturbing the customer. Thirdly, the contact person spoke the same "language" as PartCo's mould designers, thus sometimes he could even act as an interpreter between the companies.

4.2.5.3 Comparison

Both case projects were the first projects between these companies that used a resident engineer, i.e. an engineer hired by the subcontractor, and based at the customer's premises. PlastCo had their own contact person located at ElectroCo' premises, but this was such a new experiment that our interviewees and the simulation participants did not have any comments about the arrangement at the time of this study. In the PartCo case, the contact person, an experienced engineer, was deemed to be a very good communication facilitator between the companies. He also helped ElectroCo's product designer a great deal by giving him daily feedback about his designs from the manufacturing point of view. Probably this close consulting relationship substituted for some of the meetings with ElectroCo that were not possible to arrange as often as in the PlastCo case. Weekly meetings in the PlastCo case provided the same kind of feedback to ElectroCo's product designer about manufacturability as the contact person provided in the PartCo case. Therefore, it seems that a resident contact person is very useful, especially when the co-operating companies are geographically dispersed, and frequent face-to-face meetings are not possible. However, resident engineers need to have a very good knowledge of the field as well as know the subcontractor's people, practices and problems.

4.2.6 Communication in meetings

In both case projects inter-organisational project meetings were an important form of communication. Intra-company meetings were used, as well, but they are outside the scope of this study.

4.2.6.1 PlastCo case

"Weekly project meetings for change management". The reasonable geographical distance between ElectroCo and PlastCo made it possible to have on-site weekly meetings between the two companies. In addition to the project managers, also other project team members from both companies were invited. Occasionally, representatives from PaintCo and AutoCo were invited, as well. Both ElectroCo and PlastCo found regular meetings as a very useful information sharing mechanism; in earlier projects the meetings had been scheduled more occasionally, on a need basis. Now, for example, all changes to ElectroCo's product designs were discussed beforehand in these meetings and PlastCo could comment on the changes and suggest alternative solutions from the manufacturing point of view. These meetings also prevented misunderstandings, since e.g. a product designer could explain what his changes actually meant, so that a mould designer would not interpret his drawings in the wrong way. In the simulation session several persons stated that by having these meetings and discussing all the changes together, they had both sped up the project and avoided a huge number of mistakes related to product changes**.** The meetings took place in the beginning of the project at ElectroCo's premises and later on, when PlastCo had already started to build a mould and there was something to see, the meetings were held at PlastCo.

4.2.6.2 PartCo case

"**Project meetings for problem solving".** Project meetings between the companies were held somewhat irregularly, normally when there were problems to solve. In practice, this meant that the meetings took place approximately once a month, sometimes more frequently. The distance between PartCo and ElectroCo was somewhat longer than between PlastCo and ElectroCo, which may have been one of the reasons for fewer project meetings. This practice had both its strong and weak points. The meetings were never held in vain, but on the other hand, some team members complained about not having received information e.g. about the project progress in time, whereas in a meeting they would have received that information. Several team members expressed a need for more systematic project meetings between the companies, especially in the beginning of the project. These early meetings should have representatives from all functions of PartCo, also from manufacturing, because problems are easier to solve when they are discovered as early as possible. In the case project only a few persons were involved in the early phases of the project. Those functions that were not involved at all felt that they could have contributed to the project much more, if they had only been involved early enough.

After this case project, PartCo started to arrange internal weekly meetings both between functions and inside functions. PartCo's personnel found these meetings a very useful practice for distributing information. When the team members know a bit more about a project than just their own job, they can take over more easily when someone is ill or on a business trip.

4.2.6.3 Comparison

Both projects found meetings a very useful communication practice. This suggests that rich media, such as face-to-face meetings, is needed in distributed projects. In addition, informing the whole project team about the project progress and changes seemed to be necessary. In the PlastCo case, the meetings were almost weekly and the main reason for arranging them was to discuss all the changes together. Whereas in the PartCo case the meetings took place more seldom, approximately once a month and they were arranged when problems arose. This different frequency of meetings was probably due to the longer physical distance between the companies in the PartCo case. Including travelling time, a weekly meeting would have taken almost a whole day for those who had to travel. However, discussing changes beforehand and not only after encountering problems would probably have been beneficial also in the PartCo case. The same kind of practice of having meetings only when facing problems had been used earlier in the PlastCo case, as well. Now after changing to weekly meetings, this new practice was considered a clearly better one. In both cases the early project meetings took place at ElectroCo's premises and later on, when the subcontractor had something to show, the meetings were arranged at the subcontractor's premises.

4.2.7 Communicating through meeting memos

Meeting memos were written of the above-mentioned inter-company meetings in both case projects. The memos written in intra-organisational meetings are left outside this discussion..

4.2.7.1 PlastCo case

"Meeting memos as the main source of project status and change information for team members". The main source of information on the project status and changes were the memos that the project managers from either ElectroCo or PlastCo wrote during the weekly inter-company meetings. The writing and distribution of these memos was not systematic. The project managers sent the memos by e-mail to the meeting participants and to other internal project members that they thought might need the information; occasionally PlastCo's project manager sent the memos also to AutoCo and PaintCo. The memos contained information e.g. about changes to the product, mould or timetable, and activities that should be undertaken. Several persons in the simulation session expressed a need to get these memos, in order to keep up-to-date with the happenings in the project. These project team members were afraid that they might miss some information and waste effort when working with outdated information. Those kinds of situations were not new to these persons but had happened frequently in the past. Especially, inside PlastCo the lack of meeting memos was experienced as problematic. For these team members the meeting memos were often the only source of information on schedule changes, even though these memos contained only the new deadlines, not comparisons to old schedules or any analysis of the effects of the changes on other tasks or partners.

4.2.7.2 PartCo case

"Meeting memos as the main source of project status and change information for team members". The practice of writing and distributing meeting memos in the PartCo case was similar to the practice in the PlastCo case, i.e. the project managers wrote memos during inter-company meetings and distributed them by email to the meeting participants, as well as to the persons they thought would need the memos inside their companies. Most team members felt that they received the memos they needed and found them to be very useful. In the simulation session some persons brought up the fact that there should be an easy way to outline the meeting memos, so that different persons would quickly find out the contents interesting to them. Everyone does not want to know all the details thus finding easily just the needed information without reading the whole meeting memo, was regarded valuable.

4.2.7.3 Comparison

The practice of writing memos of inter-company meetings was similar in both cases. However, in the PlastCo case some project team members complained a lot about not receiving these memos, since the distribution of the memos seemed to be quite unsystematic, whereas in the PartCo case the project managers were very systematic when sending these memos by email to each other, to the participants of the meeting and to other project participants who might need that information. Thus, in the PartCo case this more systematic distribution of the memos was found to be useful.

4.2.8 Project documentation

Most documents between the firms were sent in an electronic form. Inside the firms the documents were either delivered further in electronic form or printed and delivered as paper copies. The documents were then archived inside the firms either in paper or electronic form. Inside PlastCo more paper than electronic documentation was used. In

PartCo, some transition from paper documentation to electronic documents could be seen during the case project.

None of the case companies had product data management systems (PDM) for daily project use. Even though ElectroCo had a PDM system, it was mainly used for archiving documents afterwards. Therefore, it was not very useful for the case projects. PlastCo and PartCo did not have a PDM system at the time of the study, but they were planning to buy one.

All the three biggest companies, ElectroCo, PlastCo and PartCo had electronic archives for documents, but these archives did not cover all documentation. Moreover, the documents were not updated frequently enough and it was difficult to locate them. In practice, many project members had their own personal archives, typically as paper documents or in electronic form on their personal computers. For example, the project manager from PlastCo mentioned: "I have all project documentation, except product files, as paper printouts in my folders. Actually, that is the only place in PlastCo where the whole project documentation can be found". At ElectroCo and PartCo many team members had their personal archives in electronic form on their portable computers.

4.2.9 Summary of the communication practices

Both projects had quite similar communication practices. This is partly due to the fact that ElectroCo was an active partner in both projects. However, the partnership between ElectroCo and PartCo seemed to be, at least in these projects, deeper than the cooperation between ElectroCo and PlastCo. This could be seen e.g. from a more open atmosphere and communication in the PartCo case. The communication practices and communication media used in the two cases studied are compared in Table 10.

Table 10. Summary of the communication practices and media.

Communication between companies	**PlastCo case**	**PartCo case**
Communication through project managers	- The main communication channel. All documentation and the main part of other communication between the companies was channelled through project managers. The project managers knew practically everything.	- A very important communication channel. - All big decisions and especially decisions influencing the budget or the schedule were always channelled through project managers. They were informed about smaller detail decisions that were made between the project team members.
Communication through a resident engineer	- One of PlastCo's engineers was placed at ElectroCo's premises. This was a new arrangement, so there were no real experiences about this yet.	- PartCo's resident engineer, located at ElectroCo's premises, was hired in the beginning of the project. - Experiences of having this role were extremely positive: he helped ElectroCo's designers design products that were easy to manufacture and facilitated problem solving and contacts between the companies. He informed PartCo's project manager about all the decisions.

Direct contacts between team members	- Inter-organisational direct contacts between the team members were almost non-existent. They were not totally forbidden, but not encouraged either. They would have been difficult to achieve, because the team members from different companies did not know each other.	- A few persons in addition to the project managers, had direct contacts across company borders, e.g. ElectroCo's designer communicated with PartCo's quality persons, mould designers and assembly automation line designers. The project managers were informed about all decisions made during these direct contacts.
Communication in meetings	- Meetings were held almost weekly. All changes, e.g, design and schedule changes, were discussed there before implementation. The meetings were considered to be very useful.	- Meetings were held on the need basis approximately once a month, especially when there were problems. - After the project, internal meetings were started between and inside functions at PartCo. The meeting were considered to be a good way to inform project team members.
Communication through meeting memos	- Meeting memos were the main channel to inform project members about project progress and changes. - Project managers from both companies wrote meeting memos during weekly meetings and sent these memos by email to each other, and inside their own companies to team members who had participated in the meeting or who they thought might need the information. - The memos were considered very useful. Some team members complained about not receiving all the memos.	- Meeting memos were a very important channel to inform project members. The memos were written and delivered the same way as in the PlastCo case. - All team members who needed the memos had received them and were quite happy with them. - One weakness of the memos was the amount of information they contained: everyone did not need everything and the information needed was not always easy to find. Some structuring would have been needed.
Communication media used		
Between companies	- Email was used as the main medium for both sending short messages and documents as attachments. - All offers and orders were sent first by fax, and then by regular mail. - Phone calls were used often, especially when the matter was urgent. - Product documents were sent through direct electronic connection.	- The same as in the PlastCo case.
Inside companies	- Mainly face-to-face and email.	- Face-to-face, email and paper documents.
Documentation		
Company level	- Both ElectroCo and PlastCo had their own electronic archives for documentation, but the archives covered only a small part of the documentation. - Team members had their personal archives, at ElectroCo mainly in electronic form and at PlastCo mainly in paper format.	- Both ElectroCo and PartCo had their own electronic archives for documentation, but they covered only a small part of the documentation. During the case project PartCo moved more information to their internal electronic project files. - Team members had their personal archives mainly in electronic form on their personal computers.
Project level	- No network-level document management or common archives.	- No network-level document management or common archives.

4.3 Communication problems

We identified several communication problems from both case projects based on the information collected in the social process simulation sessions and during the interviews. Most of the problems were similar in both cases, but also some case-specific problems were found. Next, the communication problems will be described in more detail.

4.3.1 Communication problems common to both cases

We recognized four communication problems that were common to both case projects:

1) Lack of common communication and information exchange mechanisms and over- reliance on key individuals
2) Lack of understanding of partners' information needs and information generation
3) Lack of direct contacts
4) Non-working inter-organisational document management

Next, each of these problems will be discussed in more detail.

4.3.1.1 Lack of common communication and information exchange mechanisms and over-reliance on key individuals

In both case projects the biggest problem in the communication was a lack of common communication and information exchange mechanisms. In both projects, inter-organisational communication was heavily dependent on the project managers' ability to share information. Since the project managers were very busy, and the distribution of information was not agreed upon, information did not always move quickly enough and sometimes did not even reach the persons who needed it. Many project members expressed a wish for making all relevant information transparent to the whole project, e.g. through a project repository, instead of relaying the whole information distribution on busy individuals.

4.3.1.2 Lack of understanding of partners' information needs and information generation

The project team members in both projects were not familiar with the partner firm's processes or operating habits. Often the team members did not know what kind of information the partner would need or what kind of information the partner could provide and when. In practice, this resulted in the existing information not reaching the partner needing that information. For example, a project team member from PaintCo complained: "I would like to automatically get all the information concerning painting that the project manager of PlastCo gets from ElectroCo. Now I have to ask for the information and it takes time. One reason for this is that PlastCo does not know what information we need." People at PlastCo, on the other hand, complained about not getting all the relevant information from ElectroCo. Moreover, PlastCo's personnel did not understand why ElectroCo required them to send e.g. a lot of measurement data to ElectroCo.

Understanding of the partners' information generation and information needs would probably increase if the project were more transparent, e.g. the simulation sessions

already increased this transparency. This way the project personnel will get a better understanding of what kind of information the other team members need and where they can get this information.

4.3.1.3 Lack of direct contacts

Some team members in both cases felt that the lack of direct contacts was problematic. Direct contacts were difficult to establish, because they were not encouraged and because the team members did not know whom to contact at the partner company. In the PlastCo case there were almost no direct contacts except for contacts between the project managers. In the PartCo case, the situation was slightly better; also a few other team members than the project managers had direct contacts. However, sometimes in the PartCo case, the messages between two individuals were delivered through three or even four persons. Many team members considered direct contacts an easier way to communicate and hoped that in the future there would be more direct contacts.

4.3.1.4 Non-working inter-organisational document management

There was no working mechanism for document and version management between the companies in either one of the case projects. This led to situations in which it was very difficult to find documents and it was often unclear whether a document was the most up-to-date one. Afterwards, when the project had ended, it was almost impossible to find old documentation.

As stated earlier, none of the companies had a PDM system for project use. All three biggest companies, ElectroCo, PlastCo and PartCo had had their internal electronic archives for documents, but these files did not cover all documentation. Moreover, the documents were not updated frequently enough and it was difficult to locate them. In practice, many project team members had their own personal files, either in electronic or paper format. Usually, it was only the project managers who had all the project documentation in their own files, exhaustive documentation could not be found anywhere else. These kinds of situations were problematic when the project manager was not present, for example, and he or she was the only one who had the document. For the others, it was very difficult, or impossible to find documents from the project manager's personal files. Many project team members would have welcomed a network-level document management system; even an internal system inside a single firm would have been an improvement.

4.3.2 Communication problems specific to the PlastCo case

We found four communication problems that were specific to the PlastCo case:

1) Lack of trust leading to information hiding
2) Misguided use of the information-push
3) Slowness of organisational adaptation to new communication needs of parallel development
4) Late arrival of orders

Next, each of these problems will be discussed in more detail.

4.3.2.1 Lack of trust leading to information hiding

Despite the long history of cooperation between ElectroCo and PlastCo we would not classify the relationship between these case companies as a partnership, since a lack of trust still existed and led to information hiding. Trust was not specifically measured. Instead, the lack of it was determined based on the interviews, where the interviewees told about examples of not daring to give information to the partner. Due to the nature of its business, ElectroCo wanted to prevent any information from leaking out, especially information concerning new products. For this reason the subcontractors were given only the minimum amount of information needed as deemed by ElectroCo – in practice, the subcontractors often received too little information. On the other hand, PlastCo wanted to protect its know-how from leaking to its customer. And to be trustworthy, PlastCo had to be very careful when giving the information they got from ElectroCo to its own subcontractors. Therefore, PlastCo gave too little information to its subcontractors rather than too much.

This atmosphere of a lack of trust and poor sharing of information was stronger than the legal agreements between the companies. For example, a project team member from PaintCo claimed: “I do not get all the documents made by ElectroCo, even though we have agreed about this with PlastCo, because the people in the field do not know about the written agreements and are too afraid to give us the documents”.

In the PartCo case the atmosphere was somewhat more open and e.g. common process improvement programs had been started. However, every issue was not open to discussion, e.g. PartCo did not want to talk about its internal mistakes in the process simulation session while its customer was present.

4.3.2.2 Misguided use of the information-push

In addition to complaining about not getting all the information needed, a few part-time project team members from ElectroCo came out with an opposite complaint: they got too much information via project-wide, intra-company mailing lists. These persons worked on several projects, so they were not interested in all the details they received.

4.3.2.3 Slowness of organisational adaptation to new communication needs of parallel development

The case companies in the PlastCo case had moved fairly quickly from a serial mode of product development to parallel development with early supplier involvement. However, the attitudes and working practices had not changed accordingly. The project team members from the subcontractor’s side were used to getting all the information they needed in one dispatch, after which they could proceed without any customer-initiated design changes. Now, they had to start with preliminary information, with the rest of the information coming in pieces. Moreover, there was a constant risk of changes. A project team member from PaintCo stated: “It would be much easier to get all information in one go.” It was difficult for these people to understand that the situation had changed drastically, now they were taken into the project in the middle of the product development phase, not after it. A mould designer from PlastCo said: “I know that the situation has changed. Anyway, it is difficult to understand that when I have just finished the mould

design, ElectroCo wants to change the design and I have to abandon my earlier work and start it all from scratch, even though I had done the best job I could!"

Despite these obvious problems, also positive comments were heard. For example, a mould specialist commented happily: "Designers from ElectroCo have accepted many of my ideas to change the design to facilitate manufacturing."

These comments show that the good things, such as the possibility to influence the design to accomplish a solution that is easier to manufacture, are easy to accept for the subcontractors. In contrast, the bad things such as changes and not being able to receive all the information at once, are more difficult to understand and accept. Many project team members from PlastCo felt that ElectroCo was simply not considering what kind of trouble the changes caused for PlastCo. These persons were partly right; ElectroCo's designers seldom knew how much work even a tiny change might mean to PlastCo.

The simulation session helped close at least partly this gap of understanding between the partners. We received comments like this: "Now I understand much better ElectroCo and its endless design changes in the beginning of a project".

4.3.2.4 Late arrival of orders

For the subcontractors in the PlastCo case, it was often difficult, sometimes impossible, to write an accurate quotation which had been requested by the customer, because the subcontractors did not have all the information needed to make the quotation. The customer did not have that information either, because there was no one who would have known in the beginning of the product development project exactly what sort of product would finally be produced, how much effort would be needed from the subcontractor, what materials would be needed or what kind of an assembly automation line should be ordered. The subcontractor had to make a lot of estimates that could have fateful economic consequences, because a subcontractor often has to offer too low a price instead of a too high one, in order to secure a deal.

Moreover, for the customer it was difficult to order in advance, because the customer knew exactly what to order only after the actual delivery of the product. According to the process simulation participants, an actual reversal of the order-delivery process had taken place several times in earlier projects between ElectroCo and PlastCo. For example, the order for a mould had arrived from the customer only after the mould had been used in production and the first parts had been delivered to the customer. Also in our case project, the prototype mould had been used before the order arrived. Late orders caused a lot of problems to the subcontractors, who could not send invoices before getting an actual order. This led to a situation where the subcontractors carried a large financial risk, since they could never be entirely certain about actually getting an order for the work already done.

The problem of late orders was very familiar also for PartCo. However, in the simulated project, the problem did not occur in any severe form. The order actually came quite early in the project, which surprised the simulation participants. When they noticed the fact from the process description, they thanked ElectroCo's buyer for his efficiency!

4.3.3 Communication problems specific to the PartCo case

We encountered two communication problems specific to the PartCo case:

1) Too late involvement of some internal functions
2) Slow arrival of change information to some internal functions

Next, each of these problems will be discussed in more detail.

4.3.3.1 Too late involvement of some internal functions

The most striking problem that was found especially in the PartCo case was too late project entry of some of PartCo's internal functions, e.g. painting, manufacturing (both injection moulding and assembly), and automation line design. These functions expressed a need to be involved already in the early phases of the project, in order to be able to influence the manufacturability of the product more.

4.3.3.2 Slow arrival of change information to some internal functions

Some of PartCo's internal functions hoped to get more information about product changes as early as possible. Information about the decided product changes did not always arrive promptly to all internal functions. Some functions had even undertaken unnecessary work because they did not know that they were working with outdated information. For example, assembly automation line designers had once worked for two weeks with old information, not knowing that changes had been made which had a large effect on their work.

4.3.4 Summary of the communication problems

We recognized four major communication problems that were common to both case projects. In addition to those problems, we listed also a few smaller communication problems that were encountered especially in either one of the projects. The communication problems presented earlier are summarized in Table 11.

Table 11. Summary of the communication problems.

Case	Problem	Description
Both cases	Lack of common communication and information exchange mechanisms and over-reliance on key individuals	Communication between the companies was heavily dependent on the busy project manager's ability to share information, which often slowed down the information flow and could cause information shortages.
	Lack of understanding of partners' information needs and information generation	Project participants were not familiar with their partner's process, thus they did not know what kind of information the partner would need or could provide.
	Lack of direct contacts	Team members did not know personnel or their responsibilities at the partner companies. Thus, they did not know whom to contact, nor were they encouraged to communicate.
	Non-working inter-organisational document management	There was no working mechanism for document and version management between the collaborating companies in either one of the projects, which, e.g. made it difficult to make sure that everybody was working with the latest version.
PlastCo case	Lack of trust leading to information hiding	Despite the long-lasting collaboration relationships, the companies preferred giving their partners a minimum amount of information to prevent any information from leaking out.
	Misguided use of the information-push	Project-wide mailing lists provided too much information to those team members working in several projects concurrently, thus finding the relevant information was difficult.
	Slowness of organisational adaptation to new communication needs of parallel development	The companies had recently changed from a serial development mode to parallel development, which required frequent communication also during the development. For many team members it seemed to be challenging to adapt to this change.
	Late arrival of orders	Making accurate offers and orders in this new parallel development situation was impossible. The partners had not figured out how to solve this problem. Thus, the customer often ordered only after the delivery.
PartCo case	Too late involvement of some internal functions	Many of the subcontractor's internal departments were involved too late, thus they could not influence the manufacturability of the product as much they would have liked to.
	Slow arrival of change information to some internal functions	Information about changes did not always arrive promptly to the subcontractors' internal departments, hence these sometime worked with outdated information resulting in unnecessary work.

4.4 Social process simulation as a research method

Social process simulation proved to be successful as a research method. In this section, the experiences of using the method are discussed and compared to other methods used to study communication. Moreover, some guidelines for successful simulations are suggested based on the gained experiences.

4.4.1 The term "social process simulation"

Earlier studies researching process simulation used the terms "simulation game" (e.g. Smeds and Haho, 1995) or "work-flow game" (e.g. Pankakoski, 1998) for very similar simulation sessions to those arranged in this study. In the beginning of this study, we used the term process simulation game as well. However, while preparing for the PlastCo simulation session, that term turned out to be misleading. Some of the simulation participants were surprised when they heard what the simulation was really about after first having heard only the name. The first impression had been for some of them that the simulation was about playing a game, a fun competition with winners and losers. Compared to this expectation, the reality was much more boring; it was really hard work to sit in a simulation session for an entire day and participate actively, even though that can be fun too! When the participants get exited the time really flies.

To avoid misunderstandings, the term "simulation game" was abandoned after the first simulation and the term "social process simulation" was used instead. Social process simulation seemed to be closer to reality. That term received some criticism, as well: "It is not a real simulation when the participants are only discussing what has happened and not really simulating the course of events."

Quite often a simulation is associated with computer simulations only. Social simulation methods are unfamiliar to many. In social simulation human beings are in the leading role instead of computers, even though computers can be used as facilitators. Therefore, to prevent misunderstandings, the term "social process simulation method" used throughout this study, seemed to be the best choice. We hope that it is an illustrative name for the simulation method used. The social process simulation method actually comprises a set of data collection methods, such as a process description session, interviews, and a simulation session. Thus, the term refers to this combination of methods.

4.4.2 Evaluation of the benefits for the research

The social process simulation method offered several benefits for our research, the most important of which were:

1) Access to the companies to collect data
2) Various data collection methods, which made it possible to collect data by using several methods from several sources and at least partially validate the data
3) A good overview of a complicated distributed project

First of all, the largest benefit of the usage of this method, surprisingly, was that it opened the door to the companies. Product developers are often very busy individuals; it might be difficult even to manage to arrange an interview with them, not to mention getting any

information about their often very secret projects. When our case companies realised that the social process simulation method could offer them direct and quick gains, they became very interested and involved in the process. It is quite obvious that research studying communication practices and problems in product development normally aims to give useful research results to the participating companies, as well, independently of the research method used. On the other hand, the benefits e.g. from the interviews may not be seen directly by the participants. Process simulation, instead, offers direct gains, e.g. by teaching the participants the processes, giving them a good overview of the project and by bringing out process development ideas. For example, since the PlastCo simulation session took place in the middle of the project, the project managers presumed that the simulation session would be of immediate benefit to the latter part of the project. In other words, the process simulation provided us an easier access to the companies.

Secondly, social process simulation was an effective and efficient method for collecting and partly validating rich data from several sources and by using several methods. We collected the communication-related data by arranging process description and simulation sessions and by interviewing, collecting documentation, and asking the simulation participants to write Post-it notes and fill in questionnaires during the simulation sessions. Obtaining data from several sources and by several methods provided an opportunity to validate the findings, i.e. to compare the finding received from different sources and through different methods.

Thirdly, by using this method we got as complete a picture of the studied complex distributed projects as possible, in quite a short time. Especially the simulation sessions gave a good overview of distributed projects that would have been otherwise quite difficult to observe.

4.4.3 Evaluation of the benefits for the participating companies

As earlier research indicates (presented in Section 3.2.2.), process simulation sessions are beneficial to the participating companies in many ways. For example, simulation gives the participants an overview of the process and also works as a process intervention method, often leading to improvements in the ways of working.

4.4.3.1 Benefits for the simulation participants

In this study, the participants of the social process simulation sessions expressed that the three most important benefits gained from the simulations were:

1) Getting a broad overview of an inter-organisational product development process
2) Bringing out problems and improvement ideas and discussing them together
3) Meeting other project participants

The first benefit, a broad overview, was mentioned as the main gain from the day in almost half of the answers to the questionnaire in the PartCo simulation. It is clear that especially in a distributed project most team members see only small part of the whole project and providing an overview like this can be an illuminating experience for them. Thus, from this point of view process simulations may be even more beneficial for distributed, inter-organisational projects than they are for intra-organisational projects.

Also, bringing out problems and improvement ideas and discussing them together was clearly one of the benefits for the companies. The participating companies in this study were especially seeking process improvements that would lead to shorter product development. Moreover, they wanted to identify the problems that cause delays. The results from the simulations met their expectations, since multiple problems and ideas were brought out. Most of the problems and ideas were communication-related.

Thirdly, many project team members felt that the simulation was a good opportunity to meet other project participants, especially from the other companies. Many of them, especially in the PlastCo case, had not met each other before, even though some of them had been working together for years.

4.4.3.2 Benefits for future communication

From the communication point of view, the social process simulation method clearly provided the participants with knowledge and experiences, which will facilitate communication later on. Our simulation participants named the following communication-related benefits:

1) Meeting the project participants face-to-face
2) Gaining a better understanding of the information generation and information needs of the participating companies
3) Gaining a better understanding of the communication requirements in the new parallel development environment
4) Gaining a better understanding of the current communication problems
5) Gaining a mutual understanding of the need for a common project document repository

Meeting the other project participants face-to-face was important because many of them had not met before, even though some of them had been working together. Meeting a larger group of partners is useful in two ways. First, after meeting and learning each other's names and roles, it is easier to know whom to contact later on. Second, it also lowers the threshold to contact when you have met the person you are contacting.

The process simulation sessions gave the participants a better understanding of what kind of information the participating companies produce and when, what kind of information they need, and why they need it. Afterwards it should be easier to ask for information. Moreover, the participants understood better why it was important to produce and deliver information to their partners. In the simulated projects it had been sometimes difficult for the subcontractors to understand why a customer wanted to have all kinds of information from them. Likewise, the customers did not always know what kind of information the subcontractors would need from them. The simulation seemed to help the partners understand each other and their information needs better.

The new parallel development situation had changed the information requirements. All the required information was not available for the subcontractors in the beginning of the project the way they were used to obtaining it, since they were involved into the project only in the middle of the product development phase and that information simply did not exist yet. In addition, the preliminary information that the subcontractors were given

could still change many times, which seemed to be very difficult for the team members of the subcontractors' side to understand, especially in the Plastco case. The simulation sessions were illuminating experiences for many of them since they saw the customer's process and really understood that they are working in the middle of the product development phase. The simulation also overturned the subcontractors' former belief that the customer was simply mean and wanted to disturb them by making changes all the time. The customer, on the other hand, could learn during the simulation sessions how much rework one tiny change might mean for the subcontractors.

The simulation participants gained a mutual understanding of the current communication problems as well. Later on it will probably be easier to start solving the problems when both parties understand that these problems exist. In addition, it is quite often one party who can at least partially remove the problems experienced by the other party.

It became apparent in both simulation sessions that the participants desired for a project repository to store the documents and information common for the whole inter-organisational project. After getting a mutual understanding of that need it should be easier to start implementing that kind of a repository.

4.4.4 Evaluation of the weaknesses of the method

The usage of the social process simulation method had some weaknesses as well:

1) A lot of preparation was required for the simulation session to succeed.
2) Most data was collected already before the simulation session, thus the session did not offer as much new data as we had hoped for.
3) Even though several methods were used to study communication, none of the methods observed or recorded the actual communication.

The first downside of the social process simulation method is that it requires extensive preparation to be successful. Each of our simulation sessions required from two to three months in calendar time for the preparations, which included e.g. a planning meeting, a process description session and interviews. This meant almost a full-time job for one researcher. After the simulation session the analysis and feedback to the companies consumed approximately the same amount of time and effort. However, we feel that without this preparation, the simulations could not have been as successful as they were. Thus, this method seems to be more suitable for in-depth case studies than for studying some specific issue from several cases. Moreover, the company participants have to feel that the participation is important for them, otherwise the simulation might not succeed.

Secondly, most of the data was collected already before the simulation sessions, e.g. by interviews. We were actually quite surprised after the first simulation session that it did not offer us as much new data as we had hoped for. The discussions during the simulation sessions complemented the picture we had received during the interviews and the process description session. These discussions also emphasised some issues that most of the participants found relevant. Naturally, the discussions, Post-it notes and questionnaires offered some new data. Thus, even though the simulation sessions were useful from the research point of view as well, the participating team members and the companies

received clearly the largest benefits.

Thirdly, even though we used several methods to study communication in these distributed projects, actually none of the methods observed or recorded the actual communication. This can be seen as one of the weaknesses of using this method for studying inter-organisational communication practices. However, evaluation of the suitability of this method for studying communication practices is not easy. Studying communication practices is always challenging, since a large part of the communication is not documented and the amount of communication in a large project is vast. Hence, getting a good picture of that communication and figuring out the communication practices is demanding. The social process simulation method helped us find out at least some of the most relevant communication practices with a reasonable amount of work compared to the large amount of possible data. Since we did not record the actual communication, but instead only discussed it, there is, of course, a possibility that not all relevant data was gathered. Probably, a few interesting practices were not mentioned, because the participants did not find them relevant or they just forgot them. Thus, this method is not a perfect one for studying communication. Nevertheless, it was good enough for our purposes, and we were satisfied with the results. However, a more thorough comparison of this method with other communication research methods would be needed in order to be able say more about its suitability to study communication.

4.4.5 Some guidelines for successful social process simulations

Based on the experiences from this study, six guidelines for arranging successful social process simulations for research purposes are presented:

1) Benefits for both the research and the participating companies need to be remembered when planning a simulation.
2) The project or part of the project chosen for the simulation has to be suitable both in breadth and depth to reach the simulation objectives.
3) The number of participants has to be chosen according to the objectives.
4) Careful preparation and data collection before the simulation session is essential.
5) In the simulation session, the key stakeholders need to be present and communication should be encouraged.

These guidelines will be explained in more detail below.

When planning a process simulation for research purposes, both the research goals and the goals set for the simulation by the participating companies need to be taken into account. It is easier to get the companies interested by creating a win-win situation. However, you should not forget your research goals either; when the companies get involved they may start leading the simulation only towards their own goals.

Secondly, you need to select a suitable section of a project or a process for the simulation, in accordance to the objectives set. If your objective is to give the participants a broad overview of a distributed product development process, you should select a broader area, maybe even a whole project. Moreover, you need to watch that discussions do not go too deep into details in the simulation. If you want to do process development instead, and

find development ideas to specific problems or processes, then a more limited section should be chosen, so that the discussions can concentrate more on details. Finding the right breadth and depth is not easy and specific advice cannot be given. In the PlastCo simulation, the plan was to simulate a broader area than could be realised: also the latter part of the project from the specification freeze to mass production release was chosen for the simulation. However, a one-day simulation proved to be too short and the final part had to be left out. In the PartCo simulation, the chosen period of the project seemed to be just perfect, the simulation was finished in time and it covered the whole area chosen for the simulation. However, in the PartCo simulation the simulated project area had several very similar change cycles and instead of going through them all, only some of them could have been chosen for deeper examination.

Thirdly, the number of participants should be limited and the participants chosen according to the objectives. In a simulation aiming to give an overview, a greater number of participants can be included. For example, in the PlastCo simulation session we had 41 participants, which was a suitable number for an overview simulation session, but too much for a problem solving and process development simulation session. Because we wanted to have more of a problem solving approach in the PartCo simulation, we limited the number of participants to 25 persons. That seemed to be a suitable number.

Fourthly, the data collection before the simulation has to be done carefully. It is essential to understand the key process areas and the main problems already before the simulation. Otherwise, the project facilitator cannot lead the discussion in the right direction and ask the right questions. If the facilitator does not understand the process, the participants might “forget to mention” important but difficult issues. Moreover, distributed product development processes are often so complicated that without any advance knowledge it might be difficult to make full use of the simulation. Preparation time gives also a good opportunity to collect data for your research purposes. Even though the process simulation sessions were the “main events” in our research, most of the data was collected beforehand. Especially interviews provided a lot of useful data. Thus, the preparatory work for the simulation is essentially important. It is not just a prerequisite for a successful simulation session, but also an important form of data collection. Even though the actual simulation session did not provide as much new data as the preparatory work, it put the pieces of the collected data together, and emphasised the matters important to the whole network.

Fifthly, you should make sure that the key members of the project are present in the simulation session. These key members are often so busy that if they do not see the importance of the simulation they may just regard something else as being more important. However, the simulation cannot succeed if any of the key members are missing. The strength of the simulation sessions is that everyone is present at the same time. It is too easy to blame those not present for all the problems. When everyone is present, the real reasons for the problems have to be discussed and everyone can express his or her opinions. However, in a simulation session some persons are inevitably more quiet than others, or they do not feel they have an opportunity to put forward their views. Therefore, questionnaires and Post-it notes were needed in our simulation sessions to collect also these thoughts. Questionnaires provide an opportunity to get answers to the same questions from all the participants. This is easy, since a simulation is finished only after everyone has filled in a questionnaire. The Post-it notes were meant for the participants to write down and share their thoughts, questions, encountered problems, and

ideas during the simulation sessions. In addition to yielding data, these notes inspired discussion when the simulation participants read each other's comments collected on the wall during the pauses. The facilitator's task is to activate the participants to start writing these notes. We noticed that it is important that many Post-it notes are written already in the beginning of the simulation, since this lowers the barrier to write them.

4.4.6 Comparison to other research methods used to study communication

There exist several research methods that are used to study communication in organisations. The communication studies presented in our literature review also used many different methods when studying communication and collecting communication data. We chose five studies that used somewhat different methods to collect data for closer examination. These studies are presented in Table 12. Four of the studies (Kidane and Gloor, 2005; Sosa et al., 2002; Moenaert et al., 2000; McDonough et al., 1999) examined communication in distributed projects, mainly concentrating on intra-company communication. The fifth study (Allen, 1984) looked at communication inside organisations, even though some inter-organisational aspects were studied as well. The studies collected both qualitative and quantitative communication data. Four of the studies used face-to-face or telephone interviews during which data was collected, e.g. by asking open-ended questions (McDonough et al., 1999) or filling in forms (Sosa, et al., 2002). Some of the studies complemented the interviews by collecting documents (Moenaert, et al., 2000) or sending questionnaires after the interviews (McDonough, et al., 1999). Allen (1984) had noted when planning his study that there were no suitable techniques that could be applied to achieve his goals, thus he had to develop the methods on an ad-hoc basis. He used several data collection methods, e.g. he asked the respondents to fill in communication logs about their communication on certain days. These logs could then be used to build social network diagrams of the communications. Kidane and Gloor (2005) built network diagrams, as well. Their data was based on email archives that were collected and analyzed using software tools.

As we can see, several different methods to collect communication data already exist. In addition to the methods mentioned the literature suggests e.g. group interviews, structured observations and laboratory experiments. Moreover, researchers can invent their own ways to collect information, if a suitable method cannot be found, like Allen (1984) had done. However, none of the above- mentioned studies had concentrated on studying communication especially in inter-organisational projects, which was the scope of this study. The company borders brought additional complexity to our study, which affected also the choice of the method.

When planning this study, we considered using existing data collection methods, but the interviews and the collection of communication logs that we suggested, did not convince our case companies. They saw that using these methods would merely disturb their work and not give any direct, quick benefits, even though the companies saw the potential for long-term benefits. Furthermore, our contact persons in the case companies believed that persuading the busy developers to contribute their time to the study would be difficult. Allen (1984) had probably faced similar problems. He mentions that because the participants of a study can be offered benefits only in long-range terms, the cost of participation should be reduced to an absolute minimum.

Table 12. Example studies using different communication data collection methods.

Authors	Subject of the study	Research subjects	Data collection
Allen, 1984	Phase 1: Information consumption patterns of R&D projects. Phase 2: Information entering and flowing through an R&D organisation.	Phase 1: Twin project approach, 33 project teams. Phase 2: 13 laboratories, altogether hundreds of professionals.	Phase 1: R&D personnel filled in time allocation forms daily and solution development record forms weekly; interviews of R&D personnel and tape-recorded progress reports by managers. Phase 2: Weekly questionnaires on randomly chosen days asking about communications during that day.
Kidane & Gloor, 2005	Studied how temporal communication patterns in the Eclipse open source community correlate with performance and creativity.	3 main projects of Eclipse open source community, mailing list archives of 33 component development groups.	Social network data was collected from online mailing lists and data about bugs and enhancements was collected from bug databases. The social network data was analyzed using a software tool developed by the writer's research group. This tool can present communication networks in graphical form.
Sosa, Eppinger, Pich, McKendrick & Stout, 2002	Studied how different factors, such as geographical distance, influence technical communication in distributed product development.	3 development teams in different multinational corporations, altogether 255 respondents in 30 facilities.	1-3 hour interviews during which both qualitative and quantitative questions were asked and a form filled. Respondents were asked, e.g. about the persons they communicate with, to rank the importance of communication, to estimate the communication frequency and media used, and to describe the content of the communication.
Moenaert, Caeldries, Lievens & Wauters, 2000	Communication requirements and capabilities of international innovation teams.	4 case studies of European multinational corporations.	Interviews with teams inside the firms, as well as with outside parties, such as subcontractors. Document collection, e.g., reports, brochures and project notes.
McDonough, Kahn & Griffin, 1999	Studied several aspects of communication in global product development teams	10 firms using global product development teams, altogether 22 respondents	1-hour phone or face-to-face interviews using open-ended and possible follow-up questions. Faxed questionnaires about the usage and the importance of different kinds of communication mechanisms and technologies.

When we compared these other communication studies and the methods they used to our research method, social process simulation, we found both similarities and differences. Interviews and questionnaires that were used both in our study and in several other communication studies are quite traditional ways to collect data about communication, whereas process description sessions and simulation days that were used in our study are new ways. The combination of these data collection methods and especially the simulation days made the difference when compared to the earlier methods: the study participants could receive direct, quick benefits from our research in addition to long-range benefits. Understanding these benefits lowered the companies' barrier to participate in this study. We saw this as one of the major benefits of the social process simulation

method when compared to the other considered data collection methods. Moreover, the process description sessions and the simulation days benefited our study by giving the researchers a good picture of these complicated, distributed, inter-organisational projects. For these reasons the simulation method seemed to be useful especially for studying this kind of projects. A negative side when compared to other methods is the large amount of work that the arrangement of the simulation days requires. In addition to that, the arrangement of a successful simulation day requires commitment from the participating companies; otherwise it cannot succeed. In summary, the simulation method both combined earlier data collection methods and introduced a few new data collection methods. Social process simulation benefited both the research and the participating companies, when applied for studying complicated projects. In that kind of projects getting an overview and understanding the cause and effect relationships could otherwise be quite difficult.

4.5 Summary

This chapter presented results from Study 1. First, the case projects, research methods and empirical data were described. Second, the communication practices, such as communication through project managers; direct communication between team members about details; communication through a resident engineer; project meeting for change management and problem solving; and meeting memos as the main source of information, were described. Third, the encountered communication problems, such as a lack of common communication and information exchange mechanisms and over-reliance on key individuals, a lack of understanding of the partners' information needs and information generation, a lack of direct contacts and non-working inter-organisational document management were described. Finally, the experiences of the use of social process simulation as a research method were discussed. The method was found to be quite useful to study communication in distributed projects, but also weaknesses were recognized.

5 Second study – Software development

This chapter presents Study 2. The used research method is described first, and then the achieved results are presented. The results include a subcontracting project type classification, a communication need classification, and the collection of communication practices and problems.

5.1 Research methods and empirical data

5.1.1 Case projects

To this second study we aimed to select inter-organisational software development projects that demand constant collaboration and communication between the parties, e.g. because of a high degree of uncertainty, dependencies and changing requirements. We expected that especially this kind of projects would benefit from successful communication practices.

We used purposeful sampling (Patton, 2002) and selected the case projects according to several criteria. Some criteria we had already in mind when choosing the projects for Study 1, and some arose from our experiences during Study 1. The six criteria used when selecting the case projects are listed next. Of these six criteria inter-organisational distribution and concurrent development were the most important ones when choosing the case projects. An obvious criterion not mentioned in the list was the choice of industry, i.e. software development.

1) **Inter-organisational development:** At least two different companies, a customer and a subcontractor or subcontractors are involved in the project.

   → Collaboration across company borders is needed.

2) **Concurrent development:** Both the customer and the subcontractor develop software at the same time.

   → Communication and collaboration are needed.

3) **Uncertainties:** The project has some uncertainties, e.g. regarding the requirements and technology and/or the division of the work cannot be perfectly specified in the beginning.

   → Communication and collaboration are needed.

4) **Ongoing or recently finished:** The project is ongoing or recently finished.

   → Easier for the interviewees to remember the practices used.

5) **Success and previous subcontractor usage:** The customer company has been successful in its field and has been using subcontractors already for some time.

   → Possibility to identify successful communication practices.

6) **Global distribution:** If possible, also the global distribution aspect between or inside the companies exists.

   → Communication and collaboration is challenging.

We started our search for suitable case projects by choosing first the customer companies. We selected nine companies that developed software, used software subcontractors, were successful in their field, and that we expected to be experienced in inter-organisational software development. Together with our first interviewees from each company we chose the case projects; from one large company we picked two projects (Alpha1 and Alpha2) and from the rest of the companies one project each. We selected different project types: two projects developing a new software product (Zêta and Thêta), three projects developing a new version of a software product (Omega, Gamma and Epsilon), two projects building a new product with embedded software (Alpha1 and Alpha2), one project developing a new version of a product with embedded software (Delta) and two projects building a new customer specific system (Beta and Êta). The case projects are briefly presented in Table 13. They are listed in the same order in which we selected the projects and conducted the interviews. Table 14 describes how these case projects fulfilled the case selection criteria presented earlier. Later on, the customer companies are seen as the main partners, which hire the subcontractors or subsidiaries for the project. Thus, by customer we do not mean a possible external customer, who might buy the end product or use the developed system, but does not participate in the development work. When referring to that kind of an external customer we will use the term end customer.

We studied in-depth the first software development project, Omega. Thus, more project participants were interviewed also from the subcontractor companies. In that case we also tried email interviews with persons who were working such long distances away that we were not able to travel for face-to-face interviews. Unfortunately, we noticed that the interviewees gave short and imprecise answers in emails, thus these answers were not useful for our study. After this experience we preferred interviewing only face-to-face. Consequently, in the rest of the projects it was impossible for us to interview participants from distant countries, where we could not afford to travel. Mainly for this reason, the team members and subcontractors could not be interviewed in all cases. When possible, we interviewed several persons also from the subcontractor. In project Zêta we interviewed three persons from the subcontractor, since the subcontractor had internal distribution between Europe and Asia, which was interesting from the communication point of view. In project Thêta we interviewed several persons from two foreign subsidiaries. In four projects the number of project managers interviewed was more than one, since also some subproject managers were interviewed. The numbers of interviewees from each case project is listed in Table 16.

Table 13. Descriptions of the case projects

Case name	Description of the case project	Industry and type of sw	Distribution and # of sites
Omega	*Case Omega* was a project, whose aim was to develop a new version of an old software product. The customer company owning the product did not have enough in-house resources for the development work. Therefore, it hired two Finnish companies to do the main part of the development: a one-man company and a small firm using development resources from Hungary and Nepal, and having project management in Finland.	Security – a new version of a software product	Finland (3), Hungary (1), Nepal (1)
Alpha1	*Case Alpha1* was a development project of a new product with embedded software. The project was carried out by the same Finnish customer company as in Study 1 (ElectroCo). This project contained a lot of uncertainties regarding the requirements and technology. The customer company had involved in this project two of its own sites, one in Finland and one in the US. In addition, it had hired a Finnish subcontractor with sites in Finland and Hungary to develop a module that had many connections to the work done by the other sites. The project was a subproject of a larger product program.	Telecom – a new product with embedded sw	Finland (2), USA (1), Hungary (1)
Alpha2	*Case Alpha2* was a development project of a new systems product with embedded software. The customer company was the same as in case Alpha1, as well as in Study 1 (ElectroCo). The project had a lot of uncertainties concerning the requirements and technology. The German office of the Finnish customer company did this project with the help of two new subcontractors, one from Germany and one from Ireland. The German subcontractor had two offices participating this project and the Irish subcontractor had part of its staff collocated with the customer in Germany and part in Ireland. The project was a subproject of a larger product program.	Telecom – new systems product with embedded sw	Germany (3), Ireland (1)
Beta	*Case Beta* was a project developing a new, quite well-defined customer specific system to a Finnish end customer, that itself was not participating in the development work, but had ordered the system from a Finnish software house. This software house had three of its own Finnish sites involved in the development. In addition, its subsidiary in Estonia and a subcontractor with two sites in Finland participated in the project by several small tasks.	Customer specific SW – a new customer-specific sw system	Finland (5), Estonia (1)
Gamma	*Case Gamma* was a project developing a new version of a software product. A Finnish customer company used a Russian software subcontractor in its projects on a long-term basis. In this project the subcontractor was given the development responsibility of certain modules.	Security – a new version of a sw product	Finland (1), Russia (1)

Delta	*Case Delta* was a subproject of a larger product program developing a new version of a systems product with embedded software. The customer company had three of its own sites in Finland participating in the project, and one site in the US. A Finnish subcontractor company did a small, quite independent subproject and also provided developers to work in the customer's premises as extra resources.	Telecom - a new product, with embedded sw	Finland (4), USA (1)
Epsilon	*Case Epsilon* was a project developing a new version of a software product. A Finnish customer company had two of its own sites in Finland and one offshore site in Malaysia. These internal sites developed mainly the core product. A subcontractor from Turkey participated in the development by developing small, quite independent additions to the core product.	Construction – a new version of a sw product	Finland (2), Malaysia (1), Turkey (1)
Zêta	*Case Zêta* was a product development project carried out by a small Finnish company. This customer company did the main part of the development work. It had hired a Finnish subcontractor company that had a wholly owned subsidiary in China. The subcontractor had sales and project management resources in Finland, whereas the subsidiary in China provided development resources for coding and localizing the product to the Chinese market.	Telecom – a new sw product	Finland (2), China (1)
Êta	*Case Êta* is a set of small ongoing development projects of customer-specific systems. The projects were carried out by a small Finnish company, which had its sales and project management in Finland. All development work was performed in two partly owned companies in India. Since the projects were quite small, we interviewed about practices used in all of the ongoing projects.	Customer-specific SW - Internet based customer specific sw systems	Finland (1), India (2)
Thêta	*Case Thêta* was a large new product development project carried out by a Finnish company. Additional resources were assigned from its newly acquired subsidiaries in Denmark and Switzerland. This was the first time these new subsidiaries were involved; therefore they were more like new subcontractors. Both of these foreign offices worked on their own modules that had many interconnections with the rest of the product. In addition to a new product, this project was at the same time developing a customer-specific implementation together with one external customer having sites in four Nordic countries.	Finance – a new software product and a customer specific-implementation	Finland (1), Denmark (1), Switzerland (1), and several external customer sites in Nordic countries participating in the customer-specific implementation

Table 14. Fulfilment of the selection criteria.

Criterion	Fulfilment of the selection criteria
1) Inter-organisational development	Our first eight case projects involved at least two different companies. However, we decided to include the two last case projects, cases Êta and Thêta, even though in both projects the subcontractors were not external companies, but the customer company's subsidiaries instead. In case Thêta, the two involved subsidiaries were newly bought and this was the first joint project with them. Both of these subsidiaries were used more like subcontractors in this project. In case Êta, the two partly owned subsidiaries had been used already for sometime. The main reason for including this case was the distribution of the work between Finland and India, which is both challenging and interesting from the communication point of view. In a way, both of these cases have inter-organisational distribution between the customer company and the subsidiaries.
2) Concurrent development	In all the projects both the customer and the subcontractor developed the software at the same time. However, in cases Êta and Thêta the concurrent development took place between the customer and the subsidiaries.
3) Uncertainties	All the software development projects that we chose had at least some uncertainties regarding the requirements and technology and/or the division of the work. However, cases Beta and Êta did not have as much uncertainty as the other projects. In case Beta the requirements were already quite well specified beforehand. In case Êta the projects were quite small, only a few person months of effort, and the technology used was quite similar between the projects.
4) Ongoing or recently finished	All the case projects were still ongoing.
5) Successfulness and earlier subcontractor usage	All the chosen customer companies had been successful from a business point of view as measured in growth and profits. Eight of the companies were also quite large and well-known in Finland. Only Zêta and Êta were still quite small emerging companies. All the customer companies had used subcontractors already in earlier projects.
6) Global distribution	All of the case projects had sites at least in two different countries. Six of the projects were distributed onto two different continents.

5.1.2 Interviews

We performed 55 semi-structured interviews, and in Case Omega, also 4 email interviews. In each customer company we interviewed, if possible, both a partnership manager responsible for software subcontracting, and a process developer involved in developing the process used between the customer and subcontractor. In some cases, the partnership manager and the process developer were the same person. From each case project we interviewed a project manager, in four cases also subproject managers and, if possible, also one or more team members and one or more representatives from the subcontractor company. These roles and the main focus in the interviews for each role are presented in Table 15 and the number of interviewees in each case project in Table 16.

The interviews lasted from two to three hours. We reserved three hours with an interviewee if he or she had several roles in the project (e.g., subcontracting responsible and process developer), he or she had promised to familiarize us with the project, or we knew already beforehand that this person would probably have a lot to tell us, e.g. because of his central role, or broad experience. Otherwise, we reserved two hours for each interview.

Table 15. Roles of the persons interviewed.

Role	Who?	Interview focus
Partnership manager	The partnership manager is a person responsible for either all software subcontracting in that company or collaboration with a specific set of subcontractors. In smaller companies this is not a separate role, but a part of some other manager's job.	We asked the partnership manager e.g. what kind of software subcontracting the company uses, and why it uses subcontracting. If this person was close to practice, we asked him also about the processes and practices used with the subcontractors. With the help of this person we chose a suitable case project and our next interviewees.
Process developer	The process developer is a person who develops the company's processes and the processes used with the subcontractors. In smaller companies this role was combined with some other roles.	We interviewed the process developer about the processes and practices that are used with the subcontractors.
Project manager	This person works as a project manager or subproject manager in a case project.	We interviewed a person having one of these roles about the collaboration and communication practices used in the case project, especially between the customer and the subcontractor, but also between the company's internal sites. We probed also about the communication problems encountered.
Team member	This person works as a case project team member in the customer company.	
Sub-contractor	Normally we interviewed at least the subcontractor's project manager or team leader. In a few cases, we were able to interview also some team members.	

Table 16. The number of interviewees in each case project.
(= email interviews, ** = subsidiary)*

Case Projects	Interviews					
	Partnership Manager	**Process Developer**	**Project Manager**	**Team Member**	**Sub-contractor**	**All**
Omega	2		1	2	5 + 4*	14
Alpha1	1	1	2	-	1	5
Alpha2	2	1	1	-	-	4
Beta	1	1	3	1	1	7
Gamma	1	1	1	-	-	3
Delta	1		2	1	-	4
Epsilon	1		1	1	-	3
Zêta	1		1	1	3	6
Êta	1		1	-	-	2
Thêta	1	-	3	2	5**	11

The interviews were semi-structured and open-ended. We had prepared four versions of the same questionnaire, a slightly different one for each of the four roles. A questionnaire for project managers can be found in Appendix 3. The questionnaire served mainly as a checklist during the interview to make sure that all relevant topics were covered. In the interviews we asked the interviewees to quite freely describe the practices they used in their projects and the experiences they had gained. We did not have any ready-made

categories of practices that we were looking for. Instead, we tried to encourage the interviewees to describe also practices and experiences that we might not think of asking.

Two researchers participated in all interviews. One of the researchers was responsible for asking questions and leading the interview. The other one took detailed notes and also added some extra questions when needed. In addition to taking notes, we tape-recorded all the interviews using a computer and an external microphone. Later on we had the interviews transcribed. We took notes during the interviews for several reasons. Firstly, we wanted to read through the notes from the earlier interviews before conducting the next interviews of the same case project to be able to remember and understand the case project better before new interviews and to uncover any issues worth asking. Secondly, reading through the notes and finding interesting topics would help us improve our questionnaire and include new topics also during the study. Thirdly, we could start the early analysis of the data with the notes. We could identify easily at least some of the most interesting topics by reading through the notes. That way we could also identify suggestions for codes, which would make the starting phase of the data analysis easier. Fourthly, we could give the participating companies feedback on their project more quickly based on the notes and without having to wait until transcriptions and thorough analysis of the interviews was ready. Finally, the notes were used as a backup in case something would go wrong with the recording. Fortunately, all the recordings succeeded.

5.1.3 Data analysis

As Miles and Huberman (1994) recommend, we analyzed the data in parallel with the data collection. The analysis can be divided into three steps: preparations for analysis, analysis during the data collection, and analysis after the data collection. These steps are presented next.

5.1.3.1 Preparations for analysis

The notes were typed out after each interview. Whenever it was possible we tried to do this within 24 hours after the interview to be able to still remember what was said during the interview. The reason for this was that the notes were often made in a hurry with short sentences, which might be difficult to understand correctly later on. Before our next interviews, we skimmed through the notes from the previous interviews in the same case project to be able to remember and understand the case project better and to uncover issues that might be interesting to include in the questions.

All Finnish interview recordings were transcribed by a student who was not otherwise involved with the study. To help her work we gave her some of the key terminology. Quite often also Finnish-speaking interviewees used special English terminology, which was sometimes difficult to understand for an outsider. After we got the transcriptions, we listened to all the recordings and at the same time checked the transcriptions to make sure that everything was transcribed correctly. In two case projects, Omega and Thêta, some of the interviews were held in English (in Omega two interviews and in Thêta five interviews). These English interviews required a lot more work to transcribe word for word than the Finnish interviews, thus we decided that for cost reasons we would not contract out the transcription, but instead write detailed notes of these interviews with the help of the recordings.

5.1.3.2 Analysis during the data collection phase

We started our analysis by reading through the notes. We had promised to arrange a feedback session after the interviews of Case 3 (Omega) to all the participants of that case project. We made this first analysis based on the interview notes, since the transcription took time and the companies hoped to get feedback quite soon after the interviews.

During and after cases 4-10 (Alpha1, Alpha2, Beta, Gamma, Delta, Epsilon, and Zêta) we read the interview notes and the transcriptions, arranged the material into categories using copy-paste technique and finally started to use a piece of qualitative data analysis software called ATLAS.ti for coding and grouping of the data. During the coding a set of codes, arising from the data, gradually took a shape. Based on this analysis, we gave feedback to the participating companies and wrote papers. Using the same analysis methods after cases 11-12 (Êta and Thêta), we gave feedback of Case 12 (Thêta) to all the participants of that project.

5.1.3.3 Analysis after the data collection

When all the interviews were finished, we decided to code all transcriptions (Miles and Huberman, 1994; Patton, 2002). During the earlier analysis we had received a good picture about the material as well as suggestions for final coding. Based on these suggestions, we created seven main codes and several subcodes under each main code. The main codes were: subcontracting project type; problem solving; peer-to-peer links; informing, monitoring and feedback; relationship building; collaboration process; and communication problems.

Having developed this coding scheme we wanted to go through all material once again to ensure uniform coding. This time, for practical reasons, we did not use ATLAS.ti, one of the reasons being the researcher's preference of reading from the paper instead of the computer screen. Thus, all the transcribed interviews were printed, read through and coded by hand. The seven main codes were marked by different colour strike-out pens and the subcodes by text in the margin. During reading and coding the interviews, more subcodes were added and the earlier codes improved. The coding was entirely based on the interviews, the codes arising from the data.

After the coding, all the coded material was read through, some subcodes were combined, and all important observations and quotations were picked out and grouped under each main code. The final results were formulated in writing based on this grouping of observations and quotations.

5.2 Identified subcontracting types

The customer companies in our case projects used several types of software subcontracting. In the interviews with partnership managers of the customer companies we asked especially about the subcontracting types these companies used. In addition to that, all other interviews complemented the picture, particularly regarding the subcontracting types of the chosen case projects. Based on the interviews, we classified the subcontracting types found in the customer companies of our case projects into four types:

1. Resource hiring
2. Independent subcontractor teams
3. Transparent box
4. Black box

With help of the partnership managers we chose the case projects according to the criteria presented earlier. From these four project types especially the second and third types, independent subcontractor teams and transparent box, suited our selection criteria. Nearly all our case projects were found to belong to these two types, as will be explained later on. The case projects were selected after discussing the project types with the partnership managers.

This classification is based on the subcontracting types found in the companies we interviewed. All these types represent projects where a customer company develops software with a subcontractor company. Many customer companies used several subcontracting types, and each of the types seemed to be suitable for a slightly different situation.

This classification can be seen as one result of this study. Its main purpose, however, is to clarify what kind of subcontracting types we studied. We hope that describing the studied project types in detail helps generalize the findings of this study. We expect that these four subcontracting types have differing communication needs and that a different collection of communication practices suits each of them.

Figure 10 presents the four subcontracting types according to how broad tasks the subcontractor is given at the time, and how the project management responsibility of the subcontracted tasks is divided between the companies. Next, the subcontracting types are described in more detail. Finally, our case projects are classified according to their subcontracting types.

5.2.1 Resource hiring

This type of subcontracting is also typically called “body shopping”. It is probably the easiest option of these four subcontracting types for the customer to start with. It does not require the application of any special collaboration practices, since the customer preserves all project management responsibility. Often these resources do not significantly differ from the customer’s own workers. The resources sit either at the customer’s or the subcontractor’s premises, and the task allocation and communication typically follow the routines and processes of the customer. The resources bring flexibility. They are used

when extra resources or some special competences are needed, but the customer does not want to outsource the whole subproject.

Most of the customer companies of our case projects used resource hiring. They felt that it was safer than hiring their own extra resources, since it is usually easier and quicker to stop using subcontractors, if the situation changes, than to fire in-house personnel. In these customer companies typically half or even more of their subcontracting was resource hiring. However, the companies commented that their aim was to increase the use of the other types of subcontracting and at least slightly reduce the proportion of resource hiring while the total share of subcontracting was rising.

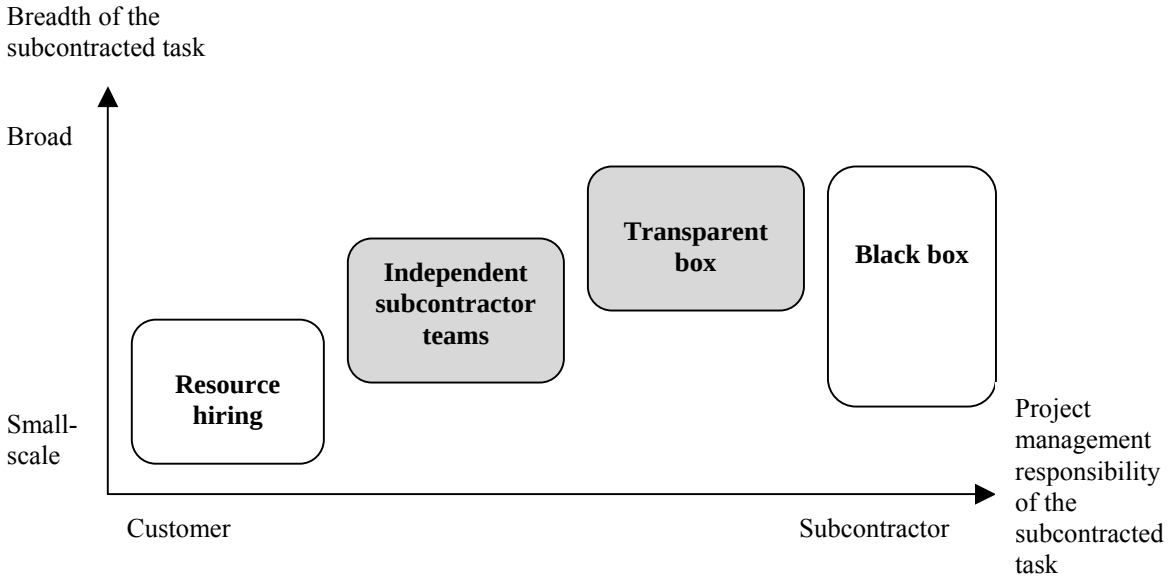


Figure 10. Subcontracting project types. This study concentrated especially on communication in the two middle types.

5.2.2 Independent subcontractor teams

The subcontractor's teams or teams from a remote site are often taken on to the project as independent sub-teams. They are given independent and quite well-defined tasks with lengths from a few weeks to a few months. The teams are often hired for a longer time period, e.g. for the duration of the whole project, during which they do several independent tasks. The subcontractor might be given several small and quite clearly defined tasks during the project. However, the tasks the subcontractor receives will probably have many dependencies to other tasks and modules, thus some communication and collaboration is required also during the execution of the tasks.

The reason for customers to hire these teams was that the customers needed resources with some specific expertise, but often they could not define any larger modules for the subcontractor in the beginning. Instead, the requirements could be defined only for smaller tasks at a time. Thus, the tasks were only given in smaller pieces. These teams had internal project management responsibility and also a team leader or a project

manager from the subcontractor. The payment was typically arranged on hourly or piecework basis.

5.2.3 Transparent Box

The subcontractor is given a large module to develop, but there is a lot of uncertainties in the requirements and changes are expected. Therefore, a lot of cooperation and communication between the companies is needed during the project. In transparent box-type subcontracting the subcontractor is typically involved in the project right from the beginning and may well have some responsibility in the requirements specification phase. The subcontractor has a project manager of its own and also internal project management responsibility. Payment may be arranged, e.g. by various risk and profit sharing solutions, or on an hourly basis. Although we here refer to this kind of subcontracting as transparent box, some companies used the term white box subcontracting instead.

This subcontracting type was used when the requirements were uncertain, the customer wanted to buy specific know-how, and also give some of the project management responsibility away. For our research, transparent box subcontracting seemed to be the most interesting mode of subcontracting, since it is very challenging from the communication point of view. It seems to require more collaboration and communication between the companies than the other subcontracting project types.

The customer's project manager in case Gamma described how they had divided the work in their transparent box-type project:

> **Quotation 1:** "We have three main components [in this product] and we have divided it so that the subcontractor has one component and we have two. (…) this subcontractor has only one component but they have an own architect and subproject manager for this component. The team there has their own small project which is part of this larger project and this has proven to be an extremely suitable solution." (Customer's project manager, Gamma)

The customer's project manager in case Alpha2 explained that they might need a lot of experimenting in their projects, thus there will be changes affecting the project partners, as well. The changes, of course, require intense communication:

> **Quotation 2:** "We might know what we want to build but we don't know how to accomplish that. We might try to do it in one way and if that does not work, then we have to try something else. If we change something in our parts, it might require changes to parts that our subcontractors do." (Customer's project manager, Alpha2)

In case Alpha1 the subcontractor was given a large module to develop. The subcontractor's project manager explained to us that for them this project type meant transparency concerning each other's work and quite intense collaboration:

> **Quotation 3:** "White box is that we see what others are doing, we are told what we are supposed to do. We are allowed to plan and make suggestions and together with others we can plan common interfaces." (Subcontractor's project manager, Alpha1)

5.2.4 Black Box

The subcontractor is given an independent module to develop with specified requirements. The size of the module is often quite large, but a small module is possible as well. The subcontractor has to have good project management knowledge, which in turn decreases the customer's need to continuously monitor the progress of the subcontractor's work. The requirements and specifications need to be clear and only few changes are expected. Critical dependencies with the development of other modules are not expected and a well-defined, modular product architecture is preferred. In this kind of a project a lot of cooperation or communication is not expected between the companies.

The companies found this project type challenging, since the requirements need to be quite well-defined and stable for the project to be successful. The advantage is that when the requirements are well-defined the subcontractor can work quite independently and, e.g. use its own processes. The payment was typically arranged on the piecework basis.

The customer's subcontracting responsible in case Alpha1, described this project type:

> **Quotation 4:** "In black box type projects the number of dependencies should be low and specifications can't change much during the project." (Customer's subcontracting responsible, Alpha1)

5.2.5 Case projects classified according to subcontracting type

We classified the chosen case projects according to their subcontracting types using the classification presented previously. Not all projects were typical examples of one specific type; instead, some of them had characteristics from two or even three types. However, we tried to place each of them to the most suitable project type. In three projects, Beta, Epsilon and Êta, we found independent subcontractor teams-type subcontracting. In six projects, Omega, Alpha2, Alpha1, Gamma, Zêta and Thêta, we encountered transparent box type-subcontracting. We tried to choose especially projects that used one of these two types of subcontracting for this study. However, in project Delta the subcontracting types used were closer to resource hiring and black box subcontracting. When choosing this project, our contact persons from the customer company claimed that they had the kind of subcontracting that we were looking for. During the interviews we quickly found out that their current subcontracting was clearly resource hiring, and in addition to that the subcontractor did small black box-type projects, during which some collaboration between the companies was needed. The tasks were quite clear from the beginning and changes were not expected. However, we decided to conduct all the interviews and include also this project into the study, since the project was internally distributed between the continents, and thus challenging from the communication point of view, and some interesting points about subcontracting came up as well.

Most of the customer companies used several kind of software subcontracting in their projects. Only two customer companies, those in projects Zêta and Êta, used only one type of subcontracting. The probable reason for this was that these companies were quite small in size and could not invest in several types of subcontracting.

In projects Thêta and Êta the collaboration took place between the customer company and its partly owned foreign subsidiaries. However, we classified also these projects according to their subcontracting project types. In both projects the collaboration and

communication between the customer and the subsidiary/subsidiaries resembled very much the collaboration in our inter-organisational projects. Thus, we wanted to classify also these projects according to the subcontracting type they most closely resembled. In project Beta the customer company collaborated with one subcontractor and one subsidiary. The customer company used similar practices with both of them and the subcontracting project type regarding both was also the same, independent subcontractor teams. Table 17 presents the classification of our case projects according to their subcontracting type.

Table 17. Case projects classified according to subcontracting types.

Symbols: ● *= The subcontracting type used in the case project.*

○ *= The subcontracting types the project's customer company also uses.*

Project type	Omega	Alpha1	Alpha2	Beta	Gamma	Delta	Epsilon	Zêta	Êta	Thêta
Resource hiring	○	○	○	○		●	○		○	
Independent subcontractor teams		○	○	●	○		●		○	●
Transparent box	●	●	●		●			●	●	
Black box		○	○			●				

5.2.6 Selecting a subcontracting type

When interviewing the customer companies of our case projects about their early steps in software subcontracting we noticed a similar pattern in several companies. Quite often the companies starting to subcontract tried the first or the last subcontracting type first, i.e., they bought resources, or tried to outsource modules as black boxes. However, typically the customers were not ready for black box subcontracting, since the requirements were not stable enough or the customer just could not state them clearly enough, and therefore did not get what it wanted. Buying resources seemed to be a safer alternative for a beginner. We noticed that a few companies that had failed in black box subcontracting moved to hiring resources, since they became scared of giving any project management responsibility out of their own company after a failure. The customer companies of projects Omega, Beta, Gamma, Delta and Epsilon had these kinds of experiences of starting with resource hiring or black box subcontracting. Later on, these companies have tried also the other types of subcontracting.

The two subcontracting types in the middle (Figure 10), independent subcontractor teams and transparent box, seem to require subcontracting knowledge from the customer company and common working practices between the companies, otherwise the project has a high risk of failure. The two smallest companies in this study, Zêta and Êta, used the subcontracting types in the middle, even though the companies were, due to their young

age, still beginners in subcontracting. Both of these companies were in a way exceptional, since they really invested time and energy in order to get the subcontracting to work. They developed the needed practices during their collaboration with the subcontractors and the persons participating their projects were determined to make the collaboration work. Many larger companies in this study had not yet totally understood how much effort it really requires to build highly successful subcontracting projects.

This project type classification cannot be seen as a continuum, where companies should start from resource hiring and aim to reach black box subcontracting. Instead, it could be used to select a subcontracting type that is suitable for the needs of each project. In our study we noticed that the companies experienced in subcontracting used several subcontracting types, since different types are suitable for different purposes and projects. Even in the same project, several subcontracting types can be used with different subcontractors. Most of the companies did not seem to consciously analyse the project and decide the subcontracting type(s) to be used based on this, even though that might have been beneficial. Among our case companies the customer company of projects Alpha1 and Alpha2 used all four subcontracting types. That was also the only company that had started to distinguish and name the different types of collaboration with the subcontractors.

Even though some companies might dream of black box-type projects, where quite independent modules can be separated for different partners to develop, in real world the projects are often very complex and have many dependencies. Thus, they require a lot of communication between the parties during the project. A customer's partnership manager in Case Alpha2 expressed this difference between the dreams and the current reality in most projects:

> **Quotation 5:** "Typically, our aim is that the subcontractor's role would be as independent as possible. In an ideal world I would give the specification to a subcontractor and say: "do this" and after half a year they would come back with a ready made product, which is like a lego brick, that I can just put into my system and it works. But in practice, in this industry the products are very complex. (…) It is very challenging to separate that kind of an independent module. In practice, in all our projects subcontractor's work is very much connected to our own work." (Customer's partnership manager, Alpha2)

We believe that this subcontracting type classification can help companies better understand their subcontracting projects and to choose suitable project types for their needs. When a specific project type is selected it also has an effect on the communication needs of the project and on the communication practices suitable for the project. Software subcontractors offering their services might also find this classification useful when profiling their expertise and designing collaboration with their customers.

In this study we concentrated on communication practices in projects that used independent subcontractor team-type or transparent box-type subcontracting, since these subcontracting types demand more cooperation and communication between the customer and the subcontractor than the other project types. Thus, the practices we will present later on are especially suitable for these two project types, even though the practices may as well be useful for other kinds of projects.

5.3 Communication needs

We wanted to get an understanding of the communication needs of inter-organisational distributed product development projects during this study. We aimed to find different reasons for communication; if we understand why communication is needed it is easier to establish suitable communication practices to fulfil these needs. Thus, knowing the communication needs forms a basis for planning the communication in distributed projects. Moreover, recognizing the often neglected communication needs will, we believe, help managers pay more attention to these important needs in the future.

Collecting the active communication practices and understanding the communication needs of our case projects took place at the same time. Our goal was to classify the identified communication practices according to the communication needs that they best satisfy. During the data analysis, the classification of communication needs and communication practices affected each other.

The most important communication needs that we recognized in our case projects between a customer and a subcontractor / subsidiary were:

1) Problem solving
2) Informing
3) Monitoring progress and providing transparency
4) Giving feedback
5) Relationship building

This classification is based on the data collected from our case projects. We encountered all these communication needs in all the projects we studied. However, the importance of each need and the suitable communication practices that satisfy the needs depended on both the type and the phase of the project. For example, communication for relationship building is needed especially in the beginning of a project and it is most important in projects where the collaborating parties do not know each other beforehand. Quite often, however, relationship building was at least partly neglected, which caused problems later on, the contact persons not being known and trust between the parties lacking. Other important but often neglected needs were problem solving and making the current project situation transparent to the partners and to the company's own distributed sites.

Next, we will discuss each identified communication need in more detail.

5.3.1 Problem solving

Problem solving communication was noticed to be very problematic in most projects. This type of communication was often not planned beforehand – in many of the projects problems just emerged and thereby also the practices to solve them. However, in all our case projects this kind of communication was definitely needed, since problems and questions appeared all the time. Problems and questions are difficult to avoid in distributed software development projects, since the requirements can rarely be specified up-front at the level of detail that would be needed. Moreover, the projects, such as our case projects, face a lot of uncertainties, e.g. regarding changes and new technologies.

If the channels for problem solving communication are not agreed in the beginning of the project, it might take a long time before the problems are solved and this can delay the whole project. When no suitable communication practices exist, the project team members easily spend a lot of time just trying to find a person who can help them, wasting both time and energy. In addition, the barrier for the subcontractor's personnel to contact the customer can be high even when having serious problems. This can easily lead to a situation in which the problems are brought up too late, whereby they are both difficult and expensive to solve. We think that managers planning distributed software development projects should definitely pay attention to this communication need already in the planning phase of the project.

5.3.2 Informing

Informing is a quite an obvious communication need in a distributed inter-organisational project. The subcontractors need a lot of information from the customer to be able to accomplish their tasks. The interviewed subcontractors explained that in the beginning of the project they need information, e.g. about requirements, work division, used technologies, project schedule, etc. During the project they need information about changes, bug reports, problems, etc. Moreover, the subcontractors wanted to get more background information and hear also the reasons behind the decisions they were given and that concerned their work. The subcontractors, in turn, needed to inform the customers, e.g. about problems and changes.

In our case projects it was problematic for the customer to know what kind of information the subcontractor would need. Moreover, the customer easily forgot to inform the subcontractor about the decisions and changes made, or the new documents produced. On the other hand, the subcontractors did not know what kind of information existed, thus it was difficult for them to ask for some specific information or document.

Clearly, informing is required in both directions, from the customer to the subcontractor and the other way around. Informing is needed both in the beginning of the project and also during the project. Informing during the project seemed to be more difficult, since in a distributed project, information just does not diffuse in coffee rooms, as in collocated projects sometimes. Instead, all information needs to be purposefully distributed, which requires planning and naming someone responsible to do it.

Many things that were "informed" also provided monitoring information, created transparency and even provided feedback. Therefore, informing, monitoring, providing transparency, and giving feedback are difficult to separate from each other.

5.3.3 Monitoring progress and providing transparency

The customer needs to monitor the progress of the work that the subcontractors and the distributed sites are performing. In our case projects this communication need was quite well taken care of. The customers' project managers and subproject managers saw it as important to monitor how the subcontractor's work was progressing.

In parallel development situations in which the work of the various sites and partners is strongly interconnected, it seems to be important to have status information flow not only

from the subcontractor to the customer, but also the other way around. In many projects we studied this communication need was disregarded. However, the subcontractors' personnel and other distant sites would have liked to get information about the progress of the whole distributed project. In addition to helping the personnel at distant sites to accomplish their tasks, this information would have motivated them, e.g. to adhere to the schedule, if they had known why it was important. The personnel at the subcontractor's sites or the company's own distant sites were very interested in the status of the larger project they were parts of. Of course, in some projects the project progress was made at least somewhat transparent to the subcontractors and other project team members. Even so, most of them hoped to get even more information.

5.3.4 Giving feedback

All the subcontractors we interviewed expected to get feedback from their work, e.g. about the quality of their work. If they had received any feedback, they appreciated it very much, no matter whether it was negative or positive. Getting negative feedback about mistakes or bugs was appreciated as well because later on it would be easier to avoid the same mistakes from reoccurring. Positive feedback was, of course, always welcomed, even though normally the customers forgot to give it.

Giving feedback to the subcontractors was a communication need that was often neglected. None of the subcontractors felt they received enough feedback. However, getting feedback seemed to be a motivating factor for the subcontractors. Thus, giving more feedback would probably be beneficial to the project.

The customers seldom expected to get any feedback from the subcontractors. Of course, some customers collected a kind of feedback in the end of the project from their subcontractors during the lessons learned-sessions. Still, receiving feedback from the subcontractors did not seem to be as important to the customers as receiving feedback from the customers was to the subcontractors.

5.3.5 Relationship building

When starting a distributed inter-organisational project it is quite common for many of the persons participating in the project not to know each other beforehand, as was the case also in many of the projects we studied. Relationship building seems to be especially important in distributed software development projects for the collaboration to succeed, otherwise there can e.g. emerge prejudices towards the subcontractors resulting in the information not being shared. Relationship building-type of communication is often a part of almost all communication. However, we wanted to separate this need, since this kind of communication is critically needed in distributed projects to build trust and cooperative relationships between the parties.

Communication is more difficult in a distributed project than in a collocated one. It is normally easier to communicate with a person that you have met at least once. Therefore, when starting a distributed project with several partners and sites that have no common history, having all the involved personnel meet face-to-face was suggested by some of our interviewees as an optimal solution, even though that was not always possible to arrange. Early face-to-face meetings also facilitated subsequent electronic communication.

Moreover, it seems to be important that distant sites and companies have ”faces”. Otherwise they were easily forgotten and e.g. their questions were not regarded as important and urgent. Trust between the parties would make collaboration in a distributed project easier. However, trust develops slowly and preferably in face-to-face situations, which are rare in distributed projects. Building a good relationship with the subcontractors also requires that they are treated more like partners and experts in their field, not like second-class citizens, as we sometimes observed. In our case projects also the subcontractors wanted the projects to be as successful as possible.

The relationship building aspect clearly needs to be remembered when planning the communication in a distributed project.

5.3.6 Summary and discussion of communication needs

Table 18 lists the communication needs encountered in our case projects between the customer and the subcontractor, and presents the direction of the communication that in our case projects was used to satisfy each communication need. Moreover, in that table we compare the needed amount of communication to the current situation in our case projects. Finally, the last column gives a suggestion for the importance of each communication need in distributed software development projects. The aim of this table is just to give an indication of what kind of communication is needed and to present some comparisons between the needed communication types that we encountered in our case projects. We did not specifically ask our interviewees to evaluate e.g. the need of each communication type, or their relative importance. Instead, the observations were gathered up from different parts of the interviews. This discussion could also give some ideas for future research. Next, the importance of each communication need in the case projects and the amount of communication needed is briefly discussed.

Informing was clearly the most important need in our case projects, since without information from the customer the subcontractor could not have done anything. That communication need was quite well taken care of, even though especially the customer sometimes forgot, did not understand to, or did not want to inform the subcontractor. Problem solving communication was the second most important communication need in these projects, since there were a lot of uncertainties questions and problems came up frequently. However, this need was not taken care of so well. Quite often problem solving communication found its channels when the situation was serious, even though that kind of communication was not planned beforehand. Thus, the success of problem solving communication rested in the hands of the responsible individuals. It seemed that the customer company did not always understand the importance of this communication.

The monitoring of the subcontractors was quite well arranged in most projects, but communication to the other direction, i.e. providing transparency to the subcontractors and distributed sites was often neglected. Giving feedback to the subcontractors was frequently neglected, as well. All subcontractors hoped to get more feedback than they currently received. Relationship building seemed to be apart of all communication, thus it was at least partly taken care of. Most often the companies thought about this communication need only when there were problems. Several interviewees hoped that in the future the companies would pay more attention to relationship building communication already in the beginning of the projects.

Often neglected communication needs, such as problem solving communication, providing transparency, relationship building and giving feedback, were communication needs that gave information especially to the subcontractor and motivated the subcontractor's personnel. It is probable that the customers simply did not see the importance of motivating the personnel there. However, to build even more successful distributed projects, also that aspect could be considered.

To summarize, there seemed to be a lot of space for improvement regarding the neglected communication needs. Especially the subcontractors needed more information and feedback from the customers.

Table 18. Summary of the communication needs in our case projects.

Communication need	**Direction (S = subcontractor, C = customer)**		**Needed amount vs. current situation**	**Importance in distributed SW projects**
Problem solving	**S** ⟷ **C**	- Interactive communication - Most often subcontractor asks and customer answers	- Higher need - Customer sometimes neglects	Very important
Informing	**S** → ← **C**	- Mostly one-way communication - Most often customer informs, sometimes also subcontractor	- Current amount quite ok - Sometimes forgotten	Very important
Monitoring progress and providing transparency	**S** → ← **C**	- Mostly one-way communication - Customer collects monitoring information from subcontractors and provides them transparency to project progress	- Monitoring ok - Providing transparency often neglected	Quite important
Giving feedback	**S** ← **C**	- Mostly one-way communication from customer to subcontractor - Subcontractor might also give feedback to customer	- Higher need - Customer often neglects	Useful
Relationship building	**S** ⇄ **C**	- Mostly interactive communication - Is part of all communication	- A bit higher need - Budget limits face-to-face meetings	Quite important

5.4 Communication practices

One of our main findings and the most surprising result of this study was that the customer companies of our case projects did not have clear organisation-wide communication and collaboration practices that would have been commonly used in their inter-organisational software development projects. Only a few companies had started to plan collaboration practices for these kinds of projects. These companies had so far taken into use only a few practices to their distributed inter-organisational projects.

The communication and collaboration practices we encountered were mainly project-specific and created by trial and error, i.e. when the project faced difficulties a new practice was created and taken into use. The practices used were planned and agreed upon already in the beginning of the project only rarely. This lack of planning caused problems later on. Even many basic project management guides recommend preparing a project communication plan first, e.g. the PMBOK® Guide (Project management institute, 2000). Even so, that just did not seem to be a common practice in our case projects.

Most of the practices found and presented here might seem quite basic. Nevertheless, even these simple practices seemed to be very useful in the projects they were used. Each project used at least a few communication practices that they themselves saw as useful. Unfortunately, most of the projects we studied used only a few diffuse practices, even though we believe that many problems could have been avoided by gathering a suitable set of practices to each project already in the early phases of the project.

During this study we asked our interviewees to describe both the useful communication practices and possible communication problems encountered in their projects. Thus, the successfulness of each practice was determined by subjective opinions of our interviewees who used those practices in their projects. Quite often we noticed that our interviewees complained a lot about problems, but the practices that seemed to work well were only mentioned in passing and did not receive much praise, unless we asked. One of our interviewees commented on this:

> **Quotation 6:** "It is the same as with processes in general, that when there are problems you will notice them, but when they work fine, you don't pay attention to them." (Customer's project manager, Alpha2)

The identified communication practices are presented next. First, we will present two groups of practices that are related to the collaboration process used and to the establishment of peer-to-peer links between companies. The collaboration process in this context refers to the software development process used in the inter-company collaboration. Process-related issues have quite a significant impact on the communication between the partners. Similarly, the creation of links between persons from the collaborating companies influences all communication. The rest of the practices are grouped according to the communication needs that they satisfy. Some of the communication practices seemed, at least partly, to satisfy several communication needs. The description of each practice has been placed under only one communication need, the one it best satisfies. In this study, we named as a practice all communication-related practices that had been used at least in a somewhat similar form in a minimum of three different projects

The description of each communication practice starts with a table presenting key information about the practice in a compact format: the name of the practice, the problem

the practice aims to solve, the description of the practice, the variations of the practice, pros and cons, the studied projects where the practice was identified, the communication needs it at least partially aims to satisfy, and closely related other practices.

5.4.1 Collaboration process

In all our case projects the partners collaborated closely with each other. The process model used in the collaboration between the partners is called here the collaboration process. In this context it basically means the software development process that is used when collaborating between the companies and distributed sites. In addition to the common collaboration process, each partner or site may have its own, more detailed process model for its internal use. Most of the collaboration between the partners actually happens in the form of communication. Thus, process-related issues have quite a large effect on the communication practices, e.g. they influence when and what kind of communication takes place and is needed. Next, some process-related issues that largely affect inter-organisational communication are discussed.

5.4.1.1 Synchronization of the main milestones

Before the collaboration with the partners or subcontractors really starts, the companies need to determine what is the software development process that the collaborating companies will use. Quite often the customer company determines the process to be used. It can simply give the subcontractor its process description saying: "This is our process, use it". This was the case in some of the projects we studied. However, it seems that it is not always necessary to enforce the same process. In our study, we found a few successful projects in which both the customer and the subcontractor used their own development processes in their collaborative projects. Only the main phases and milestones were synchronized between the companies. In particular, in cases where the subcontractor already had a well-functioning process in place, this seemed to work well. A few customer companies that we interviewed said that when they notice that a subcontractor has a good and functioning process in use, there is no reason to change that. Instead, letting the subcontractor use its own process makes starting the collaboration quicker, because the subcontractor does not have to learn a new process. However, the main milestones and project phases need to be synchronized between the collaborating companies. For example, the companies can have the same name for the main project phases even though every company's internal processes inside these phases differ, as was explained by the customer's process developer from project Alpha1:

> **Quotation 7:** "When you understand that these two are the same [when comparing the process descriptions between the customer and the subcontractor], but it is stated differently, then we could agree that we jointly name that phase and call it this. It gives a basis for having a common process which both parties have described in more detail." (Customer's process developer, Alpha1)

This synchronization is, of course, much easier if the collaborating companies use a similar software development process, i.e., the main process phases are similar. For example, when the customer uses an iterative process model, it is preferable that the closely collaborating subcontractors also use an iterative model with iterations of similar length, as will be described later on in connection with the "frequent deliveries" practice. When using an iterative process model, the iteration cycles and deliveries can be the

milestones that are synchronized. Internally, each company can then use its own software development practices. Figure 11 presents a simplified picture of the processes and their synchronization, when building the product at certain intervals.

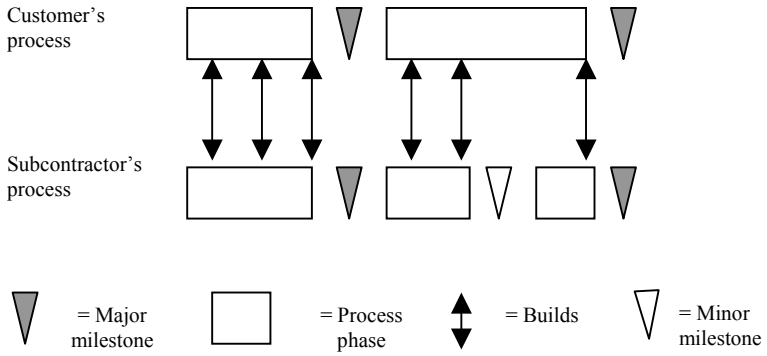


Figure 11. Synchronization of the main milestones

Synchronization of the main milestones affects inter-company communication by making the collaboration process more transparent to all participants and directing the communication to certain process points. Especially, the milestones are often points where a lot of communication takes place.

Between the milestones the collaborating companies may use their own processes and practices internally. A customer company's subcontracting responsible from project Alpha2 emphasized that if a subcontractor company has its own good internal working practices, normally it can continue using them. The most important thing, according to her is, of course, that the work progresses. However, if the subcontractor does not have practices, then the customer enforces the practices of its own processes and requests that these are used. A customer company's process developer from project Alpha1 went even further by commenting, that if the subcontractor has really good practices to suggest, then the customer should try to learn from its subcontractor.

5.4.1.2 Practices related to the collaboration process

The practices related to the collaboration process, that we encountered in our case projects were: *process walkthrough* and *frequent deliveries*. These practices will be discussed in more detail below.

PRACTICE 1: Process walkthrough

The key observations related to this practice, process walkthrough, are summarised in Table 19.

Table 19. Summary of Practice 1: Process walkthrough.

Practice name	Process walkthrough
Problem the practice aims to solve	How to ensure that participants from different organisations and also team members from the same company have a uniform understanding of the process phases, milestones and key terminology?
Practice description	The face-to-face process walkthrough aims to give all project participants a common picture of the collaboration process and terms used.
Variations	Instead of one common walk-through, several site-specific walkthroughs, or a walkthrough for key persons can be arranged. In addition to the process phases also the practices used can be discussed during the walkthroughs.
Pros	Helps create a common understanding quite quickly.
Cons	Face-to-face meetings require travelling.
Projects where used	Alpha1, Alpha2, Gamma and Epsilon
Communication needs	Informing, relationship building
Related practices	Kick-off

Some of our case projects had noticed that regardless of the process model in use, it was important to arrange training or at least to discuss about the chosen process model with all project participants in the beginning of the project. According to interviewees from projects Alpha1, Alpha2, Gamma and Epsilon it is not enough just to give a process description in the written form, instead, a face-to-face process walkthrough seems to be the best alternative. These projects had arranged a process walkthrough meeting/meetings either in the beginning of the project or during the project after facing some process-related problems. The aim of the process walkthrough is to give all the participants a common picture of the collaboration process and the terms used. Many of our interviewees emphasized the importance of a common language and common terms. They had noticed that different partners and even team members from the same company did not have the same understanding, e.g. of the names of the process phases and the milestones, or the same terminology. Sometimes the problem seemed to be that everybody thought that they had a clear idea of what a term meant, but it then turned out that others had a slightly different meaning for the same term. The customer's project manager from project Gamma gave the term "beta release" as an example. In their project the subcontractor's personnel had quite a different understanding on what "beta release" meant regarding the required quality level, than what the customer understood by that. When the difference was noticed, it was of course discussed, and a common understanding found. However, the different understandings can cause a lot of harm before they are noticed.

The process developer from project Alpha2 explained us that in the beginning of a new project it is useful to reserve a day or two for just having discussions with all the team members about the process phases, how the different tasks are related to each other and

about the practices used. This does not have to be arranged as one meeting, but if needed, it can be divided for example to several site-specific meetings. Even though the process and practices used would be exactly the same as in the earlier projects, according to him it is still, useful to do the walkthrough once again, since as time goes on good practices are easily forgotten and weathered away.

In project Alpha1, the collaboration process used between the companies was mainly given by the customer, but the subcontractor could internally use its own processes and practices. In that project the customer company arranged training for a few subcontractor's key persons on the customer's process. The aim was that these persons could then distribute the information inside their own company. The customer's process developer commented on their reasons for arranging these trainings:

> **Quotation 8:** "It helps you to eliminate the possible future problems, when we understand each other better from the beginning." (Customer's process developer, Alpha1)

PRACTICE 2: Frequent Deliveries

The key observations related to this practice, frequent deliveries, are summarised in Table 20.

Table 20. Summary of Practice 2: Frequent deliveries.

Practice name	**Frequent deliveries**
Problem the practice aims to solve	How to monitor progress in a distributed project and ensure that the modules made by different sites are compatible?
Practice description	Frequent deliveries of code usually from the subcontractor(s) and the distributed site(s) to the customer. They are most useful when the code is integrated and tested right away. Used in connection to an iterative and incremental process model.
Variations	The length of the suitable delivery cycles can vary between the projects, project phases, and project participants. Short delivery cycles (1-2 weeks) and using the same delivery cycles across sites seemed to work best.
Pros	Gives feedback and transparency of the progress to all project participants. Ensures correct understanding of the requirements and reveals the problems early. Avoids the problems of "big bang integration" in the end.
Cons	Planning and execution requires quite a lot of work, communicating and training to succeed.
Projects where used	Omega, Alpha1, Alpha2, Gamma, Delta, Êta andThêta.
Communication needs	Monitoring progress and creating transparency, giving feedback.
Related practices	-

The use of frequent deliveries from the subcontractors and distributed sites to the customer seemed to be a suitable practice for distributed use. The frequent deliveries were mainly deliveries of code. Our interviewees told that when the delivered code was integrated and tested right away this gave a good picture on how the project was progressing. Frequent deliveries normally meant that the whole project was using an iterative process model. Of course, frequent deliveries can be required from a subcontractor also when using a more traditional process model, as was done in project Beta. In such cases, the deliveries could consist e.g. of draft versions of various

documents in the early phases, and code and test cases later on.

Seven projects that we studied, Omega, Alpha1, Alpha2, Gamma, Delta, Êta and Thêta used an iterative process model with frequent deliveries of code from the subcontractors or distributed sites or both. In project Beta the customer required that the subcontractor and the subsidiary deliver code quite frequently, even though the project did not use an iterative process model. In the seven case projects using an iterative process model the deliveries normally contained functioning code, which was integrated into a build and tested. The iteration and delivery cycles used varied between the projects and also between the project phases, e.g. in the beginning of the project they could be longer and later on, in the intensive development and testing phases shorter. This was the case e.g. in projects Omega, Alpha1 and Alpha2. The shortest delivery cycle used in several projects during the most intensive development phases was one week. These once-a-week delivery cycles were used e.g. in projects Omega, Alpha1, Alpha2 and Gamma. In the end of many projects, during the testing phase, deliveries of bug fixes could come even on a daily basis. Also other cycles, such as once in two months or every two weeks, were used.

Delivery synchronization. In an inter-organisationally distributed project, the different partners might have different delivery and integration cycles. However, according to our case projects synchronizing the delivery and integration cycles between the project participants seems to be beneficial. For example, in project Alpha2 the original plan was to use the waterfall model, but after some quality and schedule problems the customer company and the Irish subcontractor started to use an iterative development model with weekly builds. However, getting used to this new weekly rhythm was not easy. Our interviewee commented that after practicing this weekly rhythm for two years it had started to work quite well. Especially coordinating the work between different teams and specifying the work well enough required learning. The customer tested each build once a week for one day and after that everybody got this tested build as a new baseline. During the early phases of iterative development the teams learned that it was better to develop only small additions at a time to avoid problems. The German subcontractor in that same project delivered at longer intervals, only once in 1-3 months. This caused additional work in the integration phase, because the amount of new code was large and not always compatible with the baseline. Finding bugs from 1–3 months' worth of work was not easy. In this project, the baseline was available to everyone through a common repository or its replica. This made it possible for all partners to test their new code against the baseline before integration. The customer's project manager emphasized the importance of using the rhythm with all parties:

> **Quotation 9:** "It has become very clear that if you can synchronize the way of working between you and your subcontractor and operate with the same rhythm, it helps a lot. When you live with the same beat, it makes communication so much easier! (…). If you don't work with the same rhythm, then you have to invest in understanding the interfaces and pay attention that you understand the problems that it causes. It is not absolutely necessary that you have the same rhythm, but then you have to be able to control all those difficulties it causes. We have not always paid enough attention to this." (Customer's project manager, Alpha2)

Similar problems regarding the delivery cycles of different length were faced in project Alpha1. In that project two sites, the subcontractor and the customer's Finnish site, used normally two-week iteration cycles and at fastest, when fixing bugs, they had even weekly iterations, but the customer's US site delivered only once every two months. This led to problems for the subcontractor, since it ended up waiting up to two months for fixes

from the customer site using longer iterations. The Finnish subcontractor in project Alpha1 described the situation:

> **Quotation 10:** "Our customer company let their US site deliver to us once every two months. We were required to deliver once a week. When we noticed that something was missing, we had to wait for two months. (…) We complained about that, and finally they changed to this same once-a-week delivery cycle, but it took all too long [to do this change]. (…) This was one of the biggest mistakes made in this project. Our average times for bug fixing were somewhere between two and three months [before the change]. (…) Our situation was quite chaotic. We were asked about the schedules, e.g. when something would be ready. We had bugs, tens of bugs, that depended on the module that the customer's US site was delivering us every two months. We couldn't know beforehand whether their bug fix would really fix it or whether there would be some interesting side effects. Our scheduling was ruined. We got all the complaints because we were the subcontractors. It was all our fault." (Subcontractor's project manager, Alpha1)

Finally, when the deliveries were synchronized the delivery chain was the following: The customer's US site delivered on Thursdays to the subcontractor, who integrated the delivery with their own code, and tested and delivered the package to the customer's Finnish site on Mondays. The customer built the whole software and tested it, and on Tuesdays or latest on Wednesdays delivered the whole build to all sites. The only exception was the subcontractor who received only a part of the build, since for security reasons the customer did not want to deliver the whole product. This delivery cycle was repeated normally every two weeks. According to our interviewees this chain started to work fine.

Other examples of using frequent deliveries. Project Êta used frequent deliveries from the Indian subsidiary to the Finnish site mainly for communication and project monitoring purposes. This quite a small project developed a customer-specific system for an outside customer that did not participate in the development, but only provided the requirements and commented when needed. The Finnish office negotiated the requirements with the customer, made a requirements specification document and delivered it to India. The Indian project manager commented on the requirements by email and asked detailed questions. The Finnish project manager answered the questions by email and discussed difficult issues through chat. The aim was not to create a perfect specification, since the project's customer could not provide that. Instead, the project was specified to such a level of detail that the Indian team could develop an initial version of the system. After the delivery of this initial version the Finnish project manager commented on it. And then, after some improvements, also the outside customer commented on the system. The project had several of these comment-improvement rounds. During the whole development, the Indian developers were encouraged to ask questions through chat from the Finnish project manager. He was also able to monitor the project progress by reviewing the code that the Indian developers checked in to a repository located in Finland several times a day. This well-functioning communication and delivery process was used in all projects between this customer and its Indian subsidiary.

Project Beta used frequent deliveries when designing and implementing a large customer-specific system. The requirements were quite stable and well-known. The customer company divided the work into small tasks and specified e.g. all windows and services in detail. These well-specified tasks were then given to a subcontractor, to a subsidiary or to the internal sites for implementation. The specification work and coding took place at the same time. Both a subcontractor company and an in-house subsidiary received tasks for

2–3 weeks at the time. When the tasks were done, a delivery was made, and new tasks were assigned. The problem with this way of working was that the delivered functionality had dependencies to another functionality, and the customer company tested these deliveries only after all the related functionality was ready. Therefore, getting the test results could sometimes take as long as half a year after the code delivery. Clearly this project could have benefited from better design and synchronization of the deliveries.

Normally, the deliveries of code started when there was something to deliver. In project Thêta the Finnish project manager had planned the project so that there were checkpoints before the real code deliveries from the Swiss subsidiary. First, he arranged a design review of the first few use cases designed in the subsidiary, and then a code review of the implementation of these use cases. Only after this could the real code deliveries start. This way of working seemed to function very well according to both parties.

Benefits from frequent deliveries. Our case projects had gained several benefits from using frequent deliveries in distributed software development. Frequent deliveries are actually one form of communication, since they e.g. provide useful monitoring information and transparency to the real situation in the project. Some benefits encountered in this study are listed below:

- *Visibility of progress*. Frequent delivery cycles and integration provided transparency of the work progress to all partners. When both the customer and the subcontractor used an iterative process model, the subcontractor regularly delivered functioning code during the development phase e.g. monthly or even weekly. Our interviewees told that when the deliveries were integrated and tested right away this gave a good picture of how the project was progressing. They had noticed that frequent deliveries made it easier for the customer to monitor the real progress of the subcontractor's work. It was actually easier to see the real situation in the project from a functioning code than from the progress reports

- *Instant feedback.* Integration and testing reports gave distributed developers instant feedback on their work, which they felt was very motivating. Moreover, when the customer saw that the subcontractor was doing a good work, the customer's personnel started to trust and respect the subcontractor and its developers' know-how, which made further collaboration easier.

- *Flexibility.* From the customer's point of view this way of development brings additional flexibility, when the customer can do changes also during the development phase without time-consuming negotiations with subcontractors. Of course, a suitable type of contracting has to be chosen. It also enables the customer company to take the subcontractors into the project already in the early phases of development, when the requirements cannot yet be specified in detail. With this kind of development process it is no longer necessary to specify all the requirements before the subcontractors are involved; instead, since the requirements are allowed to change during the project, the work can start despite technological or goal-related uncertainties. However, this requires all parties to have "an experimental mindset" and quick and open communication with each other.

- *Ensuring understanding of the requirements.* Frequent deliveries, integration and testing ensured that the subcontractor had understood the requirements correctly.

This is a typical uncertainty in distributed development, especially when the companies have not worked together before and have different cultures. Frequent integration and testing gave quick feedback, any misinterpretations became visible early, and possible misunderstandings had less damaging consequences. Moreover, learning from mistakes was instant and happened early, thus preventing problems from accumulating and creating situations that are more difficult to resolve.

- *Avoiding "big bang" integration.* Finally, frequent deliveries and integration prevented the different sites and partners from doing too long periods of independent development in our case projects, which could have led to modules that would be difficult or impossible to integrate, i.e. they avoided possible problems that would come from "a big bang integration".

5.4.2 Establishment of peer-to-peer links

Establishment of peer-to-peer links between the collaborating companies seemed to be crucial in distributed projects. Most of the communication between the collaborating companies took place between these "link persons" who were either named to their communicating roles, or who had just noticed after a while that they had ended up in that kind of a central communication position. According to our interviewees making the effort to create these links is really worthwhile: communication improves and becomes more rational.

5.4.2.1 Direct communication vs. links

The choice between encouraging persons to contact team members from a collaborating company directly, and directing the inter-company communication through only a few links named in advance came up in several projects. There did not seem to be any clear answers to this problem. The best choice seems to depend on many things, e.g. the size of the project, the type of the project, the phase of the project, and the product related dependencies. One of our interviewees, a customer's partnership manager from project Alpha2, described this problem quite well:

> **Quotation 11:** "If you try to limit the communication interfaces [between the subcontractor and the customer], e.g. by ordering that all communication should go via project managers, then there is a risk that the project managers will become a bottleneck. If there are urgent matters and too many issues to solve at the same time, the project manager just simply does not have enough time for all communication. In a larger project, with many technical specialties, the project manager is probably not a technical expert who even could solve those problems. On the other hand, if you allow free communication, meaning that just anyone from the subcontractor could contact anyone from our company, then there is again a risk that communication breaks out of our hands. If just any two persons could make agreements, which are not documented, then no one knows what happens and where." (Customer's partnership manager, Alpha2)

This company had tried to solve the problem by naming some technical experts from both the subcontractor's project team and the customer' project team, who can then discuss technical issues together.

Project phase. Many projects had noticed that in the beginning of the project only a few high-level communication links between the companies were needed when discussing about the requirements, for example. During that phase the project managers and some

technical experts could take care of the inter-organisational communication and convey information inside their companies. Moreover, during the early project phases the team members from the participating sites and companies seldom knew each other beforehand, which also prevented communication at that phase. During the development phase more direct links were needed in our case projects, and direct communication was encouraged especially in the integration and testing phases, since having too long communication chains just slowed down the communication. For example, in project Omega, the subcontractor's Finnish project manager wanted to control all communication between the customer and the subcontractor's foreign development teams, which was in a way understandable. The customer, however, felt that this person was more likely to block communication in the intensive development phases, and thus the customer started to communicate directly with the development teams. This actually seemed to be a good solution in that project phase with a lot of problems to be solved. In most of the projects, the team members were both allowed and encouraged to communicate directly at least in the integration and testing phases, when quick problem solving was needed.

Project size. In the biggest projects at least a few other communication links, besides the project managers, were clearly needed. Otherwise the project managers would become the communication bottlenecks. For example, the customer's project manager from project Epsilon commented that in addition to the project manager there needs to be at least one technical expert who communicates with the subcontractor. Similarly, in project Alpha2 the customer had named a few technical experts as contact persons that the subcontractors' personnel could contact. This kind of a practice was used also in other larger projects; normally several links between the companies were established.

In smaller projects, a few different practices were tried. For example, project Thêta allowed uncontrolled communication between the customer and its Danish subsidiary. It did not work, since there were no clear communication responsibilities, almost anyone could give new tasks to the subsidiary and sometimes no one informed the subsidiary about changes etc. With the Swiss subsidiary the customer tried a stricter approach, only the project managers between the companies communicated. The subsidiary's project manager e.g. collected questions from the developers and if they could not be solved internally, he sent them to the customer. This model actually worked quite well in this small project. A similar approach was used in another small project, Êta, between the Indian subsidiary and the Finnish customer. Mainly the Indian project manager communicated with the Finnish project manager, but all the Indian developers were allowed to contact the Finnish project manager directly if needed. In another small project, Zêta, the only communication links in the beginning of the project between the companies were the project managers, but during the development also direct contacts were needed. The project managers encouraged direct communication and introduced the developers to each other when they noticed that messages tended to remain in their mailboxes and the time-zone difference further slowed down the communication.

5.4.2.2 Practices related to the establishment of peer-to-peer links

The practices related to the establishment of peer-to-peer links that we encountered in our case projects were: *the creation of peer-to-peer links at three levels*, *the creation of role descriptions*, and naming *visiting engineers*, who among other things can create contacts and pass information. These practices will be discussed in more detail next.

PRACTICE 3: The creation of peer-to-peer links at three levels

The key observations related to this practice, the creation of peer-to-peer links at three levels, are summarised in Table 21.

Table 21. Summary of Practice 3: The creation of peer-to-peer links at three levels.

Practice name	**The creation of peer-to-peer links at three levels**
Problem the practice aims to solve	How to ensure efficient communication between the collaborating companies on all organisational levels and to avoid long and slow communication chains?
Practice description	The creation of functioning communication links between distributed organisations at three different organisational levels, management, project, and team levels, in the initial phase of the project.
Variations	The number of links depends on the project phase and size: the execution phase requires more links than the initial phase. In a small project only a couple of links between the organisations may suffice, whereas in a large project several links are useful to have, especially between experts.
Pros	Communication seems to improve and become more rational. Quick communication, instead of long and slow communication chains.
Cons	Having several communication links may be difficult to manage, especially if roles and responsibilities are not defined properly.
Projects where used	Alpha1, Alpha2, Gamma, Epsilon, Zêta and Êta.
Communication needs	Monitoring progress and creating transparency, giving feedback, problem solving.
Related practices	Creation of role descriptions, visiting engineer, relaying contacts and questions.

From our case projects we found peer-to-peer links between persons from the collaborating companies on three different organisational levels: on the management level between the subcontracting managers or similar, on the project level between the project managers, and on the team level between individual developers.

Projects Alpha1, Alpha2 and Gamma had well-functioning links between the roles on all these three levels. The other studied projects had different combinations of links, and all the projects had links at least between the project managers from the collaborating companies. The customer company's process developer from project Gamma told us how they had arranged these three levels of links:

> **Quotation 12:** "Now communication runs smoothly, because I think that we have found the way that works well. Our product development manager and the subcontractor's managing director discuss together higher-level issues, then program and project managers discuss together and finally software engineers and developers discuss directly using either IRC or email." (Customer's process developer, Gamma)

Thus, having links on three different organisational levels seemed to work fine in that project, as well as in projects Alpha1 and Alpha2. Some other projects, such as Thêta, that did not have functioning links between all these levels faced problems. The smallest projects, Zêta and Êta did not have separate management and project levels, since in these small projects the same persons took care of the tasks on both levels. To summarize, according to our data it seems that having functioning links between the collaborating companies on all these three levels is beneficial.

Management level links. On the management level, the collaborating companies needed peer-to-peer links between persons who could communicate on matters common to several projects, either consecutive or parallel projects. According to our interviewees, communication was needed about the customer's future project plans, the subcontractor's available resources, prices, infrastructure needs, problems in collaboration, future collaboration development activities, etc. The customer company of projects Alpha1 and Alpha2 had instantiated a practice of naming a subcontracting responsible from its organisation for each of its subcontractors. In ordinary projects this role was called supplier manager, and his or her tasks included e.g. distributing information between the companies and being available if any problems occurred. If the relationship with the subcontractor was meant to be strategic and long term, then the role was called executive sponsor. This customer also expected each subcontractor to name a corresponding person from their company to be a counter party in the communication on this level. The process developer from this company described the role of executive sponsor, which was named for each important subcontractor:

> **Quotation 13:** "Executive sponsor's tasks include collaboration with a person in a similar role in the subcontractor company. This collaboration between higher management creates the common understanding about long-term plans. It allows project personnel to concentrate fully on the current project. On different organisational levels there will be equivalent roles in both organisations. In my opinion this kind of an arrangement creates a good framework for longer-term cooperation. We have documented and described this and present it to our partners saying that this does not work if you don't have a similar arrangement. (…) This is the relationship level and under that is the project level." (Customer's process developer, Alpha1)

The customer company in project Gamma was a smaller firm. There a management level peer-to-peer link was established between the customer's product development manager and the subcontractor's corresponding manager. This link functioned particularly well in the form of weekly phone meetings about higher-level issues.

Project-level links. On the project level, communication took place between the project managers. Persons on this level communicated on a daily basis and this peer-to-peer link seemed to function very well in all the studied projects. We noticed that all geographically distributed sites participating in our case projects had a named leader; either a project manager, a subproject manager or a team leader. Each site had also its own project team; none of the projects had divided its project teams between sites or companies.

Project managers, subproject managers and team leaders communicated with each other and with their project teams a lot; in many projects most of their time was spent on communication. The project managers discussed with each other about administration and management-related tasks, but also about technical issues. Especially in the smaller projects the project managers were also technical experts. In larger projects also technical experts were needed in the communication between the companies and sites.

In project Thêta, the customer company named subproject managers who were located in Finland, but were each responsible for a team in a foreign subsidiary. The subsidiaries, on the other hand, had their own project managers who communicated with these subproject managers of the customer. Especially the customer's subproject manager coordinating the Swiss team devoted a lot of time for communication with the subsidiary, where his main contact was the project manager. Both contact persons found this practice very successful,

as the subsidiary's project manager commented:

> **Quotation 14:** "Having only one contact person was very good. Single point of contact made working easy. (…) He knew the whole thing and could answer almost all questions – if he did not know the answer he found it out." (Subsidiary's project manager, Thêta)

This customer company had earlier had problems, when it did not have this kind of a contact person, or subproject manager who would take care of the communication with the subsidiaries. The interviewed subproject manager was surprised at how much time all this communication demanded, clearly more than half of his time was spent on communicating and coordinating. According to him, even that was not enough. The customer company felt that this experience had taught them that for each site there should be a subproject manager responsible for the coordination and communication with that site. With the Danish subsidiary they did not have that kind of a person in the beginning, and, according to our interviewees, that collaboration got tangled up, mainly due to this mistake. A similar practice was used in project Alpha2, where the customer had named two project managers, who were each responsible for communicating with one subcontractor and represented that subcontractor in the customer's internal meetings. Also that project found this practice very useful.

Team-level Links. Our case projects often had experts in the collaborating companies who needed to communicate with each other, e.g. persons responsible for related modules and software architects. Also developers, testers etc. needed to communicate across company borders, especially in the integration and testing phases. The encouragement of peer-to-peer communication between the companies on the developer level raised contradictory opinions among our interviewees. Some commented that direct, developer-level communication was beneficial, but on the other hand, others were afraid that too much direct, uncontrolled communication between the developers might lead to situations that are difficult to manage. The reason behind this fear was that because of direct contacts the project managers may not know what is going on, and the developers may agree directly on matters that affect costs, schedule or other parts of the developed software. Especially when the personnel from different subcontractor companies discusses with each other, this might cause some concern, as an interviewee from the project Alpha1 noted:

> **Quotation 15:** "Some of our subcontractors discuss at the developer level, but we try to minimize that by choosing the areas we subcontract suitably. (…) It is not to our benefit that, e.g. subcontractors create so good discussion links [to our other subcontractors] that they could centrally decide their price and start to pressure us." (Customer's subcontracting responsible, Alpha1)

However, directing all inter-company communication through project managers may burden them or other key persons too much and it may restrict the information flow. Some projects had noticed that, and thus encouraged direct communication by introducing the developers, who needed to communicate together to each other. These kinds of situations emerged, e.g. when developers from the collaborating companies were working with modules that had common interfaces, or the customer's developers tested the modules that the subcontractor's developers had developed. The project manager of the subcontractor in project Alpha1 saw that encouraging this direct communication was important:

> **Quotation 16:** "As a project manager my task is to create the right contacts between the developers, so that I don't slow down the work and communication. Instead, as soon as possible, the right persons will discuss directly, and I'll just follow that it is working and that there aren't problems. (…) When I meet the customer's project manager and he introduces me to somebody [from the customer company], then I know that this person works with that module and we have one person working with another [related] module, and then we arrange a meeting between these persons either through email, phone or face-to-face. Then they can solve the problems together. (…) If we know that that kind of a link is needed in some area, then of course we will create the contact as early as possible." (Subcontractor's project manager, Alpha1)

The customer's subcontracting responsible from the same project supported these goals:

> **Quotation 17:** "Developers can communicate with each other directly. I think that it is not sensible to direct all communication through one person. Creating direct contacts it important, since it makes daily work faster." (Customer's subcontracting responsible, Alpha1)

This subcontracting manager emphasized that the project managers need to be informed about the issues agreed during direct conversations. Moreover, this company had introduced a practice of saving all email discussions with the subcontractors, by adding to all messages an email address, where the emails were stored.

In addition to email, chat was another popular communication medium used in direct conversations in several projects. The usage of chat is discussed more later on, in connection to the communication related to problem solving.

PRACTICE 4: Creation of role descriptions

The key observations related to this practice, the creation of role descriptions, are summarised in Table 22.

Table 22. Summary of Practice 4: Creation of role descriptions.

Practice name	**Creation of role descriptions**
Problem the practice aims to solve	How to clarify the roles and responsibilities of the participants in a distributed project?
Practice description	The creation of role descriptions, assigning the roles to team members and indicating which roles need to communicate with each other in the collaborating organisations.
Variations	Special roles meant to function on the interface between the collaborating companies can be defined, or the roles can be created and named for the whole distributed project team.
Pros	Makes the project structure and responsibilities more clear to the participants, and helps them find the correct person to contact. Easier to assign roles to persons in the project start-up than as separate tasks.
Cons	Definition and introduction requires a lot of work.
Projects where used	Alpha1, Alpha2 and Gamma.
Communication needs	Informing, problem solving, monitoring progress and providing transparency.
Related practices	Creation of links at three organisational levels, visiting engineer, problem solving responsible.

Creating roles, assigning the roles to team members and indicating which roles need to communicate with each other between the companies was a successful practice described by interviewees from customer companies of projects Alpha1, Alpha2 and Gamma. These

companies had defined and taken into use already some of the roles they had defined, but the work was still going on. Their initial experiences showed that the roles made the inter-organisational project structure more clear to all participating team members and helped them find the correct person to contact. The process developer from the customer company in project Alpha1 described their goals in this work:

> **Quotation 18:** "We would like to unify the practices of working with the subcontractors, e.g. which collaborating roles we have, which roles the counter party has, and how these roles exchange information. (…) It has been a big step for us to understand this thinking of processes and roles. We don't want to name people to do different tasks; instead we would like to say, that 'You, Mr X will take this role regarding this subcontractor'. (…) The roles are described as a group of tasks. (…) Each role includes being responsible for a specific set of tasks. When you have a specific role, people can expect that you do this and this, and you are responsible for this. (…) And finally we are trying to link also competence development to this. So if you have a certain role, you should know this and this. (…) When someone would like to get a specific role, we can directly say which are the competence requirements. " (Customer's process developer, Alpha1)

This process developer told that they aim to define a set of roles for both companies, for the customer and the subcontractor, and these roles will be used in all subcontracting projects. The persons assigned to these roles take care of the collaboration between the companies during the project. The description of the roles is a part of the description of the collaboration process. After the work is finished and taken into use the customer could e.g. ask the subcontractor "Who in your company takes care of this role?", and that way know easily whom to contact.

The role descriptions used in projects Alpha1 and Gamma defined for each role e.g. the tasks to perform, decision-making rights, responsibilities, and identified the other-party contacts. The idea was to use the same roles and descriptions in all projects. In the beginning of a new project, the roles needed are chosen and persons are assigned to the roles. When starting a project, it is easier to give the team members roles than many separate tasks. Some of the roles may not include any inter-organisational communication responsibilities, some may require that a lot. Our interviewees emphasized that it is important that the roles requiring inter-organisational communication have matching counterparts both at the customer's and the subcontractor's. That kind of role descriptions make communication as one of the tasks. Our interviewees thought that it was important to clearly define communication as part of the job description for certain roles, since it is an important task that takes a lot of time. Actually, we noticed that in some companies that did not have these kinds of role descriptions a few interviewed link persons complained that communication was a task that required a considerable part of their time, but their companies underestimated the time required for that and piled too much other work on them.

Even though in both of these projects it was the customer company who had started to create these role descriptions, the role descriptions were meant to be used in both the customer and the subcontractor companies. Especially in project Alpha1 the main purpose of these roles was to facilitate the collaboration across the company interface. In project Gamma the customer company had created the roles both for internal and external use. This company encouraged its subcontractor to use the role descriptions it had created and documented on its extranet pages. The product development manager of the customer company in project Gamma told us that they had already described almost twenty roles. According to him, normally one person was given from one to three different roles at a

time. This company had included in their role descriptions also the documents that the role holder "owns", which means having responsibility of updating the documents. The customer's project manager commented that especially in these kinds of distributed projects updating documents is easily forgotten, and the role descriptions have already provided some improvement to that.

Even though the role descriptions were quite new and still under development in the projects they were used, they seemed to be useful. Moreover, one purpose of the role descriptions seemed to be to create clear communication channels between the companies and assign the communication responsibilities to specific roles. Thus, the usage of this practice will probably encourage communicating and makes it easier to initiate communication when the communication counterparts and responsibilities are clearly defined.

PRACTICE 5: Visiting engineer

The key observations related to this practice, visiting engineer, are summarised in Table 23.

Table 23. Summary of Practice 5: Visiting engineer.

Practice name	**Visiting engineer**
Problem the practice aims to solve	How to facilitate communication and create contacts between collaborating distributed sites and companies?
Practice description	Visiting engineer visits the collaboration partner; customer, subcontractor or subsidiary, and stays and works there for a longer period of time, one of his or her tasks being facilitation of the communication.
Variations	Visits from one week to several months are most useful during the initial and final phases of the project. In a larger project, instead of one visitor a small group can be used, as well.
Pros	Visiting engineer facilitates communication by passing information, creating contacts, solving problems, and by being present for face-to-face discussions.
Cons	Most of the working time of this skilful engineer is spent on communication, thus he cannot be assigned many other tasks.
Projects where used	Omega, Alpha1, Alpha2, Epsilon, Zêta, Êta andThêta.
Communication needs	Problem solving, informing, relationship building.
Related practices	Relaying contacts and questions, creation of role descriptions, collocated testing and integration, face-to-face problem solving.

Visiting engineers were persons who visited the collaboration partner, customer, subcontractor or subsidiary, and stayed and worked there for a longer period of time. We encountered different types of "visiting engineers" in projects Omega, Alpha1, Alpha2, Epsilon, Zêta, Thêta, and Êta. The main reason to use this practice was to facilitate communication between the sites and partners. These persons both passed information and created contacts that would improve future communication. The visits created actually a useful opportunity to meet partners face-to-face and get to know each other. In addition to facilitating the communication there were other reasons to send engineers to visit. For instance, this person could train either the customer's or subcontractor's personnel, solve problems, arrange design and code walkthroughs, and even to participate

in the development as an extra resource. Quite often these persons did also their own development work during these visits. In some projects it was not only one person who made these visits, but a small team. This visiting team could stay during the whole project and act as a communication link or participate only in the requirements specification or the testing and integration phase. The visits normally lasted from one week to several months.

In project Epsilon, an engineer from the customer company visited the company's internal distributed sites for a few months each. He also visited the subcontractor, but that was a shorter visit. The purpose of these visits was both to train the personnel and to create contacts. This visiting engineer hoped that after these visits it would be easier for the distributed personnel to contact the customer. When they do not know whom to contact, they could contact at least him. After the visits the communication had clearly increased and improved.

In project Thêta, visits were not really planned beforehand, but they proved to be really useful. The project manager from the Swiss subsidiary spent almost two months in Finland in the beginning of the project and became familiar with the product and the development team there. When he returned to Switzerland he trained the team there, and during the project he was the contact person between the subsidiary and the customer. During the early project phases the Finnish subproject manager made several one-week visits to the Swiss subsidiary. During these visits he got to know the Swiss team very well. He arranged design and code walkthroughs and helped the team solve problems. Also the Danish subsidiary participating in the same project sent their project manager to work in Finland for four months during the project. The Finnish project manager found this visit very useful:

> **Quotation 19:** "It was really useful. Information flows so much better when you see that person in the corridor. From him we knew all the time what happened there [in Denmark]. And when developers there had problems or questions, he could ask us right away. He passed answers on to Denmark and could explain it quite broadly in Danish, which of course made our work easier. (…) He also understood better what they were doing in Denmark and could tell them background information that they needed but we had forgotten to tell them. He knew better what kind of information they needed to know and how it should be explained. It was really helpful." (Customer's project manager, Thêta)

In project Alpha2, the Irish subcontractor sent a small team to work at the customer's premises. The size of this team was 2-4 persons depending on the project phase. In the requirements specification phase the team was at its largest, becoming smaller later on. The main function of this small team, lead by a team leader, was to facilitate communication between the larger Irish team and the customer. In addition to that, the team did its own project-related development tasks. This visiting team and the customer had informal technical discussions daily. The customer considered this practice suitable for this kind of a project, where the subcontractor's main team was located so far away.

The customer's partnership manager from case Alpha2 explained to us that especially the initial and final phases of the project require collocated visits. In the beginning, specifying the requirements and understanding the specifications correctly is easier when collocated. Testing and integration also benefit from the visits:

> **Quotation 20:** ”Quite often we invite the whole team from the subcontractor, or at least the team leader to work with us when we are doing integration testing. We need quick bug fixing, and we don’t have time to send them descriptions of the problems and wait for answers.” (Customer’s partnership manager, Alpha2)

We further discuss collocated integration and testing in connection with problem solving communication.

5.4.3 Problem Solving

Problems and questions requiring timely solutions constantly appeared in all the studied projects, which is common for distributed software development projects. Only few of the projects had advance plans for problem solving communication. In several of the studied projects the lack of agreed channels for problem solving communication led to delays in solving the problems, which in turn caused delays on the project level. We found that the lack of suitable and defined communication channels caused the project team members to spend a lot of time trying to find somebody to help them, while wasting both time and energy. Some of the case projects had introduced useful problem solving practices already in the beginning of the project, whereas other projects created new practices using trial and error technique during the project.

5.4.3.1 Encouragement to ask questions

The barrier for the subcontractor’s personnel to contact the customer was often high, despite the fact that the problems were both severe and in need of quick resolution. The problems that were brought up late were often both difficult and expensive to solve. Especially if the subcontractor’s personnel had not met the customer’s personnel, the subcontractor had often a high threshold to contact the customer and ask questions. Some of the case companies reported that they had encouraged both the subcontractor’s and their own team members to ask immediately when they did not understand something, some information was missing or they had problems.

In addition to merely encouraging people to ask, a few interviewed companies had done more than that. For example, project Beta had introduced a problem emailbox, where anyone could send their questions, when they did not know whom to ask. Epsilon had a visiting engineer, who visited two of their own sites for several weeks to get to know the people there and encourage them to contact him later on when having problems or questions. In project Êta the customer’s managing director had stressed to the Indian development team that the most important thing is to ask when not understanding something.

5.4.3.2 Motivation to answer

In addition to encouraging developers to ask, it is equally important that in the other end there is someone, who can and will answer the questions. Getting good responses quickly was highly valued among the subcontractors’ developers. For example, in case Thêta the project manager of the Swiss team commented:

> **Quotation 21:** "[Customer's project manager] answered to emails quickly, within the same day. It was good. It gave a feeling that he was really involved. It gave a feeling of importance." (Subsidiary's project manager, Thêta)

This project manager felt that quick answers meant that the customer really appreciated the subsidiary's work. It also motivated the Swiss team to work harder to get their module finished within the tight schedule.

In case Thêta the motivation of the customer's personnel was very high to answer questions coming from the distant sites that we studied because they had noticed how skilful the developers there were. The customer's personnel knew that these developers did not ask in vain, but only when they had really tough problems and could not continue without help. The customer's personnel did not want to delay the work of these skilful fellow workers. Moreover, at the same time there was knowledge transfer in both directions. A system architect commented on the cooperation with the Danish site and the reasons behind the quick answers:

> **Quotation 22:** "We have always tried to answer quickly to questions coming from the Danish site, since they have always asked relevant questions and we know that they are doing high quality work. It is a kind of moral obligation. You just help quickly your fellow workers in trouble. It surpasses all other tasks. (…) On the other hand, from Germany from some persons we got very simple questions. Your motivation to answer decreases quite quickly when you notice that they don't follow and they don't even try to figure it out. Then our service level in answering questions drops. It's about respect between developers. When you have a high opinion on someone, you want to serve him quickly. (…) When working with the Danish site we noticed that there is knowledge transfer from them to us. This has also added to our motivation. Our cooperation functions very well. Besides that they build us software, we can learn from them. This has motivated us to cooperate more with them and share knowledge in both directions." (Customer's system architect, Thêta)

In some cases the motivation to answer the subcontractor's questions was low. At worst, the customer's developers felt that they were competing with the subcontractors. In case Epsilon the customer's developers were afraid that someone from a cheap labour country would take their jobs. This led to a situation, where the customer's testers even caused extra trouble to the subcontractor's personnel by testing their deliveries very slowly and sending them unworthy comments.

Moreover, when the customer's developers have a lot to do and get questions by email from the subcontractor's developers that they have never met, it is easy to leave the emails unanswered. It is much more important for the customer's developers to answer questions coming from the fellow team members next door than to answer to someone unknown. It seems that meeting the subcontractor's personnel face-to-face and getting to know them improves the motivation. However, it does not create any more time to answer their questions. Another important thing seems to be to make answering these questions somebody's task and to emphasize the importance of answering. A developer from Epsilon emphasized the importance of being familiar with the people you are working with:

> **Quotation 23:** "Communication does not function before you know those people, and even then it does not function very well. (…) For example, if they [subcontractor's developers] send in the beginning of a project a question here, it is easy to leave it unnoticed in your email box, so that you do not react to it until after a few days." (Customer's developer, Epsilon)

In all our case projects most of the questions seemed to be coming from the subcontractor to the customer's personnel and not the other way around. This is quite natural when there is so much new in a project for the subcontractors.

5.4.3.3 Describing the problem properly in written communication

When communicating by electronic means, especially by email, asking questions that the other party can understand is not easy. Quite often our interviewees described that in email communication they have to send several emails back and forth before even the question is understood. Especially, with the time-zone differences in effect, this kind of email exchange can take a week, whereas face-to-face the whole problem could have been solved in less than 15 minutes. However, email communication seemed to have other advantages: it does not disturb people as much as e.g. telephone calls, it leaves a trace and you can even send these emails to the whole project to inform them. In some projects people had noticed that by describing the problem properly in the first message and even giving examples makes understanding the problem much easier and it can be solved faster. However, a few persons felt that writing detailed messages takes too long and preferred phone calls. A developer from project Delta described this problem of understanding:

> **Quotation 24:** "If someone sends you by email a very short question without background information, you might not understand it at all. But if it is described more broadly, then there is a possibility to understand it. (...) It is not uncommon that both of us need to write five email messages, before we start to understand each other. If the discussion proceeds with one reply per 24 hours, then it takes one week to solve the problem. (...) Just compare it to sitting face-to-face, then you can ask those questions right away, it happens in a moment! By email the problem solving might take several times that long." (Customer's developer, Delta)

Project Gamma had developed an email culture of writing long explanations, which the project participants found useful. They had noticed how difficult it was to understand a question from a short message, and instead preferred proper explanations:

> **Quotation 25:** "...we have this email culture of writing long explanations. (...) people have clearly noticed that the others cannot understand the matter from one single sentence, instead they rather explain it properly. (…) when you notice how useful it is to yourself that you understand already from the first message what it is about, then you are willing do it for others, too. (…) years ago we used to have very long email chains, where the same matter was discussed approximately a week just because it was not clear what the question was." (Project manager, Gamma)

5.4.3.4 Media used for problem solving

Mainly five different media were used for problem solving communication: email, chat, phone, face-to-face meetings and discussion forums. Clearly the most commonly used medium was email, which had many advantages according to our interviewees. First, email does not disturb much the person receiving it. This person can read it and answer when it is best suitable for him or her. On the other hand, getting answers by email might not be that quick. Second, since emails are in written format communication leaves a trace. Some firms saved all their email discussions. They could read old emails later on when they e.g. had to review what was agreed on or if a similar problem occurred again. Moreover, several persons could participate in these email discussions and the emails could be sent to others to inform them. Thirdly, when the problem was difficult to solve or a foreign language speaker was difficult to understand, an email message could be read

through many times. The time it took before the problem was first understood and then solved by sending several messages back and forth was mentioned as the biggest problem with email usage in problem solving.

A few persons preferred using the telephone for problem solving, since it is quite quick to use and the answer is often quickly received. However, especially for small firms having globally distributed projects frequent telephone calls were not an option due to financial reasons. Telephoning does not leave a trace, which was another explanation for not wanting to use it.

Both chat and discussion forums were highly appreciated in those firms where they were used for problem solving. Both of them will be described more later on. Finally, face-to-face meetings were used when the problem was noticed to be a big one and it needed quick resolution. Moreover, face-to-face problem solving was common in the final testing and integration phases, when problems relating to several parts of the system occurred. By having the developers or experts of the different subsystems present, the problems were easier to locate and solve.

5.4.3.5 Practices related to problem solving

Next, we will present in more detail five problem solving practices used in the case projects: *problem solving responsible*, *discussion forums*, *direct contacts for problem solving*, *mediating questions and contacts*, and *face-to-face problem solving*.

PRACTICE 6: Problem solving responsible

The key observations related to this practice, problem solving responsible, are summarised in Table 24.

Table 24. Summary of Practice 6: Problem solving responsible.

Practice name	**Problem solving responsible**
Problem the practice aims to solve	Whom to contact at a collaborating organisation or site when having problems or questions?
Practice description	A problem solving responsible is a technical person who both knows a lot and is willing and able to answer questions and solve problems coming from one's own organisation or distributed partners.
Variations	Naming a person to this role in the project start-up phase would be optimal, but this kind of a role can also "emerge" during the project. The problem solving responsible can either answer the questions by himself or find answers elsewhere in the organisation.
Pros	When this kind of a person exists it is easy to know whom to contact and ask questions. Problems can be solved quickly.
Cons	Most of the working time of this skilful engineer is spent on problem solving and communication, thus he cannot be assigned many other tasks.
Projects where used	Omega, Beta, Epsilon andThêta.
Communication needs	Problem solving.
Related practices	Discussion forums, relaying contacts and questions.

No formal problem solving role existed in the beginning of any of our case projects. In four projects, Omega, Beta, Epsilon, and Thêta, developers at the subcontractor and distributed sites learned during the project that a specific individual, a system architect in all these cases, was able to answer many of the questions. Probably due to his role, this person had a good understanding of the system and was able to help the others. In consequence a lot of his time was spent on answering questions by email, phone or chat. A system architect in project Beta commented his new "role":

> **Quotation 26:** "It just gradually happened that I became "a link person". I have a lot of experience since I have been here so long. I have also been interested in the big picture of the project. But it is sometimes very hard. Because there are so many tasks, sometimes tens of tasks at the same time. And then I have my own work, the code I should develop. (…) My phone rings 40-50 times a day, but at the same time I should code thousands of lines. It is difficult to run from task to task, when you cannot concentrate. (…) Approximately half of my time goes to this kind of communication through phone or email, I'm like a help desk. (…) Here people just don't understand how many calls and emails I receive. They complain if my development work takes long time." (Customer's system architect, Beta)

In a way this "problem solving responsible" liked his new role, since he was a social person. However, he would have liked management to recognize his new position and understand that because of this new role he did not have as much time to do normal development work as he used to. He believed that one of the reasons for the subcontractor's and subsidiary's personnel to contact him was that he had arranged them training sessions. The developers had met him there, which made it easier for them to contact him. He had also sent a number of informing emails to them. For these reasons the developers might have found it easy to contact him in the first place, and when they had received help then it was even easier to contact him the next time.

These "problem solving responsibles" either answered questions by themselves or found the answers from elsewhere in their organisations. The projects that had "problem solving responsibles" were very satisfied, since it was easy to ask questions and the answers came quite quickly. However, it took quite a lot of time from these individuals to answer the questions. Three of them reported that more than half of their working time was spent on answering questions and this was not taken into account when delegating other tasks to them. Thus, in these three projects this practice was successful partly because these individuals were very responsible persons and eager to help as much as they could to make the project succeed. The fourth person in this role used at least two hours a day for answering questions coming by email or chat. This person had only one subcontractor with a few developers at his responsibility and the project manager took care of all the management tasks.

The problem solving work was not only about writing answers, but first finding out what the problem was, where it was, and finally how to remove it. In case Omega the subcontractor was improving an old system, but the customer did not want to give all the modules of an old system to this foreign subcontractor for security reasons. Thus, often the Finnish subcontractor's system architect, who knew the system, had to consume a lot of time first to find the problems, before he could respond to the foreign subcontractor's questions:

> **Quotation 27:** ”It took half of my working hours, since it was not only communication, but I also had to find out where the problem was. (…) It could take a couple of days before I discovered the problem and at the same time three or four other questions came. I felt inadequate because I did not know how I could manage all that. And then I should have done a lot of development work too. I would have liked to give away part of that communication work.” (System architect, Omega)

It was clear that in our case projects the customer companies had not anticipated the huge amount of problem solving work needed. However, already during these projects they had learned that this kind of a dedicated person is really needed. In case Epsilon the customer's partnership manager regarded it as important to have this kind of a person:

> **Quotation 28:** “There should be a person here [in the customer company], who can answer questions coming from there [from the subcontractor], so that we don't slow down their development. Or then there should be so many other tasks that they could change to. It is about organizing work, the same problem that we have with our own offices. We have tried to arrange them “back-up tasks” all the time, so that if no-one here has time to answer, then they have other tasks to do.” (Customer's partnership manager, Epsilon)

Arranging back-up tasks for the subcontractors, while the customer's personnel is solving problems and the subcontractor cannot continue their work before the problem is solved, was noticed to be a useful practice also in other companies.

The customer's project manager in case Epsilon had noticed that a technical person needs to be close to the subcontractor interface. Earlier, the project manager, who was not that technical person had tried to relay questions forward to technical experts, which was both frustrating to her and took time:

> **Quotation 29:** ”This technical person can reduce the workload that the subcontracting causes us. This person can filter out a part of the questions, most of the questions he can answer himself or find out the answers from someone else.” (Customer's project manager, Epsilon)

Thus, all the experiences of having this kind of a problem solving responsible were very positive both to the customer companies and to the subcontractors. The only problem was that the customers had not understood how much time this role really requires. Moreover, it might be a good idea to name a person to this role already in the beginning of the project, which was not done in any of the case projects. Some of them had, after these experiences, considered doing that in the future.

PRACTICE 7: Discussion forums

The key observations related to this practice, discussion forums, are summarised in Table 25.

Table 25. Summary of Practice 7: Discussion forums.

Practice name	Discussion forums
Problem the practice aims to solve	How to locate experts and get answers to problems in a distributed project?
Practice description	Distributed team members can send their questions and comments to electronic discussion forums and others following the discussion can answer or comment.
Variations	A large project can have several discussion forums, each concentrating on different topics. A smaller project might have only one forum or alternatively a project wide mailing list.
Pros	Discussion forums are useful for finding experts and getting answers to problems, they provide also transparency to current project discussions.
Cons	Discussion may die out, if the team is not active enough, or if the team members able to answer questions do not participate in the discussion.
Projects where used	Alpha1, Gamma, Delta, Epsilon and Thêta.
Communication needs	Problem solving, monitoring progress and providing transparency.
Related practices	Problem solving responsible, relaying contacts and questions, direct communication through chat

Electronic discussion forums, or bulletin boards, were found to be useful for problem solving. They were used, e.g., for finding experts on some specific technology in a large project to answer a specific question. In four larger projects, Alpha1, Delta, Epsilon and Thêta, discussion forums focusing on specific technological topics were successfully used. These projects had from 10 to 30 discussion forums each, concentrating on different technical topics. In a smaller project, Gamma, project-wide mailing lists were used for the same purpose. This project, too, had plans to introduce discussion forums later on.

Discussion forums are electronic forums where all team members can send questions and comments and other team members following the discussion can send their answers or comments. Everybody interested can follow the discussions and all discussions are saved.

All the projects using discussion forums found them to be useful. The more there was discussion, the more people followed it and the more useful it was. Only in one case project, case Thêta, the discussion died out towards the end of the project. The reason for this was probably that after the initial phases of the project there were not so many questions anymore, and due to the limited size of the project, people got to know each other and discussions moved to emails. However, also in this project the plan was to start using discussion forums again after a new, more suitable tool was taken into use.

The discussion forums seemed to have at least two clear benefits. First, they offer the project team members a possibility to ask questions and get answers even though they might not know whom to ask. Someone following the discussion might provide helpful information or could have had a similar problem himself earlier. Second, all discussions are visible and everybody can follow them. This is especially helpful when several persons might otherwise need to ask the same question, but when the answer and question are both already there, and visible to everybody, the expert answering does not have to

explain it several times. Moreover, if all the discussions were only between two persons, then there would be a need to inform the whole team about the problems and solutions.

A system architect from case Thêta commented the benefits of discussion forums:

> **Quotation 30:** ”Discussion forums are very useful to have, because then also all the others can see the discussions and the problems. If the same problems occur again, then the answer is already there. (…) The more people use it the better. It reduces the need for support, when people can find some of the answers already there.” (Customer’s system architect, Thêta)

The customer company in project Alpha1 had already a lot of experience in using discussion forums. It had a large number of discussion forums for the whole product program. These discussion databases contained mainly technical discussions, but also specifications and meeting memos. The subcontractors were not allowed to access these discussion databases for security reasons, thus the customer company took selective replicas of these databases, which were then updated regularly. This way they could show the subcontractors only those discussion forums and information that the customer deemed necessary. The subcontractor in case Alpha1 found the discussion forums that the project had very useful. The only problem was that the customer did not always give enough rights to access all relevant information, instead, the subcontractor had to ask for it. In addition to the customer’s discussion forums, the subcontractor had also its own internal discussion forums. The subcontractor’s project manager explained that email discussions are difficult to follow, when he receives so many emails every day. On the other hand, in discussion forums the discussions are normally in good order, everything is documented there, all the reasoning and arguments can be found there and anybody can go there whenever he or she wants to read the discussions.

PRACTICE 8: Direct contacts through chat for problem solving

The key observations related to this practice, direct contacts through chat for problem solving, are summarised in Table 26.

Table 26. Summary of Practice 8: Direct contacts through chat for problem solving.

Practice name	**Direct contacts through chat for problem solving**
Problem the practice aims to solve	How could the problem solving communication between distributed developers be arranged?
Practice description	Internet-based chat provides an inexpensive, and very much liked, real-time medium for communication between distributed project team members. It seems to be especially convenient for problem solving discussions between distributed developers.
Variations	Normally between two persons, but it is possible that several developers participate, or even arrange meetings. Discussions can be copied, saved and sent by email to others.
Pros	Allows an easy and cheap way for distributed developers to solve problems quickly together using real-time communication, which is easy to understand also for foreign language speakers.
Cons	Requires synchronous communication, thus e.g. time-zone differences between the partners limit the usage. Discussions are not automatically saved; others may not be able to follow these discussions.
Projects where used	Omega, Gamma, Epsilon, Zêta, Êta andThêta.
Communication needs	Problem solving.
Related practices	Discussion forums.

Direct contacts for problem solving between team members from different sites and companies existed to some extent probably in every case project. Even though the participants might not have known each other beforehand, during the project they got to know at least some of the other project participants. In many of the projects the team members started to ask questions from different persons, e.g. by email. After a while they learned who was willing and able to answer them. Sometimes these persons who were able to answer became "problem solving responsibles" as described earlier. Sometimes there emerged several links between different persons in a project. Several interviewees told us about these kinds of experiences of gradually learning whom they could ask when having questions or problems.

The discussions between the project team members normally took place either through email, chat or phone calls. Especially chat seemed to be a useful tool for these kinds of discussions. Altogether five projects, Omega, Gamma, Epsilon, Zêta, and Êta mentioned using chat in discussions between the customer's and the subcontractor's personnel. The projects used chat for written discussions, even though other properties, such as the possibility of having voice conversations, are nowadays available, as well. All the projects and individuals using chat were very satisfied with it. Because of these positive experiences, the use of chat in direct problem solving contacts is discussed in more detail.

Chat seemed to be an efficient media for communication between the developers. In our case projects, the developers working in different companies and countries communicated frequently using chat. The chat client made it easy to see who were present at another site. Our interviewees mentioned several good properties of chat: it is inexpensive compared to the telephone; it is possible to have chat discussions open all the time; chat does not disturb as much as phone calls, which require you to stop your tasks immediately; several developers can participate in the conversations at the same time; further questions can be asked right away, and thus the problems can be solved quickly; foreign language speakers are easier to understand when the discussion is in written form and for them it is easier to communicate when they can read through the message several times and think about their response before sending it; and it is also easy to copy important paragraphs from a written conversation and e.g. send them by email and inform others about the discussions. Even though chat discussions are not automatically saved, like email messages, in two case companies also all chat discussions were saved, in case they are needed later on, e.g. to check what was agreed. Chat was used for many purposes in our case projects. In project Gamma chat was sometimes used even for the weekly meetings of a small subproject.

A system architect from project Epsilon used chat to discuss with the developers in a foreign subsidiary and commented on its use:

> **Quotation 31:** "Chat is more practical than phone, especially with foreign partners. (...) It is already difficult to understand different pronunciations, not to mention the difficulties for me to even express what I want to say. (...) Writing emails takes a lot of time when you have to structure it and give background information. When I write some technical explanation, it takes time - it can take up to two hours to write one email when I search the information and go back to the code. (...) But, chat is more like talking. You do not have to structure things or think too carefully. Comments are very short. You can write about what you have on your mind. And the discussion just flows in the right direction." (Customer's developer, Epsilon)

In project Epsilon, chat was used also for problem solving discussions with multiple users:

> **Quotation 32:** ”Chat works with our Malaysian office, we do not have too big a time-zone difference, therefore we can use it. (…) It is used for technical discussion, e.g. discussing whether something should be done like this or like this. (…) Possibility for multiple users is the key thing. (…) I understand that there are normally at least three persons discussing, e.g. technical experts and developers and one of them is sitting in Malaysia or Japan.“ (Customer’s partnership manager, Epsilon)

In project Êta, chat was used in daily communication both between the Finnish project managers and between them and the developers in India. The companies involved in the project were small, thus telephone usage was limited due to financial reasons. The Finnish project manager told us that the telephone was actually not needed at all, chat and email had replaced it. In this project chat was used when someone had questions that needed quick answers. Moreover, issues that needed interactivity were discussed through chat. In chat discussions the problem could normally be solved right away. By email the same would have probably required sending several messages. In this project the Indian team saved all chat discussions to make sure that they remember what was agreed on. In addition to using chat for discussions, the team members informed each other through the chat program about their availability. From their chat program everybody could see who else was present in some of the offices. The Indian developers marked themselves to the chat program as “busy” when they did not want anyone to disturb them, and then they could concentrate on their tasks. A Finnish project manager told us that normally he had from five to ten chat discussions with the Indian team every day. These discussions lasted a few minutes each. He appreciated the possibility of real time problem solving offered by chat. After these discussions he could be sure that the message had come through and was understood. He was very satisfied with chat, since its usage improved his work performance.

Finally, chat was used in cases Omega and Êta in the testing phase, when the developers in different countries were testing and fixing bugs together at the same time. All the needed conversations took place through chat.

PRACTICE 9: Relaying contacts and questions

The key observations related to this practice, relaying contacts and questions, are summarised in Table 27.

Table 27. Summary of Practice 9: Relaying contacts and questions.

Practice name	Relaying contacts and questions
Problem the practice aims to solve	Whom to contact in a distributed project when having problems or questions?
Practice description	When the participants of a distributed project do not know each other across the sites, it is difficult to know whom to contact when having questions or problems. Projects can name a kind of contact persons, who are, among other things, responsible for relaying contacts and questions between the sites.
Variations	The customer may name a relationship manager for each subcontractor, who relays contracts and questions, or a visiting engineer can do that. The subcontractor's project manager may collect questions and convey them to the customer, or an e-mailbox for problems can be established.
Pros	Contacts are relayed and a contact network is gradually built between the partners. Problems get solved. All this happens in a somewhat organized way.
Cons	This may not be the most efficient way for building a contact network. Moreover, there is a possibility that problem solving information is not shared with others.
Projects where used	Alpha1, Alpha2, Beta, Epsilon, Zêta andThêta.
Communication needs	Problem solving.
Related practices	Problem solving responsible, discussion forums.

In our case projects most of the participants did not know each other well across the sites and companies when starting a project. Thus, they did not always have a clear idea of whom to contact when having questions or problems. Different projects had developed different solutions to this. Some did not have any specific practices for relaying contacts and questions. In those projects the team members learned by asking whom they should contact. If the person they had contacted was a wrong one, he probably named some other person to contact. Some projects had named persons, who had as one of their tasks to relay contacts, and in some other projects the subcontractor's project manager collected their questions and passed them on to the customer. In one project an email box was established from where the questions were forwarded to the right persons.

The customer company in project Alpha2 named relationship managers for each of its subcontractors. If the subcontractor's personnel did not know whom to ask when having a question, they could contact this person, who would then find out the correct person inside his or her own company.

In project Epsilon, the customer named a visiting engineer, who spent some weeks in each of the customer company's distributed sites and visited also the subcontractor. The barrier to ask questions had been very high in that project, but after the visits the communication improved immensely, and people were not afraid to contact this person. This visiting engineer knew most of the project personnel, and thus he could find the correct person, if he could not answer the question himself.

In a few projects the foreign teams at least partly communicated with their customer through their project managers. For example, in case Alpha1 the Hungarian teams, in case Thêta the Swiss team and in case Zêta the Chinese team mainly asked help first inside their own team and if they could not solve the problem internally, then it was normally the project manager who contacted the customer. The customer encouraged this behaviour, since they had noticed that otherwise different developers might ask them the same questions that they had already answered. Thus, the practice of collecting all questions to the subcontractor's project manager ensured that the customer was not disturbed when there was already internally someone who was able to help. In case Thêta the project manager of the Swiss team collected questions there and sent the questions they could not solve to the project manager in Finland. This project manager answered questions quickly, normally within the same day, which made the Swiss team very satisfied. The benefits of this practice were that the Swiss project manager had a very good idea all the time about what was happening, and the Finnish project manager did not receive any unnecessary questions and those he got were already collected. This practice functioned very well, since the Swiss team was small and both project managers well available. Thus they could react quickly. In a larger project with project managers having many other tasks this practice would probably have caused delays. The Finnish project manager commented on this practice:

> **Quotation 33:** "I think that as a practice this was a good one. All the communication came from one point. (…) They had to collect problems and questions there. Already collecting and discussing with team members solves some of the problems. And those questions they sent here came in a more organized way. And when this communication comes from only one person it requires this person to follow and know what is going on." (Customer's project manager, Thêta)

In project Beta an e-mailbox for problems was taken into use in the early phase of the project. This project was distributed between six sites and had over 50 team members, most of whom did not know each other beforehand. In the beginning it was extremely difficult to find the correct persons to ask questions. Therefore this project decided to take a "problem box" into use. The problem box was implemented as an e-mail address to which questions were sent. When the box was in active use it received between thirty and fifty messages a day. A person responsible for the problem box forwarded the questions to the persons she believed had the needed knowledge to answer. All the messages and answers to them were saved. During the early phases of the project this practice functioned very well. In the later phases of the project the problem box was removed, partly because direct contacts were established and partly because it was regarded as an attempt of the customer's technical project manager to control communication too much.

PRACTICE 10: Face-to-face problem solving

The key observations related to this practice, face-to-face problem solving, are summarised in Table 28.

Table 28. Summary of Practice 10: Face-to-face problem solving.

Practice name	Face-to-face problem solving
Problem the practice aims to solve	How to locate and solve difficult problems quickly in a distributed project?
Practice description	When problems are difficult to locate and solve in electronic communication, or are serious ones and need urgent reaction, then face-to-face meetings of all concerned parties are often the best solution.
Variations	Useful when serious problems need immediate action, or every now and then to solve several small problems that have accumulated over time.
Pros	Problems can be located and solved as quickly as possible, when all those involved are present.
Cons	Travelling can be expensive and efficient working time is lost during the travel.
Projects where used	Omega, Alpha1, Alpha2, Gamma andThêta.
Communication needs	Problem solving, relationship building.
Related practices	Collocated testing and integration.

Most of the projects used face-to-face problem solving in some project phase. It was not normally planned beforehand, instead, it was arranged only when really needed. In some projects face-to-face problem solving was arranged when problems could not be solved by email or telephone, and the problem was a serious one and needed urgent reaction. Our interviewees mentioned that this kind of problem solving was arranged with subcontractors or distributed sites at least in projects Omega, Alpha1, Alpha2, Gamma and Thêta. Another reason for face-to-face problem solving was difficulties in the testing and integration phase, which will be discussed later on.

Our interviewees told that difficult problems could be solved quickly by discussing face-to-face. Some of the problems had been impossible to locate and/or solve in electronic communication or it would have at least taken very long. When that kind of serious problems occurred, normally either someone from the customer travelled immediately to the subcontractor's site or the other way around, to help locate and solve the problems. Some of our interviewees had noticed that in addition to these big problems needing immediate action, several small problems and questions that had not been solved often accumulated as well, probably because everybody had been so busy. For example, projects Omega and Thêta had noticed that it was important to meet a few times face-to-face without any compelling reason. During these visits lasting a couple of days all accumulated issues could be discussed and most of them cleared up.

PRACTICE 11: Collocated testing and integration

The key observations related to this practice, collocated testing and integration, are summarised in Table 29.

Table 29. Summary of Practice 11: Collocated testing and integration.

Practice name	Collocated testing and integration
Problem the practice aims to solve	How to efficiently locate and solve problems in the testing and integration phase?
Practice description	When code from several distributed sites needs to be integrated and tested, often a quick and efficient way is to invite experts from all sites to work together in a collocated manner for a short period.
Variations	Normally arranged at the final phase of the project, collocation lasting from a few days to a few weeks.
Pros	Makes it possible to locate problems quickly and to discuss and try the solutions together.
Cons	Travelling can be expensive and efficient working time is lost during the travel.
Projects where used	Omega, Alpha1, Alpha2, and Delta.
Communication needs	Problem solving, relationship building.
Related practices	Face-to-face problem solving.

Another reason for face-to-face problem solving was difficulties in the testing and integration phase. To facilitate this phase, the projects had arranged collocated periods for persons from different sites in the end of the project. These periods normally lasted from a few days to a few weeks. Cases Omega, Alpha1, Alpha2, and Delta mentioned having collocated testing and integration with their subcontractors. Interviewees from some other projects, e.g. from Beta and Thêta complained about not having collocated testing, since they thought that it would have helped a lot and made that phase shorter.

The projects that had arranged collocated testing and integration visits or periods were very satisfied with them. For example, in project Omega our interviewees found the testing phase the most successful period during the entire project. A developer from the customer company commented:

> **Quotation 34:** ”A developer from Nepal came to Finland to do the final tests here, since we felt that there were so many small issues, that describing them in emails would have taken too much time. (...) This developer collaborated with a customer’s tester. They sat in the same room, computers side by side. The other one coded and the other one tested all time and told were the bugs were. (…) It progressed so fast during those two weeks!” (Customer’s developer, Omega)

Collocated testing made it possible to locate problems faster and discuss about the possible solutions. In some projects a complete testing environment could not be built to all sites, but, e.g. one customer site could have that environment. Thus, this site was clearly the only possible place where to do the final tests.

In the final testing phase of project Alpha1 a complete testing environment was built only to one of the customer sites. Moreover, some serious bugs related to several modules were found. Thus, when problems occurred, people from all distant sites were collected to that customer site in Finland first to find out where the bugs were and then to decide how to fix them. The visiting developers stayed there normally a few days at a time, except a

developer from the customer's US site who stayed there for two months. Even the time-zone difference between the customer's Finnish and US sites was found to be useful in problem solving as the customer's project manager explains:

> **Quotation 35:** "We solved some problems here during the day and sometimes we noticed that some person from the US site needed to continue from this. Then we went home, and the US site continued work during that same day. (…) This kind of a short term problem solving functioned very well in the project's final phases, when someone from the other side of the world could continue from where we stopped." (Customer's project manager, Alpha1)

5.4.4 Informing

In all distributed projects the participants seemed to need a lot of information from each other both in the beginning of the project and during the project. In most projects the customer was the main information source for the subcontractors. Even though informing is crucial for the success of the project, it was quite often at least partly neglected. In the beginning of the project, the customers perhaps did not know or give a thought to what kind of information the subcontractors would need, and thus the subcontractors did not get enough information. During the project, the customers often forgot to inform the subcontractors about the decisions and changes made, or about new documents produced. Of course, the subcontractors and distributed sites need to inform their customers, as well, but that did not seem to be as problematic as the information flow to the opposite direction. We found many reasons why the customers did not give enough information: some customers did not want to reveal too much about the new product or their core competences, some did not understand what kind of information was needed or they just forgot to inform others. Forgetting seemed to be quite common as one of our interviewees working in the customer's Danish subsidiary commented, when telling about their Finnish customer:

> **Quotation 36:** "Finns are very open in communication – when they remember to communicate!" (Subsidiary's developer, Thêta)

There is an example of an information blackout in project Alpha1. In that project the subcontractor complained that the customer gave them almost no documents without asking for them. On the other hand, it was difficult to ask for documents the subcontractor did not even know existed. In project Alpha1, the lack of information concerned even the division of different tasks and modules between the partners. The subcontractor in this project did not get enough information on how the responsibilities for creating certain modules were divided. The personnel at the subcontractor had some knowledge about the modules assigned to them and assumed that probably someone else would be doing all the rest. This knowledge was partly wrong, since some modules were needed between the parts the customer was developing and the parts the subcontractor was developing, but nobody was taking care of them. The subcontractor's project manager was quite upset when he found this out:

> **Quotation 37:** "We expected that they [the missing modules] would come from somewhere else, until we found out the truth. (…) You never know whether some matter is forgotten or whether it is just that they [customer] are not telling us about it. You just don't want to ask about things for many years, when all you get is counter questions, such as 'How are YOU meeting the deadlines?' – meaning that it is not our business. And then we get feedback that we should carry the responsibility for the whole project. (…) It is hard to be a subcontractor!" (Subcontractor's project manager, Alpha1)

Luckily, there were also successful practices for sharing information in that particular project.

5.4.4.1 Informing in the beginning

The initial phase of the project is very important from the communication point of view. In the beginning a lot of information is exchanged between the collaborating companies. Especially the customer needs to inform the subcontractor about the requirements, division of work, used technologies, schedule, working practices, roles and responsibilities, contact persons, etc. Even though a lot of information was exchanged in the case projects, many of our interviewees felt that they would have liked to get even more information. It seemed that the companies were very eager to start the "real work" in the project and more or less jump-started the projects. Thus, planning and exchanging information was not as thorough as it could have been, as a customer's project manager from project Beta expressed it:

> **Quotation 38:** "I believe that we never pay enough attention to the project starting phase, because we are too busy starting to work on the project!" (Customer's project manager, Beta)

A customer's process developer from case Alpha2 explained that a successful project start-up with a subcontractor requires proper project planning and the creation of a clear picture about the project goals to the subcontractor's personnel.

There were several ways to inform the project personnel in the beginning, e.g. arranging training, kick-off meetings and other visits, sending visiting engineers and providing project documents such as project plans. Different kinds of meetings are an efficient way of informing as will be discussed later on. Giving written instructions or other documents was an important way of informing, but not sufficient on its own. For instance, discussions were needed to ensure that the written information was understood correctly, as will be explained below.

Project plans seemed to be one of the most important documents for informing in the beginning. Usually, the customer company made the main project plan for the whole project and sometimes the subcontractors and distributed sites made more detailed plans covering their own tasks. The project plans normally contained a lot of information: project goals, project organisation, responsibilities, schedule, reporting, tasks, tools etc. The project plan was a good document to gain understanding of the project and in some projects it was even updated so that new team members joining the project later on could get a good understanding of the project already by reading it. However, in addition to neglecting to update the fact that the project plans were not distributed effectively to the subcontractors and all team members seemed to be a big problem. For example, in projects Omega and Thêta the subcontractors, subsidiaries and even the customer's team members complained about not receiving the project plan. In some cases it might have been intentional, since also the project plans contained confidential information, but more often it was probably just due to inconsideration.

During the interviews we did not explicitly ask about the contracts made between the companies. Thus, we cannot say whether the contracts included any directions about informing. However, judging by the comments we received from the interviewees the contracts at least did not seem to have a clear effect on the spreading of information during the project. None of our interviewees even mentioned the contracts in connection with communication.

5.4.4.2 Explaining and ensuring the understanding

We noticed that it was not always enough only to give the subcontractors written instructions or requirements specifications, since normally these cannot be perfect and easy for everyone to understand in exactly the same way. Instead, some of our case projects had noticed that it was useful to go through the instructions etc. together, preferably face-to-face, to make sure that they are properly understood. A technical contact person from the customer company in project Epsilon explained this:

> **Quotation 39:** ”It is not enough that you give [written] instructions about working methods or technical issues. Instructions are not enough, instead you should talk through the matter and explain it carefully. Instructions get across to them [subcontractors] only partially. (…) We explained to them our processes, our quarterly cycles etc. which all were quite unknown for them. Then we talked through our code review standards, which we had noticed to be difficult for them. They had probably not understood them, since their code did not look like what we wanted it to look. We talked it through with everybody present. I think it was very fruitful. Earlier we had just sent it by mail. (…) Surprisingly, this turned out well, earlier they probably did not know and did not understand what were the reasons why we wanted to work like this. From our side it required a lot of explaining, describing and showing.” (Customer’s technical contact person / developer, Epsilon)

In project Êta the customer’s Finnish project manager could not meet the Indian team face-to-face, because of the distance. Therefore, when the Indian team received the specification from Finland, they read it through and prepared a list of questions, to which the Finnish project manager answered with help from the external customer. Moreover, the Finnish project manager asked the Indian team in chat discussions to explain in their own words how they had understood the instructions and requirements. During these discussions the project manager could quite easily find out whether something was not understood correctly, and needed further explanation.

In project Alpha2 the customer’s project manager wanted to ensure the understanding by asking the subcontractors to make the specifications on their own:

> **Quotation 40:** ”If they don’t make specifications on their own, they cannot do it either. When they make the specification, it proves that they know what they are doing.” (Customer’s project manager, Alpha2)

5.4.4.3 Giving reasons and background information

The subcontractors and distant sites often only received orders to do something or ready-made decisions. The motivation behind these decisions and background information were commonly left out. The reason for this seemed to be quite often that the person behind the information did not understand that also that kind of information might be needed. And even if that person realised the importance of giving background information and reasoning, he or she simply did not have enough time to do this. The subcontractors explained that to understand the situation better they needed more information; they wanted to understand also the motivation behind the decisions. Sometimes not giving

enough background information had led to long discussions and arguments between the customer and the subcontractor. For example, this had happened in case Thêta, and was solved only after the customer had realised that the subsidiary did not know many things that had happened lately and had changed the situation. The customer had simply not realised to inform the subsidiary about this development. At the same time the customer expected that the subsidiary had all the same information as the customer. This actually seems to be one of the challenges in a distributed project; it is dangerous to expect that all the others have the same information as one does, since that is not normally the case. When people in a distributed project cannot meet in corridors and coffee rooms, they get a lot less information than in a collocated project. They get only the information that is particularly given to them. The customer's project manager in case Delta explained that you should not expect people to have more information than what you give them:

> **Quotation 41:** "In a distributed project you should never expect that the other person knows a matter, even though you could think that it is self-evident. It is better to make sure that he or she really knows it. " (Customer's project manager, Delta)

A customer's Finnish project manager in case Thêta had similar experiences:

> **Quotation 42:** "We don't always remember that in Denmark they don't hear our hallway discussions. We just easily forget them. We inform them about decisions or give instructions. Then they start to wonder why something has changed. And then we remember that oh, there have been many changes after we last time talked with you. The situation is not at all like it was then. (…) We don't understand to give them enough background information. It is not enough to inform them about the decisions, but it is important to explain the reasons behind them." (Customer's project manager, Thêta)

A subcontractor's Finnish project manager from case Alpha1 explained how he tried to cope with the challenges related to informing the partners. He aimed to keep their Hungarian development team informed by visiting them regularly at least nine times a year. According to him, face-to-face meetings were the best for sharing information, since during the visits it was easier for him to notice what the team members did not know:

> **Quotation 43:** "There is a lot of sorting out about who knows what and making sure that they know this and this. (…) I use email and phone. I have huge phone bills. I visit out Hungarian office often. (...) I have probably visited them nine times per year, for half a week. (…) There I clarify the details and study the situation with the precision of code lines. I figure out what they know, what they expect me to know, what the customer knows, what the customer is allowed to know, and what the customer does not what to know at the moment." (Subcontractor's project manager, Alpha1)

The same project manager emphasized the importance of getting some background information from the customer to be able to understand the continuously changing situation:

> **Quotation 44:** "When we are starting a project and don't necessarily know all the requirements and when the requirements change many times a day, then it could be useful to get some background information about what is really happening, why do the requirements change, how does the future look like and when do we get better estimates." (Customer's project manager, Alpha1)

5.4.4.4 Practices related to informing

The recognized practices related to informing were *regular meetings* and *databases for managing changes and bugs*. Next, these practices will be described in more detail.

PRACTICE 12: Regular meetings

The key observations related to this practice, regular meetings, are summarised in Table 30.

Table 30. Summary of Practice 12: Regular meetings.

Practice name	Regular meetings
Problem the practice aims to solve	How to inform, monitor the project progress, create transparency to the project situation and give feedback efficiently in a distributed project?
Practice description	Regular meetings are a good way to coordinate the project, distribute a lot of information between the project participants about changes, future tasks etc., to monitor progress, to provide transparency to the project situation and to give feedback.
Variations	Meetings can be arranged face-to-face or using electronic tools (e.g., teleconference or Netmeeting), they can be site-specific, across sites or a combination of them. The most usual interval between meetings is one week, but fortnightly or monthly meetings are common, as well.
Pros	Can be used for several purposes. With appropriate usage, probably the most useful communication practice that can satisfy several communication needs in one go.
Cons	In distributed projects regular face-to-face meetings are often out of question and finding an efficient way to arrange meetings with the help of electronic tools requires effort.
Projects where used	Omega, Alpha1, Alpha2, Gamma, Delta, Êta andThêta.
Communication needs	Informing, monitoring progress and providing transparency, problem solving, giving feedback, relationship building.
Related practices	Progress reports.

Physical meetings are difficult to arrange in distributed projects due to the geographical distances. The time-zone differences complicate matters further, making even teleconference and videoconference meetings challenging to arrange. Moreover, in large projects, there are so many participants that it is difficult for them all to be at the meeting at the same time, and in addition to that, they cannot all be interested in every detail of the project, as some of our interviewees commented. On the other hand, all team members, both from the customer and the subcontractor, need information e.g. on the project progress, changes and future tasks. They also need feedback on their work. All this informing, monitoring and giving feedback could take place during regular project meetings if they could only be reasonably arranged.

Despite the challenges many of our case projects arranged regular project meetings either using teleconference or meeting face-to-face. Only projects Omega and Alpha1 invited the subcontractors to these meetings. In project Alpha2 the customer had separate monthly meetings with each of the subcontractors, who were not allowed to participate in the customer's project meetings. Instead, the customer's project manager responsible for each subcontractor represented them in these project meetings. Projects Epsilon and Delta arranged regular meetings with their internal distributed sites using either tele- or videoconference. Projects Beta, Gamma, and Thêta had regular meetings, but in all these projects the meetings were site-specific, i.e. personnel from the customer's main site participated in their internal meetings and some of the distributed sites had their own internal regular meetings. Only the smallest two projects, Zêta and Êta did not report about having any regular meetings. In most projects the regular meetings were arranged

once a week, thus they were called weekly meetings. Only some projects had meetings more seldom, such as once a month. The length of the regular meetings ranged from half an hour to two hours at the maximum, one hour being the most popular. Some of our interviewees emphasised that the meetings should be compact.

When everybody in a distributed project could not participate in the common regular meetings, other ways to share information were invented. Some projects gathered information from distant sites before the customer's site-specific meetings and some others arranged meetings in stages. For example, project Alpha1 had arranged their weekly meeting cycle efficiently: site-specific face-to-face meetings were followed by a teleconference meeting between the team leaders and project managers from all the sites. Projects Gamma and Thêta had a different practice: the customer received weekly progress reports from the subcontractors or distributed sites first, and after that the customer had its internal weekly meeting, where also the reported information was discussed. Some of the projects, e.g. Alpha1 and Gamma, had a practice of writing memos of their regular meetings and distributing them to everybody participating in the project. Thus, also those project members not able to participate in the meetings could follow. For instance, in project Gamma the weekly meetings were the customer's internal meetings, but the subcontractors provided progress reports as an input and received the meeting memos as an output.

Project Epsilon had a practice of arranging weekly teleconference meetings between the customer company's two sites. All the team members from these sites participated in the meetings. The main purpose of these meetings was to inform and to create transparency. Netmeeting, providing voice connection and a document sharing possibility was found to be a suitable media. Since the number of participants was large, the contents and agenda were designed accordingly. Every week one team presented their progress and achievements during the last month and their future plans for the next month. Every team had this opportunity once a month. The aim of these meetings was to give all project participants a similar view of the project situation. The length of these meetings was from half an hour to one hour. Our interviewees found these meetings as a good way to share information. Because of the positive experiences, the company was planning to invite also its third distributed site to participate in the meetings.

The purpose of the regular project meetings arranged in our case projects was mainly to exchange information. The participants, especially the project manager, informed the others about the news, the current situation, and the project progress. Moreover, the future schedules and tasks, as well as open questions and possible problems were discussed. Some projects had found it useful to have both progress reports and regular project meetings. In these projects, e.g. in project Alpha1, status information was collected to the progress reports and in meetings discussions e.g. about problems were emphasized. Some other projects, especially if the number of participants at the meeting was large, felt that problem solving should be left for later discussions in smaller groups, and the meetings should focus on the project status only naming the persons who would take on the problem solving responsibility.

All the projects having regular project meetings either with their subcontractors, distributed sites, or internally, felt that the meetings were very useful. In project Epsilon, the weekly meetings were stopped for a while. Quite soon, all the teams gave feedback hoping to get the meetings back, which then led to them being reinstated. The participants

of our case projects felt that the regular meetings gave them transparency to the progress of the project in addition to distributing information. Because of these meetings, all participants had quite a good picture about the situation in the project. In case Beta the customer's project manager had once asked a developer whether the internal weekly meetings were unnecessary. She got a reply: "Not at all, otherwise I wouldn't know anything that happens here, when just sitting in my room." Many other interviewees shared this view. Moreover, the meetings also gave the participants a feeling of belonging to the same team. However, those who could not participate or were not invited to the meetings, such as subcontractors in some cases, felt that they missed a lot.

Steering Groups. Some projects, e.g. Alpha1 and Delta, had steering groups with members from both the customer and the subcontractor. These steering groups met regularly once every month or two months and discussed the current progress, changes, future directions, risks and open questions. The discussion topics were usually of higher-level issues than in normal project meetings. Project Alpha1 had a "travelling steering group" that consisted of members from all sites and partners. Since all the sites were involved, the most important decisions could be made in the meetings and none of the partners were forgotten. Because the subcontractors could participate, also their point of view and worries were taken into account. In addition to decision making, these meetings gave the participants a good overview of the whole project, which they could convey to their own teams. The fact that the meeting location changed, forced everyone in the steering group to visit all sites at least once and not everybody had to travel every time. This gave the team members at every site the possibility to meet representatives from all the other sites. This steering group normally met every six weeks.

Media. The media used in the regular meetings varied. Site-specific internal meetings were normally arranged face-to-face, but face-to-face meetings across the sites were rare. Only projects Alpha1, Alpha2 and Omega had regular face-to-face meetings with the subcontractors from distributed sites. Projects Alpha1 and Alpha2 had these meetings around once a month. Project Omega arranged the meetings weekly, which was convenient, since the subcontractors participating the meetings were all located in the same city. Teleconference or teleconference combined with document sharing seemed to be the most popular media for arranging meetings between distributed sites or partners. Videoconferencing was used only in one project, Delta, to support communication between the customer's two internal sites. Some of our interviewees from other projects had tried videoconference as well, but they did not find it useful. They felt that the picture in videoconferences was of low quality, and therefore did not bring added value. Incompatible videoconferencing equipment decreased the value further. Thus, they preferred teleconferencing to videoconferencing. One interviewee from project Alpha2 explained that they had ended up using Netmeeting in their distributed meetings after trying videoconference. Netmeeting provided both voice and document sharing, which she found useful, whereas videoconference did not add anything to that:

> **Quotation 45:** "I think that if you have never met the persons from your subcontractor, then you should meet them personally. In case you have met them, then you know how they look. Thus, seeing them poorly from the screen turning their papers does not bring any added value in my opinion. We rarely use it." (Customer's partnership manager, Alpha2)

All the projects using teleconferences or combining them with document sharing were very satisfied. Teleconferences allow lively discussions and "make distances shorter" as one of our interviewees commented. The only problems mentioned were the time-zone

differences limiting the possibilities to arrange teleconference meetings, and the difficulties of effectively giving turns to speak when the number of participants was large.

PRACTICE 13: Databases for managing changes and bugs

The key observations related to this practice, databases for managing changes and bugs, are summarised in Table 31.

Table 31. Summary of Practice 13: Databases for managing changes and bugs.

Practice name	**Databases for managing changes and bugs**
Problem the practice aims to solve	How to communicate in real time about changes and bug tracking in a distributed project?
Practice description	Providing project participants an access to change management and bug tracking systems makes communication about changes and bugs in a distributed project formal and strict.
Variations	One system that the whole project team can access is often optimal. If not possible, limited access rights or access to a replica of a subset of a selected database could be provided, e.g. to the subcontractors.
Pros	Everybody knows how to behave and all change and bug information is available in real time to everybody.
Cons	In an inter-organisational project, the partners may have different systems in use. Giving access rights to the subcontractor's or customer's personnel may be difficult.
Projects where used	Alpha1, Alpha2, Gamma, Êta andThêta.
Communication needs	Informing, monitoring progress and providing transparency.
Related practices	-

During the project execution all our case projects had several requirements changes, since there were a lot of uncertainties in these projects, e.g. the requirements were not specified in detail, and the technologies used were uncertain. Moreover, bugs requiring changes and fixes were common, which is usual in software development projects. Both changes and bugs caused a lot of information exchange between the distributed sites and companies during execution of the project. First of all, other partners needed to be informed, e.g. if the changes affected their work or if they needed to fix the bugs. Secondly, some changes were quite challenging to implement and the bugs difficult to locate and fix, thus requiring two-way discussions between the partners.

Most projects had taken into use a database system for managing changes and bugs. Quite often this system automatically took care of informing, e.g. by sending email messages when new bugs that needed action were found. In addition, the system saved all change and bug information and made that information visible also to the other team members, which was regarded as very beneficial. Unfortunately, in many projects these systems seemed to be internal and thus the subcontractors or even subsidiaries were not allowed to access them. A few projects, Alpha1, Alpha2, Thêta, Gamma and Êta, had understood either in the beginning of the project or during the project how much these access rights improved the information flow between the partners. Therefore, they arranged at least limited access to the customer company's change management and bug tracking systems for their subcontractors or subsidiaries. For projects Thêta and Êta this was quite easy, since in both projects only the customer company's own subsidiaries were involved. The

only problem was the connection speed, which was considered a bit too slow in both projects. In the other three projects the company borders made the access somewhat more difficult to arrange, but limited access rights or access to a replica of a subset of a selected database could be provided.

The projects that did not make that kind of an arrangement, took care of informing about changes and bugs between the sites and companies more informally, e.g. by sending emails, making telephone calls or by discussing the changes and bugs in meetings or through chat. This informal way was clearly not very efficient on its own, and prone to errors.

Access to the change management and bug tracking systems made the communication more formal and strict: everybody knew how to behave and all information was, at least in principle, available to everybody. From the communication point of view this was clearly a better practice than exchanging change and bug reports through email, telephone or during discussions in meetings or in chat, since these more informal ways to communicate might lead to the changes and bugs and their fixes being left undocumented. On the other hand, using a database always leaves a trace, which can be found by everybody both during and after a project. The benefits arising from the use of databases in distributed projects are actually similar to their usage in normal collocated software development projects. What is especially beneficial for distributed projects is the fact that the system takes at least partly care of the informing and provides the participants with visibility to the project situation.

The customers did not easily let the subcontractors access their internal systems, which was the case also in our case projects. For example, in project Alpha1 the subcontractor got access to a limited area of a database. That was not enough and the subcontractor needed quite often to ask for more rights, which was quite frustrating, as the subcontractor's project manager described:

> **Quotation 46:** ”It has happened many times that someone who has dependencies to our module has written a bug report, that we haven’t seen for a month. (…) And again they wonder where the problem is!” (Subcontractor’s project manager, Alpha1)

5.4.5 Monitoring progress and providing transparency

Monitoring the project status and informing about this status are the main issues discussed in this section. They are closely connected because you cannot inform about the status unless you have first explored the situation.

5.4.5.1 Monitoring progress

The customer companies of our case projects found it important to monitor the progress in the subcontractor’s teams. However, monitoring was not easy, since, e.g. measures such as the number of code lines or hours used in the coding did not give very useful information. Most of our case projects had arranged the monitoring quite well, either the subcontractor sent the customer regular progress reports, which will be discussed more later on, or the current situation was discussed in regular monthly or weekly meetings, which were described already earlier. Some projects even had both of these monitoring practices in use. In project Alpha1, for example, the customer and subcontractor had weekly teleconference meetings and the subcontractor sent monthly reports. Moreover,

frequent deliveries of code from the customer to the subcontractor were a good way to monitor the real progress in a project. In projects Thêta and Êta the subsidiaries could use the same version control system as the customer, which made it possible for the customer to monitor in real time how the work was progressing. The customers saw this as a useful opportunity that they frequently used.

Apparently, the customers normally monitored frequently how the subcontractor's work was progressing. The customers actually had a rather good picture about the situation in their subcontractor companies and at their own distributed sites. The lack of sufficient progress monitoring caused negative surprises in only a few projects. For example, in project Omega one of the subcontractor's teams was heading in the wrong direction, and since their real situation was not noticed early enough, most of the work they had done by the time the situation was discovered, had to be discarded.

5.4.5.2 Providing transparency

In the interviews we noticed that it was not only the customer's project managers who needed progress information, but also the subcontractors' personnel, the customer's distant sites and even the customer's local developers hoped to get more information about the progress of the project and its current state. Even though it was mainly progress and status information about the project that the subcontractors and distributed sites were hoping to get, we think that visibility and transparency are better words to describe their expectations. These persons hoped to gain more visibility into the progress of the project, the possible changes, future plans, and even persons present at the different sites.

The customer's system architect in project Beta commented on the situation and believed that their subcontractors' situation is even worse than his own situation regarding to project transparency:

> **Quotation 47:** "I don't have any concrete possibility to follow the project progress. The only possibility is to communicate with project managers. (…) I would like to know exactly what the situation is, how much we are late, how much is still undone, what the effort estimates are, etc. I am interested to know. (…) I feel that they [the project managers] know the situation, but they don't tell everything. (…) Maybe they don't want to stress us about being late or something. (...) Or maybe they just don't know the exact situation. Anyway, I would absolutely like to get more information." (Customer's system architect, Beta)

The project personnel seemed to be very happy if they gained any visibility into project's current state. For example, a customer's developer in project Delta told us about their internal practices to create transparency:

> **Quotation 48:** "Every two or three months we have a status review. The program leaders visit every site and present the program status. (…) It is good to see the situation quite broadly. In your daily work you see only your own small piece. (…) It is useful to have every couple of months this kind of reviews that enable you to see the whole program. (…) Every week we have an internal project meeting where you can see the situation at project level. (…) I would still like to have more transparency to the project progress, especially to be able to compare our short-term goals and schedules to the actual progress. (…) In our project meetings we are verbally informed about it, but it is difficult to get a picture of the situation. I would like to have graphical presentations about the progress, because from them you could see the situation at a glance." (Customer's developer, Delta)

The interviews showed us that in addition to helping the personnel at distant sites to accomplish their tasks, all transparency of the project situation also helped motivate them,

e.g. to adhere to the schedule, since they understood better why it was important. The subcontractors commented that in parallel development situations in which the work of the various sites and partners is strongly interconnected it is important to have the status information flow not only from the subcontractor to the customer, but also in the other direction.

Visibility on who are currently present at the distant sites, was requested e.g. in project Thêta. The lack of this transparency caused problems in that project. For example, the customer's personnel sent email messages to the subsidiaries and if someone was on a holiday or sick, they did not get any answer. In their local office the customer's personnel was using automatic "out of office" messages which the email program sent as a reply, when someone was away more than a day. Then, the sender knew to contact someone else when he got this message as a reply. Problems arose with the subsidiaries, since the personnel there did not use that practice. Thus, the sender could not know whether the lack of reply meant that the receiver was e.g. solving the problem he had received via email, or whether he was out of office. If the sender had known the situation e.g. that the person was sick, he could have sent the message to someone else and not waited unnecessarily. Those projects that used chat programs had noticed that the program's feature of showing who are currently present is a useful one in a distributed project regarding communication. That feature allows checking who is present at distant offices and available for communication either through chat, phone or email.

To summarize, the subcontractors, distant sites and even the company's own collocated developers hoped to gain more transparency especially regarding the progress of the whole distributed project. They often felt that the information was flowing only to one direction, i.e., upwards, to the customer and the customer's project manager, and not to the other direction, even though that seemed to be equally important.

5.4.5.3 Practices related to monitoring progress and providing transparency

Many of the practices mentioned earlier are clearly related to the monitoring progress and providing transparency, e.g. the practices "regular meetings" and "databases for managing changes and bugs", that were presented above. One practice not mentioned earlier and related to monitoring the progress and providing transparency is *progress reports,* which will be presented next.

PRACTICE 14: Progress Reports

The key observations related to this practice, progress reports, are summarised in Table 32.

Table 32. Summary of Practice 14: Progress reports.

Practice name	Progress reports
Problem the practice aims to solve	How to monitor progress and provide transparency in a distributed project?
Practice description	Progress reports are collected regularly from the distributed partners. They can include information about the tasks accomplished, future tasks, problems, open questions, risks, etc.
Variations	Weekly reports are most common, but depending on the project phase and size different intervals can be used. The report length, contents and formality can vary. Normally the customer's project manager collects reports, he may also combine them and send a summary to all the distributed participants. The progress reports can be combined with regular meetings.
Pros	When the reports are extensive enough they provide a good picture of the project situation.
Cons	A short report may not contain enough information and the writer may try to hide problems.
Projects where used	Alpha1, Alpha2, Beta, Gamma, Epsilon, Zêta andThêta.
Communication needs	Monitoring progress and providing transparency, informing.
Related practices	Regular meetings, frequent deliveries.

The customers asked their subcontractors to send progress reports in projects Alpha1, Alpha2, Beta, Gamma and Zêta. In projects Epsilon and Thêta, the progress reports were sent only between the distributed sites of the customer company. None of the projects sent only time reports. Instead, the reports included quite a lot of information. For example, a weekly report could include the tasks accomplished during that week, comparison to the plan, the tasks planned for the following week, open questions, problems, risks, and future estimations about the task and problem solving schedules.

Normally, the length of these reports was a few pages. The projects had experimented with different lengths and formats to find a balance between the level of details needed and suitable length. If there was too much information, people did not have time to read the report. If the reports were very short, there was a risk for the information being too superficial and not useful to anyone. For example, the customer's project manager in case Thêta explained that if a problem is described too superficially, no one understands it and ends up thinking that the sender will probably solve it on his own. But when it is described properly, someone might notice e.g. that the subcontractor is using an old version, or that someone had had that same problem already earlier, or that the problem is not even a relevant one. The format of the progress reports was often quite free, they could be written with bullet points or include some tables.

How often the progress reports were written and sent depended e.g. on the project phase and on the other practices that were used for monitoring. For example, in project Alpha1, the project meetings partly compensated for reports, thus the subcontractor sent the progress reports only monthly. The most common cycle in our case projects for sending the reports was once a week. But in some projects and project phases also different cycles

were used, such as once a month, every two weeks or even daily. This most intensive reporting rhythm was used in some projects especially in the testing phase.

In project Zêta the subcontractor normally sent progress reports once a week, but during the most intensive phase progress information was sent daily. The customer's project manager was very satisfied with that:

> **Quotation 49:** "…in that phase [the most intensive development phase] we got daily progress information [from the subcontractor] after each working day. That was great! You knew all the time what was still undone. (…) It was a very simple email, there was first the names of all [subcontractor's] team members and after each name their working hours and a few bullets about what they had done during that day, and a few bullets about what was still left." (Customer's project manager, Zêta)

In a few projects the customer's project manager put together all the reports he or she got from the subcontractors and distributed sites and sent that summary report to everybody. This practice was used e.g. in case Thêta. In that project, the project manager made summary reports of the whole project and one subproject manager collected the summary reports of her subproject. The customer's project manager explained what these summary reports included:

> **Quotation 50:** "It was a simple table, one row for each subproject. There you could find the tasks done during this week, planned tasks for the next week, open issues, problems, questions and risks. There could be e.g. ten bullets about the tasks done, etc. They were just short sentences, so that we knew what it was about and could ask more if needed. (…) It was of course hard to collect it every week, since I had to pressure them a bit to get the information. (…) However I believe that especially for our foreign sites it was a good way to know how things were progressing and that there is life elsewhere too." (Customer's project manager, Thêta)

The customer's subproject manager in that same project felt that the progress reports she compiled were useful both for her and all the others:

> **Quotation 51:** "It has been useful for me to prepare the progress reports since putting them together requires me to ask people what they have done. It is a good way to follow what is happening and what needs to be done. Because of these weekly reports monitoring is much easier. I hope that it is useful for all the others, too. They can see from the report what others have been doing and what is the overall situation in the project. (…) I hope that if someone has already had the same problems [that are listed in the report], he will notice it and that way at least part of the problems can be easily solved." (Customer's subproject manager, Thêta)

The developers from the subsidiary (project Thêta) considered the reports useful. The reports helped them understand how the project as a whole was progressing, and whether someone already had faced the same problems.

In project Beta, monitoring was a combination of meetings and reports. The customer's subproject manager explained that she got progress reports from the subcontractor and from their foreign subsidiary always on Mondays. On Tuesdays she had a weekly meeting with the subproject team members working at the local site. After that she had a very good idea of the situation in her subproject. Finally, on Wednesdays she participated in the project coordination group meeting, where she reported the situation in her subproject.

Also in project Alpha1 the monitoring included both meetings and progress reports. The customer and the subcontractor had a set of weekly meetings, both local face-to-face and distributed teleconference meetings. In addition to that, the subcontractor and the customer company's own distributed site submitted monthly reports to the customer. In

the early phases of the project, the reports concentrated on the status information, later on they moved more to foreseeing the future, e.g. estimating the risks and possible problems. The subcontractor saw that it was important that the customer commented every point, especially the problems and risks, since they often required the customer to do something. If there was no reaction from the customer's side, the subcontractor contacted the customer and asked for comments.

Both the customers and the subcontractors in our case projects regarded the progress reports as useful. When the customer knew the situation in the subcontractor's teams, it could react quickly if the project was not going in the right direction and could also help in resolving problematic situations. The possible feedback received from the customer gave the subcontractor confirmation that the correct tasks were being performed. Getting feedback also motivated the team members. Moreover, if a summarising progress report was sent back to everybody, they got a good picture of the situation in the entire distributed project.

5.4.6 Giving feedback

In our case projects the subcontractors really appreciated getting feedback e.g. about the quality of their work. They hoped to get comments also when they were doing something right, not only when things went wrong. Getting feedback seemed to be also a motivating factor. We found that in some case projects the subcontractors did not receive any feedback on their work. In those projects it seemed that this communication need was totally ignored. Luckily, we came across a couple of successful practices as well.

The subcontractors were very happy when they received feedback. The customer's project manager in project Beta told us that their own foreign subsidiary had hoped for feedback, thus she visited them a few times:

> **Quotation 52:** "They were very happy when we visited them with the end customer, since they could feel that we were really interested in what they did. They have said all the time that it is important that they can feel that their work is valuable, and that they do not have to hear only complaints, and commands to 'repair this and this'. Instead, they would like to be in the same boat, really working together." (Customer's project manager, Beta)

The feeling that their work is appreciated seemed to be important to the subcontractors' personnel. In project Thêta, the Swiss subsidiary was given a tight schedule and since the project contact person from the customer always answered their questions very quickly, they expected that the project was important for the customer. However, when they made the final delivery of their module, the only feedback they received was the comment "fine". Then they started to wonder what had happened, whether there were bugs and whether their module was taken into use or not. They were certain that there had to be bugs that were found when integrating the module with the rest of the system and hoped that the customer would invite them to help with the integration. But they heard nothing. Thus, even though this subproject had been excellent according to both the customer and the subsidiary, the subsidiary's project team felt very bad after the project. They had worked hard to reach the tight deadline, but after that they had heard nothing. They started to doubt whether the project was important at all. Probably next time when the customer starts to cooperate with its subsidiary, the subsidiary's team will have doubts and their motivation is not as high as it could be.

5.4.6.1 Indirect feedback

In addition to giving the subcontractors direct feedback, the customer also often gives them indirect feedback. The subcontractors interpreted as feedback, e.g. how well and quickly the customer answered their questions, what was the style of writing in the emails they received, whether they were invited to project meetings and parties, and whether they were informed properly.

When interviewing the subcontractor's or subsidiary's personnel we asked them which company they felt they belonged to. Most of them answered that they felt that they belonged to the customer company or to the project team of the whole distributed project. However, quite often they felt that the customer company treated them as second-class citizens and not as equal team members. For instance, the subsidiary's project manager in case Beta expressed it "You get a feeling that we are ONLY subcontractors". Another example was realised when we travelled to interview the subcontractor's project manager in case Alpha1. We had a meeting at the customer's premises, since this project manager had other meetings there on that same day. The customer's project manager had reserved a meeting room for us. However, when we arrived at the reception, we were informed that we were not allowed to be in that meeting room without someone from the customer company present. The subcontractor's project manager commented, "This is how the subcontractors are normally treated here".

5.4.6.2 Listening to the ideas

An important and motivating sign from the customer was at least to listen to all the ideas coming from the subcontractor. It was even better if some good ideas were implemented. If the treatment was curt without good reason, the effect could be exactly the opposite. For instance, the subsidiary's project manager in case Beta was unhappy when telling us how badly the customer's subproject manager had treated her developer's ideas. She doubted whether this person treated the ideas coming from her own developers in the same ways as the ideas coming from the subsidiary's developers.

Fortunately, some managers had different kinds of practices, e.g. the customer's project manager in project Gamma thought it important to listen to the subcontractor's ideas:

> **Quotation 53:** "I have noticed that it is essential to give [subcontractor's people] a possibility to present their own ideas. (…) It is important to listen those ideas and not just to say that now you should do this and this. Instead, we should listen to them." (Customer's project manager, Gamma)

The subcontractors in projects Beta and Thêta were pleased because the customer had listened to their ideas and thoughts about possible improvements. In addition to that, the customer had implemented some of their suggestions. Listening and implementing the ideas coming from the subcontractors seemed to be beneficial, since they might have very useful suggestions. In addition to that, by giving the subcontractor's team a possibility to influence the project in this way, their commitment to the project improves according to our interviewees.

5.4.6.3 Practices related to giving feedback

The practices related to giving feedback, *design and code walkthroughs* and *lessons learned*, will be presented next.

PRACTICE 15: Design and code walkthroughs

The key observations related to this practice, design and code walkthroughs, are summarised in Table 33.

Table 33. Summary of Practice 15: Design and code walkthroughs.

Practice name	Design and code walkthroughs
Problem the practice aims to solve	How to ensure that the participants of a distributed project have understood the requirements and coding instructions correctly?
Practice description	Common code and design walkthroughs can be used as early checks that the distributed teams have understood the requirements and coding instructions correctly.
Variations	Most useful when arranged early enough when only part of the coding or designing has been done, so that the teams get feedback as quickly as possible. In addition to face-to-face walkthroughs, using Netmeeting or even commenting by email or phone can help already.
Pros	Helps ensure that distributed teams have understood the requirements and coding instructions correctly and are progressing in the right direction. The teams appreciate early feedback.
Cons	When done in a late phase some of the benefits are lost.
Projects where used	Alpha1, Beta, Gamma, Delta, Epsilon, Êta and Thêta.
Communication needs	Giving feedback, monitoring progress and providing transparency.
Related practices	Frequent deliveries.

Arranging design and code walkthroughs both with the subcontractors and with the company's own distributed sites seemed to be useful. Walkthroughs were arranged with the subcontractors in projects Alpha1, Gamma, Delta, and Epsilon. Internal company walkthroughs with distributed sites only were arranged in projects Beta, Thêta and Êta. The walkthroughs were used as early checks that the distributed teams had understood the requirements correctly and were doing what they were supposed to do. In later stages, the deliveries of code could fulfil this need. The distributed sites also felt that the walkthroughs were useful since they got immediate feedback on their work. These walkthroughs were the most useful when arranged early enough, i.e. when the subcontractor had not designed or coded too much. For example, in project Thêta the customer's subproject manager travelled to the newly bought Swiss subsidiary for a design walkthrough when the Swiss team had designed the first few use cases. He gave the team feedback and guided them into the desired direction. During his next visit the customer's subproject manager arranged a code walkthrough for the implementation of these first use cases. After that, the implementation could safely start on a broader scale, and everybody knew that the work was on the right track. The customer's subproject manager explained us his reasons for arranging these walkthroughs:

> **Quotation 54:** "The idea was that they [the Swiss team] implement a couple of use cases there first. And then we review the code together, so that I can make sure that the work progresses into the right direction there. (…) These two use case were then regarded as a kind of coding standard. I think that this was a good idea to do in that phase. Then you can see if it is going in the wrong direction and you can still do something about it." (Customer's subproject manager, Thêta)

The whole Swiss team participated in the walkthroughs. They appreciated very much the feedback they received. The customer had sent them coding examples, but that was not enough to understand the coding standard the customer wanted to use. Altogether the customer's subproject manager visited the Swiss team for three walkthroughs. During these visits, he could also answer questions and help with problems.

In project Beta, the customer reviewed in the beginning all the code their subsidiary delivered. The subsidiary's project manager was satisfied with getting feedback both about the problems that needed corrections and positive feedback about the things that were done well. She doubted whether the cooperation would have succeeded without this feedback.

In some projects the walkthroughs were done at rather late project phases to be as useful as they could. For example, in project Delta the customer wanted to review all delivered code, but because of late reviews the same mistakes occurred repeatedly in the code. In many projects the customer had coding guidelines for the subcontractor to follow. However, merely giving the guidelines did not seem to be enough, but walkthroughs were needed as well to ensure correct understanding.

The walkthroughs were not always planned beforehand. For instance, in project Gamma the customer's project manager had felt that he did not know what was going on at the subcontractor's. In consequence, he decided to arrange a design walkthrough, which helped.

One or two successive design or code walkthroughs were often regarded as sufficient, since they already pointed the way. In addition to having normal face-to-face meetings, the walkthroughs could be arranged using Netmeeting or the reviewers could send their comments by email. These comments were then discussed by email or telephone.

PRACTICE 16: Lessons learned

The key observations related to this practice, lessons learned, are summarised in Table 34.

Table 34. Summary of Practice 16: Lessons learned.

Practice name	Lessons learned
Problem the practice aims to solve	How to collect feedback and improvement ideas from distributed teams and how to give feedback to them?
Practice description	In the end of a project lessons learned sessions can be used to collect development targets, improvement ideas and successful practices from the project participant to benefit future projects. Feedback to project participants can be given as well.
Variations	Can be arranged as one meeting or separate meetings at different sites, can even be combined with the kick-off meeting for the following project.
Pros	Gives an opportunity to collect valuable information and give feedback. Gives a clear closure for a project.
Cons	Some of the information learned during a project may have already been forgotten. The collected information may not be used.
Projects where used	Alpha1, Gamma and Delta.
Communication needs	Relationship building.
Related practices	-

In projects Alpha1, Gamma and Delta, inter-organisational lessons learned sessions were arranged at the end of the project. The main reason for the customer companies to arrange these meetings was to gather feedback from persons who had worked in the project in any of the participating companies. The customers were looking for development targets for their following projects, improvement ideas, and successful practices. In addition to that, the lessons learned sessions offered an opportunity to give feedback to all developers, and also to the subcontractors. However, it seemed that in the case projects giving feedback to that direction did not receive as much attention as it could have been given. On the other hand, already gathering and discussing improvement targets and ideas together with the subcontractors was a kind of feedback to them, as well.

In project Gamma the customer's project manager commented that the lessons learned sessions were an important means to bring out the problems so that they do not disturb the following projects. In this company's projects the lessons learned session was sometimes combined with a kick-off meeting of the next project. This seemed to be a convenient combination for that company, since the subcontractor's personnel had to travel only once. Normally, a few persons from the subcontractor participated in these meetings. The same subcontractor had worked in several consecutive projects for the customer. The customer's project manager pointed out that the lessons learned meeting at the end of the project also functioned as a clear sign of closing the project. Since the same team from both companies often continued in consecutive projects, it had been sometimes difficult to say where one project ended and the next one began. Moreover, this project manager saw the lessons learned session as more important than the kick-off meeting, because of its learning dimension.

In project Alpha1 the customer's project manager arranged a separate lessons learned session at every project site, also at the subcontractor's site. The emphasis in these sessions was on gathering feedback, mainly improvement ideas, from all personnel.

Unfortunately, we could not collect many experiences about lessons learned sessions, since the projects were still ongoing, and thus most of them had not reached the phase where the lessons learned sessions are normally arranged.

5.4.7 Relationship Building

When starting a distributed inter-organisational project it is quite common that the project personnel coming from different organisations do not know each other beforehand, as was the case also in the projects that we studied. In that kind of projects early relationship building and trust building are especially important for the collaboration to succeed. Relationship building actually takes place during all collaboration and communication between the parties. However, in distributed projects the communication possibilities are much more difficult to arrange than in collocated projects.

5.4.7.1 Early face-to-face meetings

It is normally easier to communicate with a person whom you have met at least once. Therefore, when starting a distributed project with several partners and sites that have no common history, an optimal solution would be to have all involved personnel meet face-to-face. Early face-to-face meetings also facilitate later electronic communication. For this kind of situations the literature suggests common kick-off meetings for the entire

project (Carmel, 1999). If a kick-off meeting could not be arranged, our case projects found it useful to arrange other face-to-face meetings for persons acting as important communication links. For example, system architects or other key persons could go to the subcontractor's site to train the project team there, or some subcontractor's key persons were invited to the customer's site for training or for a short collocated working period. All these early meetings and successful collaboration during the project build trust between the participants. When the participants have managed to build a good collaboration relationship in the early phases and they trust each other, subsequent collaboration and communication is easier.

5.4.7.2 Trust building based on professional skill

When there were limited possibilities to arrange face-to-face meetings, other practices to build good relationship and trust between participants were found. The practice presented earlier, "frequent deliveries", was useful also from a trust building point of view, since being able to produce functioning code in the early phase of the development builds trust between the parties. This trust is based on their professional skills.

We noticed also other ways to build trust between distant partners based on their professional skills. For example, in project Zêta a developer from the customer company communicated with the subcontractor's Chinese developers only through email and chat, and started to trust these developers when receiving their feedback:

> **Quotation 55:** "It was nice to build trust this way when you notice that they give relevant feedback and you find out that these guys know their stuff. That became obvious quite quickly." (Customer's developer, Zêta)

In project Beta the project manager started to trust the subcontractor because of their skills and open and honest communication:

> **Quotation 56:** "They [team members from subcontractor] have been so honest and open and really skillful. They have asked questions, made suggestions and clearly proven to be professional. In some phase I noticed that I trust them more than our own people!" (Customer's project manager, Beta)

The subcontractor from the same project felt that they had gained this trust by working successfully and thus achieved a better position:

> **Quotation 57:** "During this project we have gained trust through successes in the development and working practices. Thus, we have gained more freedom and responsibilities in this project. (…) Typically, trust is built through working together." (Subcontractor's project manager, Beta)

Another example comes from project Thêta, where trust was built during collaboration between the personnel from the customer company and its two subsidiaries. The customer's developers noticed quite quickly that in the Danish subsidiary the personnel were really skillful, since they could pose difficult questions. Thus, the motivation of the customer's developers to answer their questions rose, since they did not want to keep these skillful developers waiting:

> **Quotation 58:** "We have always tried to answer quickly any questions coming from the Danish site, since they have always asked relevant questions and we know that they are doing high-quality work. It is a kind of moral obligation. You just help quickly your fellow workers in trouble. It surpasses all other tasks. (…) On the other hand, from Germany from some persons we got very simple questions. Your motivation to answer decreases quite quickly when you notice that they don't follow and they don't even try to figure it out. Then our service level in

> answering the questions drops. It's about respect between the developers. When you have a high opinion on someone you want to serve him quickly. (…) When working with the Danish site we noticed that there is knowledge transfer from them to us, which has also added our motivation. Our cooperation functions very well. Not only do they build us software, but we can learn from them, as well. This has motivated us to cooperate more with them and share knowledge in both directions." (Customer's system architect, Thêta)

The above examples show that proving one's professional skills builds trust and improves later communication and collaboration during the project. This way trust can be built even without any face-to-face meetings, like the example from case Zêta showed.

5.4.7.3 Organisation chart

An organisation chart covering the whole inter-organisational project was missing in many of our case projects. This was quite surprising, since it is quite an easy thing to draw up, and can help a lot. Such a chart makes it easier to find the correct persons to contact when questions emerge. In project Gamma a simple web page with information about the project personnel, including names, roles, photos, and contact information was regarded as very useful:

> **Quotation 59:** "We are actually just now creating a web page, where we put the roles in every project, the names of persons taking care of those roles and their photos on our common web server [that both subcontractor and customer can access]. For some reason it is nice to see what the person you are talking to on the phone looks like." (Customer's process developer, Gamma)

In another project, case Alpha1, the customer did not want to give the subcontractor its internal organisation chart, which caused difficulties to the subcontractor. The subcontractor's project manager tried to solve the problem by creating to their intranet an organisation chart of the customer by adding new persons, their roles, and their contact information, when he met them. He was planning that in the next project this kind of an organisation chart will be done at the project start-up and will include also photos of the whole project team, since it seemed to be quite probable that for cost reasons everybody cannot meet face-to-face.

Also other projects had experienced similar problems of not having a good picture of the whole distributed project team. Thus, some of our interviewees hoped to get a better description of the project organisation already at the project start-up.

5.4.7.4 Practices related to relationship building

Next, the practices that our case projects noticed to be useful for relationship building, *kick-off* and *giving faces,* will be described in more detail.

PRACTICE 17: Kick-off

The key observations related to this practice, kick-off, are summarised in Table 35.

Table 35. Summary of Practice 17: Kick-off.

Practice name	Kick-off
Problem the practice aims to solve	How to get project participants from distributed sites acquainted with each other and project goals and tasks?
Practice description	A common kick-off meeting for a project or a sub-project team, consisting of members from different sites and partners includes both official program about the project and unofficial program for the participants to get to know each other.
Variations	In a small project it may be possible for everybody to participate in one kick-off, but in a large project sub-projects can have their own kick-off meetings. One possibility is to invite only key persons, or arrange a kick-off in connection to some other meeting or training.
Pros	Participants of a distributed project get acquainted with each other, project goals and tasks, and the roles of different partners.
Cons	Travelling can be expensive, thus in a project with long distances a common kick-off may not be the best solution.
Projects where used	Alpha1, Alpha2, Gamma and Thêta.
Communication needs	Relationship building, informing.
Related practices	Giving faces.

For start-up of a new distributed project, the literature often suggests arranging a common kick-off meeting for the whole project team. However, in practice our case companies seldom found it possible to arrange kick-off meetings for the whole project or even for a sub-project. Actually, none of the studied projects arranged a common kick-off meeting where they would have invited all project personnel participating in the project, both from the customer and the subcontractor companies. This was probably mainly due to cost reasons, since many of the projects were large and the distances to travel were long. Moreover, in many case projects the personnel had not even thought of arranging a kick-off meeting, since they were not used to having them. Still, a few projects, Alpha1, Alpha2, Gamma and Thêta, arranged kick-off meetings for a smaller group of people, e.g. for their subproject team or the company's internal project team. In the customer companies of projects Alpha1, Alpha2 and Gamma arranging kick-off meetings seemed to be common, but inviting the subcontractors was quite new. Normally, the aim of the kick-off meetings was that the project participants from geographically distributed sites get to know each other and also get acquainted with the project goals and tasks, and roles of the partners.

The customer's subcontracting manager from project Alpha1 told us that they normally arrange a kick-off meeting where they invite also the subcontractors if very close collaboration during the project will be needed:

> **Quotation 60:** "If we have closely collaborating teams from our company and from the subcontractor, we quite often arrange a kick off meeting for these people. The main reason is to establish communication links. The team members also meet in person and get to know each other. (…) It is a kind of team building. (…) These meetings last normally one day." (Customer's subcontracting manager, Alpha1)

The programme during that kind of a day includes presentations of the project team, the project goals, and the schedule. In the end of the day the programme is more unofficial, during which the people can get to know each other. In spite of all good intentions, this case project, Alpha1, did not arrange a real kick-off meeting, but replaced it with a two-day planning meeting, in which the project managers, team leaders and some other key personnel of this subproject participated from all four sites. The customer's project manager saw this meeting as a very successful one. According to him the meeting had perfect timing, right after the project set-up was decided and planning together was needed. During those two days many things were agreed and new ideas came up. Moreover, the participants got to know each other quite well while meeting face-to-face and spending time together. Even so, the subcontractor's project manager was quite unhappy when everybody could not meet:

> **Quotation 61:** " Everybody should be present in a kick-off, since the idea is to get to know each other. Then you realise that there is a person at the other end of the phone line. (…) Our work would have run more smoothly, if everybody had met everybody. (…) In the next project that we are just starting we try to learn from earlier mistakes. (…) Our goal is to gather together as many persons as possible." (Subcontractor's project manager, Alpha1)

In project Alpha2 the kick-off meetings were typically small and team-specific. If the subcontractors were involved, at least their most important link persons were invited. The customer company saw the kick-off meetings as important opportunities to build commitment between the collaborating partners and to increase motivation. In addition, the subcontractor's personnel should get a feeling of being a part of the project and understand their role and their importance for the success of the project. Moreover, the team members learn to know each other in a kick-off.

In project Gamma the customer company invited also the most important persons from the subcontractor company to the kick-off meetings, in addition to their own personnel. Sometimes even the entire subcontractor staff was invited. Since the customer and the subcontractor had already had several consecutive projects, they used to combine a lessons learned session of the previous project with a kick-off meeting of the next project. Their kick-off meetings concentrated on clarifying the team members' roles in the coming project, explaining the content and tasks of the project, and on building team spirit. The customer company's project manager explained that without this combined lesson learned and kick-off meeting, it would be difficult to see when a previous project ends and the next one begins.

PRACTICE 18: Giving Faces

The key observations related to this practice, giving faces, are summarised in Table 36.

Table 36. Summary of Practice 18: Giving faces.

Practice name	Giving faces
Problem the practice aims to solve	How to improve collaboration and communication between distributed project participants not familiar with each other and to avoid negative attitudes towards distant partners?
Practice description	Arranging opportunities for everybody to meet at least someone from all the other sites he or she will be collaborating with, gives these distant sites and partners "faces".
Variations	Most useful when meeting opportunities are arranged in the early phases of a project, can help also when facing problems. Can be arranged in connection with other meetings, trainings, collocated working periods, etc. Meetings do not even have to be work-related.
Pros	Meeting collaboration partners face-to-face makes later collaboration and communication easier.
Cons	Requires expensive travelling as well as planning the most useful meeting opportunities.
Projects where used	All.
Communication needs	Relationship building.
Related practices	Kick-off.

We noticed in our study that distant sites and subcontractors were easily forgotten. Their questions were not regarded as important and urgent to answer as the questions from colleagues nearby. It seems to be much easier to disregard questions or deliveries coming from unknown persons. If a common kick-off meeting was not arranged in the beginning, our case companies arranged other possibilities for collaborating team members to meet during the project, using trial and error technique, most often in response to problems.

"Giving faces" in the beginning of the project. Arranging an opportunity in the early phases of the project for everybody to meet at least somebody from all other sites he or she will be collaborating with, seemed to be a well working practice in our case projects. This gave the distant sites and companies "faces", i.e. they were no longer unknown and easily disregarded partners, when the team members knew at least someone from each site. "Giving faces" to the sites seemed to be one of the major benefits of various face-to-face meetings in our case projects. Another benefit was the meeting and getting to know how a collaborating team member looked and what kind of a person he or she was, which made future electronic communication much easier, as a subcontractor's project manager in case Beta explained:

> **Quotation 62:** "The most important reason to meet the whole project group at some phase is to learn to know the people. Then everybody has the courage to make phone calls, when he or she knows how the other person looks. This is actually the only reason to meet face-to-face." (Subcontractor's project manager, Beta)

Getting to know the collaborating partners personally was experienced to be beneficial. After that, the physical distance did not matter that much, as a project manager from project Êta commented. He had visited the Indian team for a week and after that, additional visits were not needed:

> **Quotation 63:** ”The distance does not matter so much, when I already visited them and know everybody. When you learn to trust those guys then it does not matter so much that you cannot meet. (…) I think that we have quite good communication tools: with Messenger we can communicate in real time and also email works. I think that we do not have so much need to be there.” (Customer’s project manager, Êta)

Some of our interviewees had marked that it did not matter so much what the collaboration partners did together when the aim was to get to know each other. Also activities not related to work served the purpose. After these visits the communication had improved a lot, as a customer’s developer working as a visiting engineer in project Epsilon had noted:

> **Quotation 64:** “I noticed when I visited the Malaysian office that it is of primary importance to do something together with those people. It probably does not matter what it is, it could as well be a beach holiday or something. When you know those people the threshold to communicate is lowered so much!” (Customer’s visiting engineer / developer, Epsilon)

In project Gamma the customer’s process developer had had similar experiences on how merely “doing something together” improves communication between partners. Thus, they arranged opportunities for the software testers to meet:

> **Quotation 65:** “The aim is that our software testers who work with them [the subcontractor’s personnel] would meet face-to-face at least once a year. Maybe they could drink together vodka in St. Petersburg or drive go-karts in Finland. It is so surprising that even though they would not talk about the project at all, the communication always improves. (…) For example, we are arranging this summer a meeting between our software testers who work with the subcontractor and all their testers working on our projects.” (Customer’s process developer, Gamma)

A practise presented earlier, a travelling steering group, was also beneficial in giving faces to the different sites, when these meetings were arranged around the network of sites.

”Giving faces” after facing problems. Even though many of our interviewees thought it was important to meet the collaboration partners in the early phases of the cooperation, many of our case projects arranged opportunities for face-to-face meetings only after facing problems. This happened, for instance, in projects Epsilon and Beta.

In project Epsilon, the customer’s testers were reluctant to test the code delivered by a foreign subcontractor. They preferred to test their local co-worker’s code first. After mutual visits the communication barrier between the customer and the subcontractor became lower and the situation improved significantly. After the visits the subcontractor’s personnel was confident to ask for help even when having only small technical problems. Earlier, they had tried to solve all problems on their own. The project manager from the customer company commented:

> **Quotation 66:** “We had difficulties to get our acceptance testing people to understand that we are in the same boat [with our subcontractors] and it is no use being enemies. (…) [The reason] might be that when these developers get a delivery and it is not functioning perfectly well, and they know that it is not made by their friends here, but by someone living in Turkey who they think is trying to do it as cheap as possible. (…) And that was the reason why it [testing] was delayed here, because it was not motivating. (…) [In this project] we learned a lot (…) about communication and how much it actually helps to see those [subcontractor’s] faces. It was difficult to believe it beforehand!” (Customer’s project manager, Epsilon)

In project Beta, a joint cruise trip was organized in the middle of the project when the project was facing challenges. The project manager explained her motivation for arranging it:

> **Quotation 67:** "This had already been such a long project that I felt that to keep people motivated during the challenging final steps of the project we should do something together." (Customer's project manager, Beta)

The project manager had planned official programme only for one hour, the rest was reserved for the people to get know each other. Before this meeting, the subcontractor's personnel had never been invited to any project meetings or other happenings arranged for the whole project. Thus, many of the workers from the different sites had never met each other before. After the trip the communication and collaboration improved according to the interviewees. A customer's subproject manager saw this as a very successful get-together:

> **Quotation 68:** "There were many happy get-togethers, when persons that had been exchanging emails for two years saw each other for the first time. Namely, the subcontractors had not been invited before to any of our general meetings or happenings. (…) The participants regarded this as a very successful event. (…) There were several persons that saw each other for the first time. Thus the persons with whom they had been exchanging emails got now faces. That was great!" (Customer's subproject manager, Beta)

Other parties of this distributed project saw the trip as very useful, as well. The project manager from a subsidiary commented this trip:

> **Quotation 69:** "The trip was useful, because there we saw persons we had never met, but with whom we had been exchanging email every day. We also met the end-customer for this project for the first time." (Subsidiary's project manager, Beta)

The project manager of the subcontractor company was also positive:

> **Quotation 70:** "The trip was a good gathering. It energized this project. It has really paid its price back many times!" (Subcontractor's project manager, Beta)

Continuation visits. In addition to the first visits that "gave faces" and taught the distant team members to know each other, some longer lasting projects had found it useful to arrange additional visits later on during the project. For example, interviewees from projects Alpha1 and Gamma explained that for maintaining team spirit, face-to-face meetings are needed at least once a year during the project. These visits were arranged, e.g. after reaching a milestone, which offered a perfect opportunity to celebrate a common achievement together. Visits can be useful also without any special reason, as one project manager had noticed:

> **Quotation 71:** "In the beginning the Danes sometimes travelled to meetings in Finland. Then we made a mistake when we did not show them around here to meet all our team members during the same visit. Some of them met our key developers only a few months ago even though they could have met two years ago! Now we have tried to show them everyone here when they have visited, so that they can get a picture of the people working here. Another thing we have learned is that it is useful to have mutual visits every now and then, if just possible, even though you might not have any special reason. You will notice that there is a lot to talk anyway, open issues etc. The world looks like a much brighter place after that kind of a day!" (Customer's project manager, Thêta)

Another reason to have these continuation meetings is to maintain motivation of the distant teams. Especially when someone from the customer company, e.g. a customer's project manager visits the subcontractors regularly, they get a feeling that they are

regarded as important and their motivation and commitment to work for the project improves. The same is true with visiting the company's own distant sites. Moreover, if the developers from distant sites can meet the project manager for the whole project regularly, this has also a motivating effect, as a customer's process developer from project Alpha2 explained:

> **Quotation 72:** "According to our experience, the boss should be physically available for discussions every now and then. (…) The program manager should visit all the sites preferably once or twice a month, or at least four times a year, so that the people can discuss with him and identify that this is our leader. If he is just a face on the screen, then he is not really our program manager. (…) If the program is very large, then this person should be the project manager that is closest to these people. It builds team spirit and increases motivation. People notice commitment from very small signs. (…) Software developers read from these small signs whether they are regarded as important and their work as valuable." (Customer's process developer, Alpha2)

5.4.8 Summary of the communication practices

The previous sections presented the communication practices collected from our case projects. The aim of those sections was to provide answers to the main research question about what kind of communication practices are used in inter-organisational, geographically distributed product development projects.

The described communication practices were grouped under seven headings: collaboration process, establishment of peer-to-peer links, problem solving, informing, monitoring progress and creating transparency, giving feedback, and relationship building. These headings arose from the data. The five last headings were communication needs that seemed to require communication practices to fulfil them. The two first ones, collaboration process and establishment of peer-to-peer links, included practices that could have fulfilled several communication needs, but it seemed to be more logical to present them as separate groups.

When we started our interviews we did not have any ready-made list of possible communication practices. Instead, we asked our interviewees to describe quite freely the communication practices they used in their distributed projects. Moreover, we improved our open-ended questions all the way during the interview round, based on the results from the earlier interviews. This way we felt that our questionnaire improved during the interviews, when our interviewees mentioned matters that we had not understood to be important when preparing the initial questionnaires. For example Patton (1990) recommends this method.

Due to this exploratory approach of our study, we cannot give exact lists of which practices were used in which projects. The final set of communication practices was formed from the data during several analysis rounds. In addition, all the practices used in the different projects differed somewhat from each other. Thus, when analyzing the data, we needed to determine when these slightly different practices could be combined and categorised as one practice, and when they were clearly different practices. In the earlier sections we listed, described and named as "practices" those practices that were used in several projects in approximately the same way and for the same purpose. We also listed the projects where they were used and gave examples of how they were applied. We did not name as practices the practices that were not used in several projects, e.g. "synchronization of the main milestones", or were more like advice than communication

practices, such as "giving reasons and background information", but presented these as findings. We will discuss classifying the practices and the difficulties related to that further in Section 7.1.

Table 37 briefly summarizes all the communication practices presented earlier. Table 38 presents which practices were used in each of our case projects and whether the practices were used between a company's internal distributed sites or between collaborating companies. Table 39 suggests in which project phase each of the practices would be most beneficial to use and whether they need to be designed in the beginning of the project. These suggestions are based on our interviewees' comments. Most of the practices were designed, or recommended to be designed in the beginning of the project, and used, or recommended to be used during the entire project. Only a few practices were used exclusively in the early or in the end phases of a distributed project. Finally, Table 40 presents a suggestion on the connection between the communication practices and the communication needs. The table was built by finding first the communication needs that each practice could satisfy best and then the communication needs that each practice could be helpful in satisfying, as well. This table is also based on our interviews. The purpose of this table is to give an indication about the relationship between the communication needs and communication practices. Further research is certainly needed about the subjects of these two last tables, i.e. which practices could be best suitable for different project phases and which practices could be used to satisfy each communication need.

Table 37. A summary of the communication practices.

Practice		**Short description**
Collaboration process	1.Process walkthrough	The face-to-face process walkthrough aims to give all project participants a common picture of the collaboration process and terms used.
	2.Frequent deliveries	Frequent deliveries are mainly deliveries of code, e.g. once a week, usually from the subcontractor to the customer. They are most useful when the code is integrated and tested right away. Gives good feedback and transparency of the progress to all project participants.
Peer-to-peer links	3. Creation of links at three levels	The creation of functioning communication links between distributed organisations at three different organisational levels: management, project, and team levels, seems to improve communication and make it more rational.
	4. Creation of role descriptions	The creation of role descriptions, assigning the roles to team members and indicating which roles need to communicate with each other between the collaborating organisations, makes the project structure and responsibilities more clear to the participants, and helps them find the correct person to contact.
	5. Visiting engineer	Visiting engineers visit the collaboration partner; customer, subcontractor or subsidiary, and stay and work there for a longer period of time. They facilitate communication by passing information, creating contacts, solving problems, and simply by being present for face-to-face discussions.
Problem solving	6. Problem solving responsible	A problem solving responsible is a person in a central role in the project, e.g. a system architect, who both knows a lot and is willing to answer questions coming from distributed partners. Thus, it is easy for them to ask questions and the problems are solved quickly.

	7. Discussion forums	Distributed team members can send their questions and comments to electronic discussion forums, and others following the discussion can answer or comment. Forums provide transparency to current project discussions and are useful for finding experts and getting answers to problems.
	8. Direct communication through chat	Internet-based chat provides an inexpensive, and a very much liked, real-time media for communication between the team members in a distributed project. It seems to be especially convenient for problem solving discussions between distributed developers.
	9. Relaying contacts and questions	When participants in distributed projects do not know each other across the sites, it is difficult to know whom to contact when having questions or problems. Projects can name some kind of contact persons, who are, among other things, responsible for relaying contacts and questions between the sites.
	10. Face-to-face problem solving	When problems are difficult to locate and/or solve in electronic communication, or are serious ones and need urgent reaction, then face-to-face meetings of all concerned parties are often the best solution.
	11. Collocated testing and integration	When work done at different distributed sites needs to be integrated and tested, then often the most efficient and quickest way is to invite representatives from all sites to work together collocated for a short time period.
Informing	12. Regular meetings	Regular meetings are a good way to distribute information between the project participants, e.g. about project progress, changes and future tasks. Meetings can be either site-specific, across the sites or a combination of them. They can be arranged, e.g. as a teleconference if physical meetings are difficult or too expensive to arrange.
	13. Databases for managing changes and bugs	Providing the project participants an access to change management and bug tracking systems makes the communication about changes and bugs in a distributed project formal and organised: everybody knows how to behave and all information is available to everybody.
Monitoring progress and providing transparency	14. Progress reports	Progress reports collected from distributed partners and subsequently combined provide a good picture of the project situation. These e.g. weekly or monthly reports can include information about the tasks accomplished, future tasks, problems, open questions, risks, etc.
Feedback	15. Design and code walkthroughs	Common design and code walkthroughs can be used as early checks that the distributed teams have understood the requirements and instructions correctly, and are progressing in right direction. They are most useful when arranged early enough, so that the teams get feedback as quickly as possible.
	16. Lessons learned	Lessons learned sessions are opportunities to give feedback to the team members, and to gather development targets, improvement ideas and successful practices that can benefit future projects.
Relationship building	17. Kick-off	Arranging a common kick-off meeting for a project or a sub-project team consisting of members from different sites and partners, is useful: the participants get to know each other, they get acquainted with the project goals and tasks and the roles of the partners.
	18. Giving faces	If a common kick-off meeting is not possible, arranging other opportunities for everybody to meet at least someone from all the other sites he or she will be collaborating with, gives these distant sites and partners "faces". Especially meeting other team members they will have close collaboration with, makes later electronic communication easier.

Table 38. Communication practices and their usage in each of the case projects

(S= practice used between the customer and the subcontractor, D= practice used either between the customer company's or the subcontractor company's own distributed sites)

Practice		Project									
		Omega	Alpha1	Alpha2	Beta	Gamma	Delta	Epsilon	Zêta	Êta	Thêta
Collaboration process	1. Process walkthrough	-	S	D+S	-	S	-	D+S	-	-	-
	2. Frequent deliveries	S	D+S	D+S	-	S	D+S	-	-	D	D
Peer-to-peer links	3. Creation of links at three organisational levels	-	D+S	S	-	S	-	S	S	D	-
	4. Creation of role descriptions	-	D+S	D+S	-	S	-	-	-	-	-
	5. Visiting engineer	S	D+S	S	-	-	-	D	D	D	D
Problem solving	6. Problem solving responsible	S	-	-	D+S	-	-	D+S	-	-	D
	7. Discussion forums	-	D+S	-	-	S	D	D	-	-	D
	8. Direct communication through chat	D+S	-	-	-	S	-	D+S	D+S	D	D
	9. Relaying contacts and questions	-	S	S	D+S	-	-	D+S	S	-	D
	10. Face-to-face problem solving	S	D+S	D+S	-	S	-	-	-	-	D
	11. Collocated testing and integration	S	D+S	S	-	-	S	-	-	-	-
Informing	12. Regular meetings	S	D+S	D+S	-	-	D	D	-	-	-
	13. Databases for managing changes and bugs	-	D+S	D+S	-	S	-	-	-	D	D
Monitoring progress and providing transparency	14. Progress reports	-	S	S	D+S	S	-	D	D+S	-	D
Feedback	15. Design and code walkthroughs	-	D+S	-	D	S	D+S	D+S	-	D	D
	16. Lessons learned	-	D+S	-	-	S	D+S	-	-	-	-
Relationship building	17. Kick-off	-	D+S	D+S	-	S	-	-	-	-	D
	18. Giving faces	S	D+S	D+S	D+S	S	D+S	D+S	D+S	D	D

Table 39. A suggestion for project phases in which it is the most useful to use and design each communication practice.

Practice		Needs to be designed in the beginning	Used in the initial phases	Used during the whole project	Used in the final phases
Collaboration process	1. Process walkthrough		X		
	2. Frequent deliveries	X		X	
Peer-to-peer links	3. Creation of links at three levels	X		X	
	4. Creation of role descriptions	X		X	
	5. Visiting engineer			X	
Problem solving	6. Problem solving responsible	X		X	
	7. Discussion forums	X		X	
	8. Direct communication through chat			X	
	9. Relaying contacts and questions			X	
	10. Face-to-face problem solving			X	
	11. Collocated testing and integration				X
Informing	12. Regular meetings	X		X	
	13. Databases for managing changes and bugs	X		X	
Monitoring progress and providing transparency	14. Progress reports	X		X	
Feedback	15. Design and code walkthroughs		X		
	16. Lessons learned				X
Relationship building	17. Kick-off		X		
	18. Giving faces		X	X	

Table 40. Relationship between the communication practices and the needs that they satisfy.

Symbols: ● = This communication practice is suitable for satisfying especially this communication need.

○ = This communication practice can be helpful in satisfying this communication need.

Communication practices	**Communication needs**				
	Problem solving	**Informing**	**Monitoring progress and providing transparency**	**Giving feedback**	**Relationship building**
1. Process walkthrough		●			○
2. Frequent deliveries			●	○	
3. Creation of links at three levels	○	○			○
4. Creation of role descriptions	○	●	○		
5. Visiting engineer	○	○			○
6. Problem solving responsible	●				
7. Discussion forums	●		○		
8. Direct communication through chat	●				
9. Relaying contacts and questions	●				
10. Face-to-face problem solving	●				○
11. Collocated testing and integration	●				○
12. Regular meetings	○	●	●	○	○
13. Databases for managing changes and bugs		●	○		
14. Progress reports		○	●		
15. Design and code walkthroughs			○	●	
16. Lessons learned				●	
117. Kick-off		○			●
18. Giving faces					●

5.5 Communication problems

Communication-related challenges were clearly seen as the biggest problem in all our case projects. Our interviewees gave comments such as "The worst problem in this project is the lack of communication". One reason behind the problems seemed to be the fact that the companies had not planned communication practices much before starting the project. Communication in distributed projects also took more time than our interviewees had expected before starting the project, which also posed challenges. Next, we will present the communication problems that seemed to be the most challenging ones according to our interviewees, and that were mentioned by several persons. These problems were related to problem solving, informing, time-zone differences, geographical distances, motivational issues and misunderstandings. Cultural differences and prejudices related to them also came up as a part in some communication problems. This was expected, since many projects had participants coming from different cultures. However, in our case projects these problems did not belong to the most important ones, and since cultural issues were left outside this study, we will not concentrate on them here either.

5.5.1 Problem solving

Problem solving communication was found to be really challenging in all our case projects. This communication need was pretty much neglected in the planning phase of the project, and thus most of the projects had not planned communication practices that would satisfy this need. The lack of planning could be seen as the reason behind many of the problems mentioned by our interviewees. Here we have grouped these problems under two headings: *lack of contacts and link persons* and *lack of responsible persons and time to answer***.**

5.5.1.1 Lack of contacts and link persons

In the studied distributed projects it was quite typical that personnel from different collaborating partners had not met each other before the project. Thus, it was difficult especially for the subcontractor's and subsidiary's personnel to know whom to contact at the customer organisation. Often they did not know the roles, names, or contact information of the customer's personnel. Even when this information was known, the threshold to contact an unknown person seemed to be high. Instead of contacting and asking questions, the developers sometimes simply tried to solve the problem on their own, which easily took more time and could lead to wrong solutions, which needed to be modified later on.

For example, in project Thêta the Danish subsidiary's personnel did not know the customer's personnel or their responsibilities. Thus, they often sent emails with questions to the wrong persons, until they got a picture of the customer's organisation step by step after being guided to ask from the next person. The customer had not named a person responsible for the subsidiary's part of the project either, thus several persons from the customer assigned tasks to the subsidiary. Since no one from the customer was responsible for the cooperation with the subsidiary, things did not work out. Luckily, the subsidiary's personnel were really skillful and motivated, and found solutions to problems also on their own. Mainly for this reason, the subsidiary's part of the project did not turn

out to be a catastrophe, but succeeded quite well, after all. However, the subsidiary's personnel was quite unhappy with the customer and also the customer admitted that not naming a definite contact person, who would have been responsible for both the communication and coordination was a big mistake that they will not repeat in their future projects.

Of course the subcontractor's or subsidiary's personnel in all our case projects learned, to know more and more persons from the customer organisation during the project and also the other way around. Thus, in the end of the project cooperation was normally running already quite smoothly.

5.5.1.2 Lack of responsible persons and time to answer

If the customer company did not name a responsible person to take care of the subcontractors, e.g. to make sure that their questions are answered, it was easy for busy developers just to disregard the subcontractors' questions and emails. First, finding out answers and then, e.g. writing them in email would take a lot of time, thus the developers preferred to finish their own tasks first. This led, of course, to problems in the subcontractor companies, when their work was slowed down or even stopped when waiting for answers or trying to solve the problem on their own. A customer's product development manager in case Omega described these problems:

> **Quotation 73:** "…we could not answer to questions [coming from subcontractor] as fast as we should have. The subcontractor's schedule was extended because we were not able to answer their questions. (…) … we put up a discussion forum, but we did not understand to name a person whose responsibility would have been to see that all questions are answered. (...) Everybody answered their own questions, but then there were questions that were not anybody's responsibility, thus questions were left unanswered." (Customer's product development manager, Omega)

In case Thêta, the customer did not name any one person responsible for answering their Danish subsidiary's questions, which the customer's product development manager felt to be a mistake:

> **Quotation 74:** "We were busy here all the time. The developers from Denmark sent questions about their technical problems by email to several persons here. It was nobody's responsibility here to answer their emails. The Danes felt that we were not at all interested in their work, since we didn't even bother to answer. On the other hand, the developers here felt that the Danish team was complaining all the time and that they should have tried to solve their problems on their own, since people here were so busy. Finally, I sent a developer from here to Denmark to solve the problems, which helped a lot. The Danes were very happy when finally someone bothered to put some effort into it and clarify the situation. These problems were clearly caused by the lack of time and undefined responsibility." (Customer's product development manager, Thêta)

The project manager from the Danish subsidiary found the final face-to-face meetings very helpful, since the problems that had bothered for a long time were solved quickly. However, these problems both affected their motivation and the deadlines were impossible for them to keep because of the delays in getting answers. Thus, the Danish project manager named these problems of getting answers as the biggest problem in the whole project. The customer learned from these problems, and when hiring their Swiss subsidiary to work for the same project later on, they named one person responsible for communicating with the Swiss team and coordinating their work.

The managers from the customer companies often did not understand how much time answering the subcontractors' questions and solving their problems really took with the developers. One example is the practice described earlier, problem solving responsible, which was an unplanned solution that happened to emerge in a few projects, when one person started to answer the questions. All the interviewed "problem solving responsibles" revealed that more than half of their working time was spent on answering questions. For this reasons their own work suffered, and they often worked overtime without compensation. They felt that the managers did not understand how much effort they had put into this and they hoped for some kind of recognition, e.g. in the form of giving them more time to take care of this new "role" properly.

5.5.2 Informing

In all our case projects the problems related to informing were in one way or another connected to the lack of information and informing. Only a couple of interviewees mentioned that in addition to missing some information they had also had problems because of getting too much information from which it was difficult to find the essential pieces. We grouped the problems under three headings: *partner's information needs unclear*, *company borders restrict information flow for confidentiality reasons*, and *forgetting or disregarding the informing of distant sites or partners*.

5.5.2.1 Partner's information needs unclear

In distributed projects the participating organisations found it difficult to understand each other's information needs. Especially the customer companies in our case projects seemed to have this problem; they did not know what kind of information their subcontractor's needed. Therefore, giving only the needed information and not too little or too much, was challenging for them, as some of the customers described:

> **Quotation 75:** "[The biggest problem] is communication; too little communication or advising at the wrong time. We do not have a good picture of what they [subcontractors] don't know." (Customer's project manager, Epsilon)

An idea came up whereby the subcontractors who know what they need could be more active and tell their customers what kind of information is needed:

> **Quotation 76:** "It might be a good idea that the subcontractor could tell us what kind of information or specifications they need to accomplish their tasks. Now it depends quite much on what I imagine that they need." (Customer's project manager, Zêta)

On the other hand, the subcontractors complained that when they e.g. do not have access to the customer's information systems they cannot know what kind of information is available, thus it is very difficult for them to ask for any specific information or document:

> **Quotation 77:** "The problem is that information distribution is really restricted in this project. We are actually not allowed to see anything. We have to always beg that we would like to see that and that. (…) It relates to documents, discussion forums, bug reports, releases and source code. It means that we have to know beforehand what we want before we can ask for it." (Subcontractor's project manager, Alpha1)

5.5.2.2 Company borders restrict information flow for confidentiality reasons

The reason why the customers want to restrict the amount of information they give to their subcontractors is most often that they do not want to reveal too much about their new products to "outsiders". This leads to two problems: First, the customer gives the subcontractors only the minimum set of information, and what this set includes is determined by the customer, who most often does not know what kind of information is really needed. Secondly, the subcontractors are not allowed to get access to the customer's information systems, such as databases, where they could search for information.

The customer company of project Alpha2 was one of the companies having a very restricted information policy. Their partnership manager described their policy:

> **Quotation 78:** "When doing subcontracting we need to give out confidential information [to subcontractors]. Of course the principle is that the less we give the better, which means that we don't want to give information too openly. To be able to do its job the subcontractor still needs some information but on the other hand we don't want to tell everything. (…) Sometimes our own people don't know what they can tell a subcontractor and what they cannot. (…) It is a difficult interface, we don't want that the subcontractor feels like an outsider, but still there is information that we want to keep inside our own company." (Customer's partnership manager, Alpha2)

Moreover, this customer company did not even let their on-site subcontractor participate in their internal project meetings due to these confidentiality reasons. Instead, one of the customer's project managers represented each subcontractor in the meetings and relayed the information between the subcontractor and the meeting. The customer's representative explained this by the novelty and thus confidentiality of the product under development.

Some of the customers had started to think about categorizing information and documents, so that they would know what kind of information each subcontractor needs and is allowed to see. Project Alpha1 had started to give their subcontractors identity codes, whereby they could define the allowed information and documents under each code. However, this system still had its problems, as one of their subcontractors complained:

> **Quotation 79:** "There are a lot of subcontractors in this program. Every subcontractor has an identity code, on which depends whether it can see a report or not. In some phase it happened that if someone from the customer company wrote a message concerning a report, none of the subcontractors could see that report anymore. With good luck you might remember that there had been this kind of a report and you could ask for it. Then they notice that the reading rights are missing. (…) It is actually a good property, you don't want to know everything! There is a lot of information. (…) I wrote a script that dumps the whole database to my disk. Then I could compare the last situation to the next one, and find out if something was missing and send the document ID numbers and ask to get them back. (…) It required a couple of weeks extra work to have next year easier. You have to put it into proportion." (Subcontractor's project manager, Alpha1)

In none of our case projects did the customer company let their subcontractors access all their project-related information systems, such as configuration and version management systems, bug and change management databases, or even project intranet pages. In a few projects, Alpha1, Alpha2 and Gamma, the customers allowed their subcontractors to see a limited amount of information, e.g. by accessing a limited replica of some database. On the other hand, in both company internal projects, cases Thêta and Êta, the customer allowed their subsidiaries to access a common version management system, which was

regarded as very useful in both projects. This access provided visibility to both directions, the subsidiary could follow what others were doing and the customer saw how the subsidiary's coding was really progressing. The only problem was the slow network connection between the sites. In most other projects our interviewees complained about the lack of this access, which caused e.g. extra work of sending files and saving the same information in two places, sometimes in two different version management systems. Sometimes also old document versions, such as specifications, were used and thus work was wasted, when it was forgotten to give the subcontractors updated information.

Moreover, the company borders often prohibited the customer from giving its subcontractor all ready-made code, which made the work of the subcontractor more difficult, since it e.g. could not test its code against the rest of the product.

5.5.2.3 Forgetting or disregarding the informing of distant sites or partners

As some of our interviewees commented, "there's a lot of information in the corridors", meaning that when a project team is collocated quite a lot of information is communicated informally, when meeting in coffee rooms or the corridors. This information flow seemed to be almost missing between the sites in some of the distributed projects, which naturally caused information shortages. To substitute that kind of informal information flow between distributed sites or partners would have required active informing efforts. It seemed that many of the case projects had not thought about this difference between distributed and collocated projects when starting the project, and thus had not planned any special informing efforts.

In particular for the customer companies it was quite easy simply to forget to inform the subcontractors, e.g. about the changes made to the product or the schedule. When the subcontractors were out of sight, they were also out of mind, and thus informing them was easily forgotten, especially when it was not anybody's responsibility. Moreover, as mentioned earlier, when the customer did not know what kind of information the subcontractor would need, it was easier just to give them the information they would most certainly need. Especially the background information, e.g. explanations behind the changes and decisions made, that the subcontractors and subsidiaries hoped to get was easily disregarded. The customer did not realise that that kind of information would be needed.

One of our interviewees from a subcontractor company commented that in a way the lack of information can also be a positive thing, since then you do not have the problem of getting too much information. A few projects had already faced the problems of receiving in some situations too much information, from which it was difficult to find all the relevant information. Finding the right balance between informing too little and too much seems to be really difficult. For example, in project Alpha1 the subcontractor complained both about having serious problems of not receiving enough information while, at the same time, this subcontractor had access to some of the customer's databases having a huge number of documents. It was not possible for the subcontractor to follow all that information, even though sometimes the customer's developers expected them to know things that could be found in some of the databases. However, most of our interviewees felt that the lack of information is currently a far worse problem than getting too much information. They preferred getting too much information to not receiving some of the critical information.

5.5.3 Time-zone differences and geographical distances

Time-zone differences and geographical distances were seen by our interviewees as problems that limited communication hugely. Quite often the literature about global software development mentions time-zone differences as an advantage that could be exploited by arranging "round-the-clock development". However, our case projects had not tried to achieve these advantages. Instead, the projects having time-zone differences experienced them as problematic mainly due to the limitations that these differences posed to synchronous communication. Geographical distances, instead, were not experienced to be as problematic to communication as time-zone differences, even though they limited communication quite a lot, especially face-to-face meetings. These two problem areas, named here as *time-zone differences limit synchronous communication*, and *geographical distances limit informal communication and face-to-face meetings*, are described in more detail next.

5.5.3.1 Time-zone differences limit synchronous communication

All our case projects having significant time-zone differences between the participating sites experienced that as a big problem regarding communication. Our interviewees felt that time-zone differences were a far worse problem than e.g. geographical distances. If geographical distances were long, but time-zone differences small, then synchronous electronic communication was quite easy to arrange. Companies could e.g. arrange meetings using conference calls. With large time-zone differences, synchronous communication was limited: At the worst, all spontaneous communication, such as phone calls or chat discussions, was out of the question and even communication planned in advance, such as teleconferences were challenging to arrange, since a part of the team had to participate out of their normal working hours every time.

The time-zone differences caused most trouble in problem solving situations, since problem solving could take a lot longer using asynchronous electronic communication than when communicating synchronously, e.g. by using the telephone or discussing face-to-face. The following examples illustrate this problem:

> **Quotation 80:** "We have an eight-hour time-zone difference [between the sites in Finland and the US]. (…) It is the biggest problem, worse than the geographical distance. (…) When I have something to ask, or I would like to discuss with people from that site [the US] then I would like to call them right away. But I cannot, since they are sleeping. (…) (Customer's project manager, Delta)

> **Quotation 81:** "The time-zone difference is considerable [between Finland and Malaysia], in practice we have only a two-hour time window during which we can communicate personally. This time is typically used so that they send us one question a day and we try to answer during that same day, but we do not always have time to answer that quickly. Inside this house we can ask tens of that kind of questions during one day, but when the distance gets long, the frequency of questions drops. Thus, the work tasks proceed very slowly." (Visiting engineer / developer, Epsilon)

As the above example describes, trying to solve problems using only email and facing time-zone differences simultaneously is really time-consuming. A system architect from project Omega explained how a typical problem solving situation proceeded: When a subcontractor's developer working on the other side of the world had a problem, he sent this system architect a question by email. The next morning when the system architect arrived at work, the question was in his mailbox, but he did not quite understand it. Thus, he wrote back and asked for more explanation. The next morning the answer was waiting,

but he needed still more information. This way the discussion continued, until the problem was first understood and all relevant information gathered, and finally the answer was found. Exchanging emails could easily take a week, which was quite frustrating, as he explained:

> **Quotation 82:** "By email it may take a week to solve a problem, which could be solved face-to-face in one minute!" (System architect, Omega)

5.5.3.2 Geographical distances limit informal communication and face-to-face meetings

In distributed projects geographical distances between the partners are inevitable. The distance limits both the number of planned face-to-face meetings, and the possibilities for informal, unplanned meetings and communication. Some of our interviewees had noted how much information that is communicated informally in collocated projects, is not communicated at all in distributed projects:

> **Quotation 83:** "Here [in this site] we do several applications and between these subprojects there are discussions in corridors and in coffee rooms etc. All this is left out when people work at different sites. (…) It is one clear disadvantage in this kind of projects. Sometimes there is a lot of information in coffee rooms." (Customer's project manager, Alpha1)

Our interviewees commented that when this kind of informal communication is limited it causes problems, since all relevant information is not communicated to the distant partners. If the possibilities for informal communication are limited it requires a lot of effort to replace it, e.g. by actively informing partners, which is, however, quite easily disregarded.

In connection to a practice presented earlier, "giving faces", the lack of face-to-face meetings came up already. When the collaborating partners have never met each other, it is often difficult to work together across distances. Problems arise, when e.g. the subcontractor's developers do not know whom they could ask for help in the customer organisation when having questions. Moreover, they might also have a high barrier for contacting an unknown person. Furthermore, when the customer's developers receive questions from the subcontractor's developers that are unknown to them, these busy developers might leave the questions unanswered or give quite rude answers. Thus, the barrier to communicate is raised even further. Early face-to-face meetings could have reduced these communication problems. Even so, many case companies had felt in the beginning of the project that the geographical distance made it too expensive to arrange these meetings.

During the project execution, the limited possibilities for face-to-face meetings were problematic especially in problem solving and in the integration and testing phases. Communication in that kind of situations was noted to be quite inefficient and problems were solved very slowly when communication took place only by electronic means. The limited opportunities to arrange face-to-face meetings were problematic also regarding to the idea generation phases and brainstorming type of work, which was, according to our interviewees, almost impossible to do only by communicating electronically. For example, a customer's project manager from Gamma explained that in the innovation phase when you would like to explain your ideas, it is easier when you can draw a picture while explaining, but when you are using email, then explaining and getting immediate feedback is much more difficult.

5.5.4 Motivational issues

We noticed several motivation-related communication problems. For instance, motivation of both the subcontractor's and the customer's personnel to communicate with each other was sometimes lacking. Also, the lack of feedback and lack of transparency, were communication problems that seemed to have an effect on the motivation of the developers working in a distributed project. Next, these problems, *lack of motivation to communicate*, *lack of feedback* and *lack of transparency* are described in more detail.

5.5.4.1 Lack of motivation to communicate

The lack of motivation to communicate was sometimes evident at the collaboration partners for many different reasons. At the company level the policy seemed to be quite often to give the least possible amount of information for security reasons. The companies did not want to reveal too much about their new products, technological and process-related know-how, or other business aspects. Especially the customer companies seemed to think this way. In addition, the customer company's personnel was not always aware of which information they were allowed to give their subcontractors and what they should keep only inside their own companies. As a result, if a person was not sure, it was safest not to tell too much. At the personal level, the personnel from different companies experienced each other as competitors in some cases. Especially, in a few customer companies the subcontractor's or subsidiary's personnel were experienced as a threat, since "they could steal our jobs", as one of our interviewees put it. Thus, in that kind of situations the motivation to help or answer the subcontractor's questions was quite low. In some cases, the subcontractor's or subsidiary's personnel felt that the attitude of the customer's personnel towards them and their suggestions was quite cold. The subcontractor's or subsidiary's personnel got a feeling that they were treated as "ONLY subcontractors", even though they themselves felt that they were working together, towards the same goals. The same kind of message was passed, e.g. by not inviting the subcontractor's personnel to project meetings where all the customer's internal distributed sites participated. This had happened, e.g., in project Beta. The customer's project manager in project Beta had noticed this and tried to explain it:

> **Quotation 84:** "I have noticed that there has been some suspiciousness in our project towards the subcontractors, people have not wanted to share all information with them." (Customer' project manager, Beta)

Also, in projects Epsilon and Omega the customer's personnel was quite suspicious towards the subcontractors. The developers were busy and not very motivated to help the subcontractors. In both projects the customer's personnel had, e.g. left some of their subcontractor's questions unanswered or given quite rude answers, in style "are you stupid since you don't know even that". After receiving that kind of messages it is natural that the subcontractor's motivation to ask questions sinks! In project Omega the customer's management had hired the subcontractor company against the wishes of their own developers, and in a too early project phase, according to their project personnel. Even the initial face-to-face period together with the subcontractors did not erase that earlier mistake. In project Epsilon the information and instructions given to the subcontractor had been poor, thus the subcontractor's developers made unnecessary mistakes. Hence, when the customer's testers tested that code, they felt that the subcontractors cannot do anything right. Thus, the motivation to test the subcontractor's deliveries quickly, and to give useful testing feedback, was very low. The customer's

project manager explained that the messages from the customer's testers clearly conveyed their attitude towards the subcontractors. She got a feeling that she had to censor the messages her testers wrote to the subcontractors so that the subcontractors would not lose their motivation entirely! In this project, the situation improved after mutual visits, and the communication found a new level.

5.5.4.2 Lack of feedback

The developers working in distributed projects, especially in the subcontractor or subsidiary companies, found the lack of feedback quite unmotivating. When the communication was infrequent, the distant sites and partners were remembered easily only when there were problems. Thus, these team members felt that they received feedback only when they had done something wrong. When everything was running smoothly, they did not hear anything. As one of our interviewees commented; when the distributed teams were out of sight, they were also out of mind.

The subsidiary's project manager in case Beta complained especially about the lack of feedback on their delivered code:

> **Quotation 85:** "Sometimes I feel that this is like a black hole, that we send our deliveries somewhere, but no-one knows what happens to it. Then we get the next tasks and no-one has time to think about the earlier tasks anymore. (…) But if you haven't received feedback during the last six months, you start to wonder whether you are doing it right or not. Of course there are bugs, but if the customer tests it first after half a year, you have already forgotten what you did. Then you have to go back to it, which is difficult. (…) The only feedback I personally get from the customer's project manager is when I have done something wrong." (Subsidiary's project manager, Beta)

This lack of feedback seemed to both lower the motivation to work and increase the number of unnecessary mistakes, when the developers had to work for long periods without feedback. The distributed team members hoped to get at least some feedback already in the early phases of the project; the earlier they get the feedback, the easier it is for them to change the direction.

5.5.4.3 Lack of transparency

Many of our interviewees felt that they did not have a good picture of the situation in the distributed project as a whole. In our case projects it was quite normal that the project manager monitored the situation, especially the project progress at different sites. In addition to the project managers, also project team members from distributed sites expressed their desire to get more frequent information about the project situation. They wanted to know e.g. where the project was going, what was happening in the other parts of the project, how their work affected everybody else's work, what kind of changes had been made, or what kind of problems others were having. For example, in project Gamma the customer's product development manager had noted the existence of these problems after getting the results of the subcontractor's motivation survey:

> **Quotation 86:** "What we should improve about communication is to improve the subcontractor's team members' understanding about what effects their work has. This understanding is not as good as those people sitting in here [in our premises] have. (…) We have done motivation surveys with our subcontractor. (…) so far communication has been the worst thing and the most unmotivating issue. (…) The transparency has not been sufficient (…)." (Customer's product development manager, Gamma)

Another interviewee commented that they had had moments during the project, when they felt it difficult to continue working since the customer kept them in the dark regarding the project situation. Thus, according to our interviewees, the lack of transparency seemed to affect their motivation to give their best in the project.

5.5.5 Misunderstandings

In our case projects misunderstandings easily arose when communicating electronically. Especially written communication, such as emails were easy to misunderstand. Moreover, the use of terms was sometimes problematic, since the same terms could have slightly different meanings in different companies, or even in the minds of the different developers. Next, these two groups of misunderstandings, *misunderstandings in electronic communication*, and *differences in terms used*, are briefly explained.

5.5.5.1 Misunderstandings in electronic communication

The misunderstandings that happened in electronic communication were quite often related to the interpretation of the tone of the message. The receiver might have interpreted that a short email message going straight to the point meant that the writer was angry about something, when he or she could have been only busy. Interpreting that kind of nuances seemed to be difficult, especially when the persons exchanging the emails had never met. An example of that kind of a problem comes from case Beta:

> **Quotation 87:** ”Around 95 % of our communication [between the customer and the subsidiary] occurs through email. You get all kinds of messages, but you cannot easily see from the message, whether the person is really angry or not. Maybe you interpret from the message that things are worse than they are. But you don’t know it. You can’t see it. (…) Sometimes I read a message [coming from the customer’s subproject manager] a couple of times and think what on earth have we done again! I don’t know whether she is angry or is it just her style to write. She just commands: ‘repair this’. I don’t know what kind of a person she is. If you would sit next to her, you would know what she really means.” (Subsidiary’s project manager, Beta)

When communicating electronically e.g. through the telephone, email or chat, it seemed to be difficult to judge whether the receiver had really understood the message. When meeting face-to-face, it is easier to see from the other person’s face whether he or she has understood the message. In addition, it is more laborious and slow to ask counterquestions especially when communicating through email than in face-to-face situations. Thus, those kinds of questions are easily not asked. Instead, the person receiving a message could draw conclusions by him or herself, without requesting more information.

5.5.5.2 Differences in terms used

The terms used in the collaborating companies differed somewhat and even when the same terms were used, their exact meaning could vary. Especially the process-related terminology had some differences. Thus, when the project team members from collaborating companies were using the same terms, different persons could have a slightly different meaning for the same term in their mind. When the terms were not defined in the beginning of the project, the differences did not come up until in a situation of facing problems. For example, in project Gamma, the term Beta release was related to a different quality level in the customer company than in the subcontractor company. One

of our interviewees explained that these terminology problems were worse when communicating electronically, since the people did not ask for explanations to the terms as easily as in face-to-face situations. As an improvement, some interviewees suggested arranging process walkthrough meetings, where the most important terminology would be defined together.

5.5.6 Summary of the communication problems

The previous sections listed and described the communication problems that our case projects had faced. Some of the problems were also mentioned earlier, in connection to the communication practices. There, it was explained, e.g. what kind of problems the case projects had had before implementing a specific communication practice. The sections above aim to provide answers to the research question about what kind of communication problems are encountered in geographically distributed, inter-organisational product development projects.

When collecting the communication problems by interviews, we tried not to influence our interviewees' answers in this exploratory study. Thus, we had not prepared any lists or categories of problems from which the interviewees could choose from. Instead, we asked them to freely describe the problems they had encountered. As mentioned earlier, this caused similar kind of challenges when describing the communication practices. Namely, some of the problems the projects had could have remained unmentioned. In addition, problems are experienced quite subjectively. The practices used are more objective, almost everybody being involved in some practice can describe it similarly. Some problems might also affect only a few persons' work, or some persons might experience an issue as problematic, whereas some others do not see it as a problem. Thus, we could not make any exact lists about in which projects each of the problems were encountered. Instead, we described the problems that several of our interviewees had mentioned and gave examples of the problematic situations.

The communication problems collected from our case projects and presented above are briefly summarized in Table 41.

Table 41. Summary of communication problems.

Problem		**Short description**
Problem solving	Lack of contacts and link persons	If the personnel from different collaborating partners have not met each other before the project and contact persons are not named, it may be both difficult to know whom to contact at the other organisation, and the threshold to contact an unknown person can be high.
	Lack of responsible persons and time to answer	If the customer company does not name a responsible person, e.g. to make sure that the subcontractors' questions are answered, it is easy for the busy developers just to disregard these questions and emails, since answering takes a lot of time. This can slow down or even stop work at the subcontractor when waiting for answers.

Informing	Partner's information needs unclear	Partners do not know each other's information needs fully, thus it is difficult to give just the right information. If they do not have access to each other's information systems, they cannot search for information by themselves, either.
	Company borders restrict information flow for confidentiality reasons	Companies do not want to reveal too much information about their new products or know-how to their partners, they often prefer giving a minimum set of information. Especially, when the partner's information needs are partly unknown, this minimum set is often not enough.
	Forgetting or disregarding the informing of distant sites or partners	When a project team is distributed, the informal information flow is at least partly missing. Replacing it would require active efforts, which are easily disregarded. Since distributed sites are out of sight, they are easily forgotten to be informed about changes etc.
Time-zone and geographical distances	Time-zone differences limit synchronous communication	Especially large time-zone differences limit synchronous communication. At the worst, all spontaneous communication, such as telephone calls or chat discussions, are out of the question, and even communication planned in advance, such as teleconferences are challenging to arrange, if some in the team have to participate out of their normal working hours.
	Geographical distances limit informal communication and face-to-face meetings	The distance limits both the number of planned face-to-face meetings, and the possibilities for informal, unplanned meetings and communication. Thus, some relevant information is easily not communicated. Moreover, problem solving, integration and testing are difficult and take more time over distances.
Motivational issues	Lack of motivation to communicate	At the company level the policy is quite often to give the least possible amount of information, because of not wanting to reveal too much. At the personal level, the motivation to help unknown, distant colleagues can be low.
	Lack of feedback	The distant sites and partners are easily remembered only when there are problems, thus the feedback is infrequent, often negative and comes too late. This lack of feedback both lowers the motivation to work and increases the number of unnecessary mistakes.
	Lack of transparency	When project managers, team leaders and team members do not have a good picture of the situation in the whole distributed project, e.g. concerning the project progress, changes, problems, and future directions, their work and their motivation can suffer.
Misunderstandings	Misunderstandings in electronic communication	Misunderstandings are common when communicating electronically, e.g., through the telephone, email or chat. The tone of the message can be interpreted wrong, and it is difficult to judge whether the receiver has really understood the message.
	Differences in terms used	The terms used in the collaborating companies differ somewhat and even when the same terms are used, their exact meaning can vary. When the terms are not defined in the beginning of the project, the differences may not come up until facing problems.

5.6 Summary

This chapter contained a description of Study 2. First, the used research method was described, and then the achieved results were presented. We chose ten case projects for this study: all of them developed software and were organisationally and geographically distributed. The data was collected by 59 interviews, which were tape-recorded and transcribed. The qualitative data was then coded and grouped. The received results included subcontracting project type classification, communication need classification, and as the main result, a collection of the communication practices, as well as a collection of the communication problems.

The subcontracting project types used by the customer companies of our case projects were: resource hiring, independent subcontractor teams, transparent box, and black box. The encountered communication needs were: problem solving, informing, monitoring progress and providing transparency, giving feedback, and relationship building. We grouped the identified communication practices according to the communication needs they best satisfied, and added two more groups of communication practices: collaboration process and the establishment of peer-to-peer links. We named and described each communication practice, and gave examples of their usage in our case projects. Altogether we named eighteen communication practices, such as frequent deliveries, visiting engineer, problem solving responsible, regular meetings, progress reports, design and code walkthroughs, and giving faces. Finally, we described the communication problems that our case projects had, and grouped them under the headings: problem solving, informing, time-zone difference and geographical distance, motivational issues, and misunderstandings.

6 Cross-study summary and conclusions

In this chapter we first discuss the differences between Studies 1 and 2. Then, we compare the findings gathered from each of the studies, and summarize the results with regard to the research questions.

6.1 Comparison of the studies

Both studies consisted of several case projects: Study 1 had two projects, and Study 2 comprised ten projects. During Study 1 we wanted to gather understanding of the communication practices and problems of distributed projects by studying a couple of case projects in depth. Based on that understanding, Study 2 aimed in the first place to collect successful communication practices from a larger number of projects. In Study 2 we gathered also communication problems and extended our understanding of the communication needs.

The cross-case analysis between the case projects within each study was presented already in connection to the studies. Since the industry of the case projects in each of the studies, and the goals of the studies differed somewhat, we did not find it useful to compare individual case projects between the studies. Instead, we compared the results received from each of the studies.

The choice of the industries and the case projects to the studies most probably had an effect on the results received. We chose a few interesting differences between the studies that we will compare next. First, the project sites in each case project were locally distributed in Study 1, compared to global distribution of the sites in Study 2. Secondly, the type of developed product differed between the studies. In Study 1, the plastic products developed were tangible, whereas the software developed in Study 2 can be regarded as intangible. Thirdly, most of the case projects were inter-organisational, between at least two different companies, however, in Study 2 we chose two distributed intra-company projects as well. Fourthly, Study 2 was built on Study 1, therefore the results received from Study 2 are already somewhat more developed, e.g. regarding the communication practices.

6.1.1 Local vs. global distribution

The projects developing plastics products were locally distributed, i.e., both the customer and the subcontractors were located inside the same country. Due to quite short distances, these projects had possibilities to arrange regular face-to-face meetings between the participating companies. The meetings were very important for communication in these projects. Our interviewees from the customer company of these projects told that they preferred to do product development with local subcontractors expressly because then it was possible to meet at any time when needed. The software development projects in Study 2 had all some global distribution. The longer distances clearly caused challenges to the communication, since face-to-face meetings were both more expensive and time-consuming to arrange. Thus, the number of face-to-face meetings was quite low, and the project participants often did not know each other well, which limited the communication even more.

6.1.2 Tangible vs. intangible products

In the projects developing plastics products it seemed to be essential to meet face-to-face. One of the reasons for this was the importance to see the product while discussing about it and its possible defects and their correction. Quite often the participants brought to meetings physical products, exemplars that they discussed about. For example, in project PartCo most of the product-related problems were linked to the external appearance of the product. During the development, problems e.g. with the paint and painting process, such as particles in the paint and scratches in the painted product, occurred. In addition to discussing the faults in the meetings, in both case projects the subcontractor had sent a resident engineer to work in the customer's premises and to help in solving the problems. This person both facilitated the work of the customer's designers to design products that are easy to manufacture, and solved problems related to faults in the products. Since the resident engineer had a good knowledge about the subcontractor's process, he could quite easily judge whether the faults encountered were due to the subcontractor's process and which part of the process had caused them. Thus, the tasks of the resident engineer required him to be present, check the designs and comment on them frequently, and check the faulty products whenever they appeared.

Moreover, the faulty plastic parts were sent by normal mail from the customer to the subcontractor and also the other way around, for evaluation or finding out the reasons for the defects. This kind of communication required seeing the products as well. After receiving the product, the conversations could then take place through telephone or even email. The only problem was that delivering the products by mail took always a couple of days. Thus, before starting the actual problem solving they had to wait for the mail to arrive. Also, when the subcontractor's mold designers or quality personnel discussed with the customer's designers through email or telephone, one of the difficulties experienced was that they could not simultaneously show from an exemplar or from a 2D or a 3D design the exact point they talked about. To sum up, the development of the physical products in these projects seemed to require face-to-face meetings, where the participants could see the 2D or 3D designs or the exemplars at the same time when discussing about them.

When comparing the industries, we noticed that the need for face-to-face meetings did not seem to be as essential for the development of the software as it was for the development of the plastics products. When developing intangible products, i.e. software, it was quite easy and quick to send code across distances, for instance by email using fast speed connections. When both parties had the same code, then discussing about it through the telephone, or even through chat was possible. Even looking at the same screen from two different places at the same time was possible between some intra-organisational sites. Similar possibilities would have been useful for the development of the plastics products, as well, e.g. two distributed persons could have benefited from seeing the same screen showing a 3D design at the same time when discussing about it. Technically that could have been possible, but security and cost reasons prohibited it in our case projects. Even though the development of software seemed to be easier across distances without many face-to-face contacts than the development of plastics products, many of our interviewees mentioned that the distribution caused challenges to the software development, as well. For example, phases when a lot of communication was needed, such as problem solving and testing and integration, were much slower when distributed than when working face-to-face. Despite the difficulties, the development of intangible products, in this case

software, was possible without close physical proximity of the partners. The intangible nature of the product made it possible to send the code electronically, and thus very quickly to different partners for problem solving or integration and testing.

In the software development, practically all the information was in electronic format, paper documents were nearly non-existent. Thus, at least in theory, all the information could have been made available in electronic format to all the project team members that were distributed to different sites. Mainly the security and confidentiality issues prohibited that, whereas the low-speed connection was another obstacle. In contrast, a lot of paper documents were used in the development of the plastics products, although most of them existed in electronic format, as well. There were several reasons for the usage of paper documents, e.g. paper documents were needed in the manufacturing, since computers were not available by every machine. Moreover, only a few persons had on their computers the expensive programs that could show 2D or 3D design documents. For instance, in the PartCo case the subcontractor's quality personnel complained about having to go to a different building if they wanted to open a 3D document they had received from the customer, since in their building no one had a program for that. In the future, when the technology develops and the costs sink, electronic information will be easier to handle and distribute in the distributed development of tangible products, as well. It will probably not fully replace the need for physical exemplars in the communication, but will make the communication somewhat easier and quicker. For example, in case PartCo the customer had already started to use a digital camera for taking pictures of faulty products and then sending these pictures by email to the subcontractor, so that the problem solving could start already before the physical products arrived.

In conclusion, we found that the most notable communication-related difference between developing these kinds of tangible and intangible products was related to the need of face-to-face meetings. In the development of plastics products it was quite often important that both parties saw the developed physical product while discussing about it, whereas the software code, due to its electronic format, was easy to send electronically and thus look at and discuss about also when distributed.

6.1.3 Inter-organisational vs. intra-organisational distribution

In Study 1 both projects were inter-organisational. Moreover, the subcontractor's internal distribution came up especially in the PartCo case. The subcontractor had several departments involved, some of them were geographically separated. In Study 2 eight case projects were inter-organisationally distributed even though many of them had also intra-company distribution, e.g. subsidiaries and geographically distributed sites were involved. Two projects in Study 2 had only intra-company distribution between the customer and its partly owned subsidiaries.

In this research we wanted to study especially inter-organisational communication between the collaborating companies. Therefore, we did not pay so much attention to the communication between distributed internal organisations. However, we made some observations about the differences in the communication when comparing distributed internal organisations with the inter-organisational setup. Intra-organisational collaboration was often quicker to start, e.g. a subsidiary's team was easier to hire even

without proper specifications, since no agreements were made or they were quite informal. On the other hand, a few interviewees complained that it was in a way more difficult to work with an internal organisation than with subcontractors, since with subcontractors you have clear agreements about responsibilities etc. and you can take legal action if the subcontractors do not follow them. With internal organisations agreements are often informal and impossible to enforce.

The information exchange was easier with internal organisations from the point of view of confidentiality, since an internal organisation could often be given confidential information that would not be given to subcontractors. Thus, it was easier to build information systems with internal distributed sites that all the participants could be allowed to access. For example, in Study 2 a few case projects had systems for version management and tracking bugs and changes in their internal distributed use. Moreover, with internal organisations changes were easier to make without frequent negotiations about prices. This was especially beneficial when using iterative development, where changes to the original plan were common. In addition, with internal organisations it is more common to use the same processes and develop common practices. It is also probably more common to have several consecutive projects with internal organisations, thus the personnel will gradually learn to know each other better and working and communicating together would become easier.

In spite of these differences it seems that the same communication practices that we recognized, would be suitable to use in both distributed intra- and inter-organisational projects. Their implementation would probably be easier in intra-organisational projects, but both types of projects will most likely benefit from their usage.

6.1.4 Communication practices

Since Study 1 was carried out before Study 2, the results received and the material collected for Study 1 certainly had an effect on our thinking and thus on the results received from Study 2. We can see this development of thinking especially from the results received to the main research question about the communication practices. When collecting and analysing the data for Study 1, we had only a rough idea on how a communication practice could be defined. During Study 2, as our understanding developed, also the definition developed. In Study 1, the practices were named separately regarding both case projects, since the practices differed a bit between the projects and having only two projects it was quite difficult to make generalizations. Therefore, in Study 1 the names of the practices were quite long and described the practices more, whereas in Study 2, we tried to use quite short and more general names for the practices. The practices named and described in Study 2 are therefore on a more general level, and thus probably more suitable to different types of projects than the practices collected from Study 1.

6.2 Comparison and summary of the received results

Next, we will summarize and compare the results received from Study 1 and Study 2 to our four research questions, which concentrated on the communication practices, the communication problems, the communication needs, and the usage of the social process simulation method.

6.2.1 Communication practices

The main research question of this study was:

RQ1: What kinds of communication practices are used in geographically distributed inter-organisational product development projects?

Material for answering this research question was collected from both studies. The communication practices encountered in our case projects were not very special, instead, both studies reported the usage of quite basic communication practices. However, already the very basic communication practices reported seemed to be beneficial. In addition, the participating companies had seldom planned beforehand or given instructions about the communication practices that could be used in their distributed projects. Thus, quite often the project participants had to improvise and develop practices when needed.

Furthermore, we noticed that new communication and collaboration tools or information systems developed for distributed use were not very popular in our case projects. Most of our interviewees did not even suggest their usage e.g. as a solution to the communication problems. In contrast, they suggested changes to their working practices and communication practices. Even small practical changes seemed to help. Both studies showed a similar direction in their results. This does not suggest that the communication tools would not be needed in the future, on the contrary, good tools are certainly needed. However, our results show that tools are and cannot be the only solution, but simple working practices and communication practices that support the distributed way of working are important, as well. Tools will most probably be essential in supporting these practices.

Next, we will discuss and compare the communication practices discovered in both studies. We have grouped this comparison under seven headings: collaboration process, communication links, problem solving, informing, monitoring progress and providing transparency, giving feedback, and relationship building.

6.2.1.1 Collaboration process

We encountered a few communication practices that were related to the product development process. First of all, in Study 2 a practice called “Process walkthrough” was needed to communicate to the project participants about the process to be used in the coming project. Study 1 did not report a similar practice, but our interviewees revealed in the simulation sessions that they did not have a good picture about the process phases and the participants of the distributed project, even though the companies had had joint projects already earlier. The simulation session seemed to be a good experience to many team members in gaining that picture. In Study 1, the practice “Resident engineer to facilitate contacts and relay information” was used, among other things, for distributing information about the subcontractor’s process to the customer and the other way around.

In Study 2, none of the projects had a similar practice.

Another process-related practice, “Frequent deliveries”, was used in several projects in Study 2. Frequent deliveries were often deliveries of code from the subcontractor to the customer. Most often the projects using frequent deliveries had an iterative process model in use, i.e. the system was built and tested frequently, and new features or improvements were added to the following iterations. This process model had a large effect on communication, since the frequent integrations and the synchronization of work required constant communication. Moreover, the deliveries themselves and the test results had an important communicative role, since it was possible for all parties to observe how the project was really progressing from the code and test results. Thus, this process model provided transparency to the project situation.

In Study 1, a corresponding practice was used, even though it was not central from the communication point of view in that study, and thus we did not pick it up as a practice then. Namely, in Study 1 both projects built the entire physical product a few times during the project. In those projects, builds were made more seldom than in software development, where even weekly builds were used. This was natural, since building a physical product required a lot more preparation than building software. For instance, it could require making changes to the moulds, moulding the parts, and sending the parts by mail. The builds in Study 1 contained, also other parts than the plastic covers. These builds showed, among other things, whether the plastic parts fitted together, and whether there was enough room inside the covers for the other parts. All parties could get feedback from these builds. Thus, in a way they functioned in a similar communicative role than the frequent deliveries in Study 2. The most notable difference was that the frequent deliveries and builds in Study 2 were more frequent, and therefore had a larger effect on the way of working and communicating in Study 2, than the builds had in Study 1.

In conclusion, we can say that, according to both studies, builds during the development and iterative type of process model seem to be beneficial for the communication in distributed projects that have a lot of uncertainties. That kind of a process model facilitated communication e.g. by bringing actual check-points and transparency of the project situation to the participants.

6.2.1.2 Communication links

Communication links that emerged or were created between the collaborating companies differed somewhat both between the studies and between the case projects inside each study. During the data collection and analysis a question came up: whether to direct communication between the companies through only a few link persons, or to allow or even to encourage direct communication between the team members from the participating companies. The opinions and experiences of our interviewees differed regarding this issue; both communication channels had advantages and disadvantages, while the best solution probably lies somewhere between these extremes depending e.g. on the situation and the project type.

We recognized a few practices related to communication links from both studies. In Study 2, we named a practice “Creation of links at three levels”. We observed that functioning communication links between the companies at management, project manager, and team levels seemed to be beneficial for communication. If links on one or two of these levels

were missing, problems tended to occur since also part of the communication was missing. The link between project managers functioned quite well in all projects of Study 2, whereas functioning management level links and/or team level links were sometimes missing. In Study 1, we observed that the projects managers from the participating companies formed very strong communication link pairs between the companies. We named the encountered practices as ”Project managers as gatekeepers between companies” (Case 1/PlastCo) and “Project managers as information distributors and decision makers” (Case 2/PartCo). Actually, in Study 1, the project managers formed the main communication channel between the companies. They took care of the informing both inside and between the companies and participated actively in decision making and problem solving. In Study 2, the project managers’ role as information distributors was not as notable as in Study 1, since in Study 2, more other links between the companies existed as well. Moreover, in Study 2 the project managers did not participate as much in problem solving as in Study 1. Instead, experts discussed about the problems directly. For example, in Study 2, according to a practice called “problem solving responsible” it was quite often the system architect who had both enough technical knowledge and a good picture of the whole project, and thus was able to answer questions and solve problems. In Study 1, the project managers were those persons who had the best picture of the whole project, and enough technical knowledge, as well. Therefore, they were able to participate and coordinate the problem solving. In contrast, in Study 2, the project managers did not always have enough technical knowledge to participate in problem solving on their own. Therefore, technical experts normally communicated directly in problem solving situations. Meanwhile, in Study 1, the problems, such as scratches and particles in the paint, were somehow “easier” both to understand and to find the reasons behind, when compared to the complex problems hiding inside the software in Study 2.

In addition to communicating through the project managers, at least some direct contacts were established in Study 1. Namely, from the other project in Study 1 (Case 2/PartCo) we encountered a practice ”Communication through direct contacts about details”. In that project, direct contacts were found to be useful, and the team members hoped to have even more direct contacts and communication in the future. In both Study1 and Study 2 direct contacts were quite often difficult to establish when persons from the collaborating companies did not know each other beforehand, and thus did not know whom to contact. Furthermore, contacting an unknown person seemed to pose a quite high barrier to many. Moreover, some of our interviewees were scared that direct communication would be difficult to control, e.g. developers from different companies could make decisions that affect the whole project without informing the project managers. Despite these fears, none of the projects reported having those kinds of problems. Instead, our interviewees coming from projects that allowed and encouraged direct communication, were satisfied with the well-functioning communication. In contrast, the interviewees from projects having only a few links complained about slowness of communication and lack of information due to too many steps in the communication.

In summary, in all case projects the project managers seemed to be very strong and important communication links between the companies. They monitored the project’s progress, made decisions, and distributed information between the companies and inside their own company. Moreover, other direct contacts between the companies seemed to be important for the communication, as well. None of the projects planned to reduce direct communication, instead, despite the fears of some managers many of our interviewees

expressed their desire to establish more direct communication links between the collaborating companies to facilitate the communication. For example, one of the persons supporting direct communication was the customer's project manager from project Epsilon. She had earlier been almost the only communication link between the companies and sites, which had been problematic, thus she was now very eager to add new links:

> **Quotation 88:** "We have tried to add communication links between the distributed parties so that there are many contact persons, and all information does not go through only one person. So that as many persons as possible would be responsible for communication in both ends, thus they cannot just wait passively, because that person does not tell me anything'!" (Customer's project manager, Epsilon)

This discussion about either directing the communication between the companies through only a few link persons, or encouraging the creation of direct communication links did not lead to any exact answers. The best solution seemed to be a combination of these depending e.g. on the project type and phase. For example, in many of the projects in Study 2 the early project phases, such as requirements specification, required only a few higher-level links, whereas the later phases, such as integration and testing, benefited from low-level direct communication links.

In Study 2, another recognized practice was "Creation of role descriptions", which so far only a few case projects had recently started to use, but which appeared to be useful. The customer companies had started to describe and name roles suitable for distributed projects, and expected the subcontractors to name persons to the corresponding roles in their organisation. The roles facilitated communication, since they were easy give to the project participants and the roles had e.g. some specific communication tasks and responsibilities in inter-organisational communication. In Study 1, we did not observe a corresponding practice of describing and naming roles. However, both projects in Study 1 had actually named one role, resident engineer, that included a lot of inter-organisational communication tasks. In conclusion we can say that describing and naming roles that have communication responsibilities and are used in all inter-organisational projects seems to be a practice that can be very useful. This research could only scratch the surface of this issue, thus it can be left as an idea for managers to develop further and future studies to research.

In Study 2, we encountered a practice "Visiting engineer", which seemed to have a positive effect on communication. Visiting engineers visited the collaboration partner; customer, subcontractor or subsidiary, and stayed and worked there for longer periods of time. They facilitated the communication by passing information, creating contacts, solving problems, and simply by being present for face-to-face discussions. A comparable practice was found in Study 1: "Resident engineer to facilitate contacts and relay information". This practice differed somewhat from visiting engineer. In Study 1, both projects had a resident engineer, who came from the subcontractor and worked permanently at the customer's premises instead of making short visits like the visiting engineers did. Our interviewees were very satisfied with this practice of having a resident engineer. This practice could have been suitable for the projects in Study 2 as well, but still none of those projects had a permanent visitor. Maybe the need for face-to-face communication in the development of tangible products, as discussed earlier, is one of the reasons why the resident engineer was needed in Study 1, but in Study 2 the projects were satisfied with the visitors staying shorter time periods, and did not express a wish for

permanent visitors.

6.2.1.3 Problem solving

Communication related to problem solving was found to be an important form of communication in product development projects according to both studies. It seems that when developing new products in an uncertain environment with several partners, different kinds of problems and questions will almost certainly occur and communication is needed to solve these problems. Quick and efficient problem solving seemed to be especially important, since often the projects could halt until the problems were solved. Several communication practices emerged in both studies to solve these problems. Often these practices were created by trial and error when problems came up.

In Study 1 the other case project (Case 2 / PartCo) had a practice named "Project meetings for problem solving", i.e. meetings were arranged between the companies mainly when problems emerged. In the other case project (Case 1 / PlastCo) the practice "Weekly meetings for change management" partly prevented the problems from occurring, when the changes and possible problems were discussed together already beforehand. In addition to these named practices both projects from Study 1 solved urgent problems also outside the meetings. Especially the project managers participated in the problem solving by communicating a lot, especially through the telephone, but also through email. The more urgent the matter was, the more popular choice the telephone was as the communication medium. The resident engineer participated in the problem solving at the site, as well.

Whereas in Study 1 face-to-face meetings were the most important communication medium for problem solving, in Study 2, problem solving took mainly place through electronic communication media. In Study 2, chat, email and discussion forums were the primary communication forums for problem solving. Telephone calls were used only occasionally and face-to-face meetings were arranged when difficult problems that were urgent to solve occurred. We named some of the communication practices used in Study 2 according to the communication media used: "Discussion forums", "Direct communication through chat" and "Face-to-face problem solving". The differences between the studies regarding the communication media were in part due to the larger geographical distance that many of the projects in Study 2 had compared to the distances in Study 1. Another reason might be the need for face-to-face meetings discussed earlier. Our case companies developing tangible products explained these to be important, whereas software code was easier to distribute and discuss about also across distances provided both parties could see the code. Still, another difference might be that the developers of software were more used to using their computers for communicating, and many of them had used chat and discussion forums in their work already earlier.

"Problem solving responsible" is a practice found in Study 2. Persons who were often central figures, such as system architects, who knew a lot about the project and thus could help in solving the problems ended up having this role. In Study 1, the project managers and the resident engineers were that kind of central figures, as discussed earlier. The practice "Relaying contacts and questions", encountered in Study 2, emerged when the participants of distributed projects did not know each other across the sites, and therefore it was difficult to know whom to contact when having questions or problems. Certain persons were needed to relay contacts and questions between the sites. In Study 1, the

resident engineer did that kind of tasks, as well. He knew practically all project personnel from both organisations and therefore was able to both forward questions and relay contacts. These successful practices show that in a distributed project it is important to have a person, who is easy to contact when having problems, and who has both the time and ability to help either by participating in the problem solving or by relaying contacts. Otherwise people easily delay contacting and telling about the problems, and instead try to figure out the solution on their own, which takes both time and may lead to erroneous conclusions.

"Collocated testing and integration" is a practice encountered in Study 2. Collocation was challenging to arrange in many of the projects due to the long distances. If arranged, integration and testing was the phase when collocation was essential, making work much more efficient and quicker. In Study 1, the situation with physical products was different, building the product and testing it did not pose similar problems. Instead, in Study 1, collocation with the resident engineer was needed especially in the early design phases, when possible future problems could be avoided by including the manufacturing point of view.

In conclusion, it seems that problem solving communication is and will be central for distributed product development projects. These projects typically have a lot of uncertainties, when several partners are involved, projects use new technologies and requirements can still change. Consequently, questions and problems are likely to occur. Several differing communication practices were found, suitable for different kinds of situations and needs. However, planning the used practices already in the early project phases was most often missing. Instead, practices were invented when needed or they just emerged. Still, many of our interviewees found communication related to problem solving problematic. Therefore, it seems that designing and planning the problem solving practices already in the beginning of the project might be beneficial.

6.2.1.4 Informing

Since several sites and partners were involved in our case projects, a lot of informing was needed especially in the beginning of the project, but also during the project. In the beginning the participants needed information, e.g. about the project goals, project partners and their roles, tasks, schedule, process and working principles. During the project, information about different kinds of changes, decisions and problems was needed. Actually, most of the communication practices used involved at least some informing aspects. Here we will discuss only those practices that concentrated mainly on informing.

In both studies information was distributed especially in different kinds of meetings. In Study 1, the practices "Weekly project meetings for change management" and "Project meetings for problem solving" were used to distribute also other kinds of information than merely change and problem information, e.g. the project status was discussed there. Since in these projects all team members could not participate in the face-to-face meetings, they often received the most important information from the meetings memos that were sent as email attachments. We named this practice as "Meetings memos as the main source of project status and change information to team members".

In Study 2, the practice "Regular meetings" was a very important informing channel for many projects. In these projects, due to the distances, face-to-face meetings were often difficult to arrange across the sites, thus meetings were either site-specific or they were

arranged using electronic communication media, such as teleconference. Similarly to Study 1, project status information was distributed also in these meetings. The meeting memos, if written, did not come up as an equally important informing channel as in Study 1.

In Study 1, the project managers seemed to be the most important information distributors. In one case project (Case 1 / PlastCo), the project managers formed basically the main channel for information distribution between the companies. They passed on information and controlled the information flow, thus this practice was named as "Project managers as gatekeepers between the companies". In the other case project of Study 1 (Case 2 / PartCo) the project managers were also an important informing channel, but not the only one. The practice was named as "Project managers as information distributors and decision makers". In Study 2, the project managers were important information distributors, as well, but they did not rise to an equally central informing position as the project managers in Study 1. One reason for this might have been that in Study 2, the projects had also other channels for informing, such as direct contacts, databases, discussion forums, etc. In both studies email was probably the most commonly used media for informing: documents were sent as attachments and short messages in the body text.

In Study 2, the practice "Databases for managing changes and bugs" was also grouped under informing. The reason for this was that when the project participants had access to these databases, they could find important information in there by themselves. Moreover, some systems even sent automatic emails, e.g. about bug reports to those persons whose responsibility it was to fix these bugs. Both bug reports and change requests had quite a formal process for handling. In Study 1, we did not encounter a corresponding practice, since the participating companies did not have any common databases, or access to each other's databases, even though a common database for the project documents, such as design documents, was asked for. If information is available for everybody, then less active informing is needed. On the other hand, finding the relevant information from a large amount of data is difficult, as some of our interviewees in Study 2 had already noticed.

In summary, the most important practices for informing the project participants were clearly the project meetings and informing through the project managers. The project managers then distributed the received information inside their own company. These practices were used in both studies, and both in the beginning and during the project. The only named practice that was used especially in the beginning was "Kick-off", a special starting meeting that was used in a few projects in Study 2, but not in Study 1. The most notable difference between the studies was that in Study 1, only a few practices and channels were used for informing, whereas in Study 2 several channels were used. For instance, whereas in Study 1, face-to-face meetings and telephone calls or emails between the project managers were the main informing media, in Study 2 also several other electronic media were used, such as databases and internet-based media, such as discussion forums and chat.

6.2.1.5 Monitoring progress and providing transparency

Monitoring the project situation was important and challenging for the project managers in both studies. Distribution caused the challenges, since the project managers could not meet the distributed teams daily, discuss with them and monitor the situation. Instead, other means for monitoring were needed. In Study 1, the situation was somewhat easier than in Study 2, since the project managers from the customer and subcontractor communicated daily, and because of the reasonable distance, face-to-face meetings could be arranged quite frequently. Thus, for the project managers these conversations and project meetings where the project status was discussed were sufficient. In Study 2 the distances were longer, thus face-to-face meetings were not arranged so often. Instead, e.g. teleconference meetings and "Progress reports" were used. Some of our interviewees from Study 2 mentioned that not meeting other partners face-to-face made it possible to hide problems. According to them, you could already see from a subproject manager's face whether something was troubling him or her before you could see that from a report. Even though face-to-face meetings were clearly preferred for monitoring the project situation, progress reports were useful as well when better solutions were not available.

In addition to the project managers, also subcontractors and project team members needed information about the project status. In a distributed project, it was difficult for them to see during their daily work, what was happening in the other parts of the project. However, they hoped to get that kind of transparency for the project. They needed transparency to be able to accomplish the tasks that had dependencies to other tasks, but being able to see the big picture was also a motivating factor. The need for transparency came up in both studies, and the lack of it was often mentioned as a problem. Thus, it seems that the used practices where not sufficient to satisfy this need.

In both studies the project meetings provided some transparency to those participating in the meetings. Others were informed, e.g. by sending them the meeting memos in Study 1 and progress reports in Study 2. Thus, the practices "Meeting memos as the main source of project status and change information to team members" and "Progress reports" can be mentioned as used communication practices in Studies 1 and 2 respectively. As we discussed in connection to informing, several other practices helped to create transparency as well. These included "Frequent deliveries", "Discussion forums" and Regular meetings" in Study 2, and "Weekly project meetings for change management" and "Project meetings for problem solving" in Study 1.

In short, we noticed during both studies that providing transparency of the project situation both to the project managers and the team members of a distributed project was important. However, good communication practices were at least partly missing. Meetings, meeting memos and progress reports were the most important practices that were used for monitoring progress and providing transparency.

6.2.1.6 Giving feedback

In both studies especially the subcontractors and distributed teams needed feedback to make sure whether they were doing what they were supposed to do. All feedback received was normally highly appreciated, it was also a motivating factor. In Study 2 we recognized "Design and code walkthroughs" and "Lessons learned" as practices that provided feedback. In Study 1 we did not encounter corresponding practices. Instead, feedback to the subcontractors was given e.g. in meetings, and when receiving model

parts and either accepting or rejecting them. Moreover, in Study 1 communication especially between the subcontractor's and the customer's project managers was very frequent, thus giving feedback was quite a natural part of these discussions. In Study 2, the longer distances, electronic communication media and in many projects the lower frequency of communication probably reduced the amount of natural feedback received. Therefore, separate practices for giving feedback were needed. Still, the amount of feedback was seen as too low according to many interviewees in Study 2. To conclude, only a few practices to give feedback were encountered, however, more attention and practices would most probably be welcomed.

6.2.1.7 Relationship building

Relationship building was noticed to be important according to both studies, since when the partners knew each other well collaboration and communication was easier. Practically, all communication affected relationship building, especially face-to-face meetings. When meeting face-to-face, the partners could get a picture of what kind of persons their partners where, in a way they got "faces". In Study 2 we named this as the practice "Giving faces". In Study 2, especially the long geographical distances caused that the team members communicating together electronically had not always met each other, which was experienced as problematic. Early possibilities for face-to-face meetings were hoped for. A few projects in Study 2 had already started to arrange "Kick-off" meetings in the beginning of the project. In addition to discussing project-related issues, one important goal of these meetings was to acquaint the distributed team members with each other. For instance, electronic communication benefited from the meetings and became easier between the collaboration partners. In Study 1 we did not encounter a similar practice.

In both projects of Study 1 the customer company and the subcontractors had already worked together before these projects. Therefore, at least some key team members knew each other from before. Moreover, due to the close physical distance, several face-to-face meetings were arranged during the project, which was of course beneficial for building a good relationship. Thus, the cooperation and communication seemed to function quite well. However, several persons mentioned in the simulation sessions that one of the benefits of the session was that they met some of the partner's personnel face-to-face for the first time. Consequently, arranging meetings even more systematically could have been beneficial.

To conclude, both studies showed that in a distributed project it is beneficial to arrange face-to-face meeting opportunities in the beginning of the project at least to those persons who will be closely collaborating. After that electronic communication is more efficient.

6.2.1.8 Summary of the collected communication practices

We have collected the recognized communication practices of Study 1 and Study 2 in Table 42. The table compares whether a corresponding practice was identified from both studies. The practices collected from Study 2 are presented first, since naming, description and grouping of the practices were more developed during that later study.

Table 42. Comparison of the identified communication practices.

Grouping of practices	Comparison of the identified communication practices	
	Study 2	**Study 1**
Collaboration process	"Process walkthrough"	No similar practice.
	"Frequent deliveries"	Model pieces were delivered and product built also during the development, but more seldom than in Study 2.
Communication links	"Creation of links at three levels"	"Project managers as gatekeepers between the companies" "Projects managers as information distributors and decision makers" "Direct communication about details"
	"Creation of role descriptions"	No similar practice.
	"Visiting engineers" stayed and worked occasionally for short time-periods at different sites or in the partner's premises.	"Resident engineer to facilitate contacts and to relay information". Subcontractor's resident engineer was working permanently in the customer's premises.
Problem solving	"Problem solving responsible"	"Resident engineer" and project managers participated in problem solving.
	"Discussion forums"	No similar practice.
	"Direct communication through chat"	No similar practice.
	"Relaying contacts and questions"	"Resident engineer to facilitate contacts and to relay information"
	"Face-to-face problem solving"	"Project meetings for problem solving"
	"Collocated testing and integration"	"Resident engineer to facilitate contacts and to relay information"
Informing	"Regular meetings"	"Weekly project meetings for change management" "Project meetings for problem solving"
	Project managers as important information distributors, but not as central as in Study 1.	"Project managers as gatekeepers between the companies" "Project managers as information distributors and decision makers"
	"Databases for managing changes and bugs"	No similar practice.
Monitoring progress and creating transparency	"Progress reports"	"Meeting memos as the main source of project status and change information to team members"
	Other practices contributing: ""Frequent deliveries", "Discussion forums", "Regular meetings"	Other practices contributing: "Weekly project meetings for change management", "Project meetings for problem solving"

Feedback	"Design and code walkthroughs"	No similar practice.
	"Lessons learned"	No similar practice.
	Other practices contributing: "Regular meetings"	Other practices contributing: "Weekly project meetings for change management", "Project meetings for problem solving", and sending model parts, their acceptance information or reclamations and related discussions
Relationship building	"Kick-off"	No similar practice.
	"Giving faces"	Regular meeting possibilities made it easier to see the partner's faces, even though not named as a practice.

6.2.2 Communication problems

In addition to the main research question we had three supporting research questions. The second research question was:

RQ2: What kinds of communication problems do geographically distributed inter-organisational product development projects have?

Material to answer this research question was collected from both studies. We presented earlier the major communication problems that were found in each study. Next, we will discuss and compare the communication problems found in Study 1 and Study 2. We have grouped the problems under six headings: change management, problem solving, informing, time-zone and geographical distances, motivational issues, and misunderstandings.

6.2.2.1 Change management

One big difference between the studies regarding the encountered communication problems was related to change management. In Study 1, informing about frequent changes was new to the partners. Thus, the communication practices that would have taken care of it efficiently were not yet planned properly. One problem related to this was named as "Slow arrival of change information to some internal functions" (Case 2 / PartCo).

In contrast, in Study 2 most software development projects had quite formal procedures for change management in place already. Moreover, changes in the software did not always have as large an effect on the other parts of the project as most changes related to plastic products had. If a change was not communicated properly in the plastic products development, it inevitably resulted in that some partners relayed on old information, and in consequence could have wasted all their efforts. In software development the effort was wasted entirely in fewer cases and the whole attitude was different; changes were a natural part of the development. In contrast, in the development of plastic products in Study 1, the change to parallel development was still new. Therefore, the people were not so accustomed to the frequent changes that were caused by this new way of development. We called this problem as "Slowness of organisational adaptation to new communication needs of parallel development" (Case 1 / PlastCo). Moreover, in Study 1 all partners were

not asked to contribute to the development early enough. This problem was called “Too late involvement of some internal functions” (Case 2 / PartCo).

To sum up, in Study 1 change management was not taken care of properly, especially informing about the changes was insufficient. The reason behind might be the recent change to parallel development, whereby the communication practices were not developed yet. In Study 2, the projects developing software were used to changes and had mainly well-functioning change management processes. Hence, to our surprise, problems related to change management did not play as central a role in Study 2.

6.2.2.2 Problem solving

Both Study 1 and Study 2 found problem solving challenging. As mentioned earlier, problem solving communication seemed to be pretty much neglected when planning the projects. Nevertheless, the studied distributed product development projects had a lot of questions and problems that required inter-organisational communication to be solved.

First of all, in both studies it was difficult to find the correct person to contact when having problems or questions. In Study 2 we called this problem “Lack of contacts and link persons”. If the personnel from the collaborating partners had not met each other before the project and contact persons were not named, it was difficult to know whom to contact at the other organisation, and the threshold to contact an unknown person was often high. In Study 1, the problem was basically the same, but in those projects the personnel was not even encouraged to contact co-workers at the other organisations directly. Instead, even though direct contacts were not forbidden, the companies clearly preferred the inter-organisational communication to flow through the project managers. Thus, the problem described by the project personnel was named as “Lack of direct contacts”.

In Study 2, especially the subcontractors and the customer’s distributed sites had a lot of questions and problems to which they needed answers from the customer. Quite often email was used for asking these questions. If the customer company had not named a responsible person to make sure that the questions were answered, it was easy for busy developers just to disregard these questions and emails, since answering would have taken a lot of time. This problem was named as “Lack of responsible persons and time to answer”. In Study 1 we did not encounter a similar problem. The subcontractor’s personnel did not complain about not getting answers to their questions. One of the reasons for this might have been that the project managers in Study 1 coordinated communication and problem solving quite effectively. Thus, they also took care that the questions going through them were answered.

To sum up, problem solving communication was clearly needed in distributed projects, but taking care of it was often neglected. One of the biggest problems was that the personnel from different organisations often did not know each other or their roles and responsibilities. Therefore, knowing whom to contact when having questions or problems was difficult.

6.2.2.3 Informing

Both studies considered informing as a challenge. A central problem in both studies was that the partner’s need for information was unclear. As a result, it was difficult to know

what kind of information to give to a partner. On the other hand, when the partner himself did not know what kind of information existed, it was difficult even to ask for information. In Study 1 we called this problem "A lack of understanding of partners' information needs and information generation" and in Study 2 we named it as "Partner's information needs unclear". Of course, a solution to this problem could have been to give all information to the partner, but finding the relevant pieces would be difficult when getting too much information. A few persons already found that problematic, therefore we named this problem as "Misguided use of the information-push" (Case 1 / PlastCo). The person who needs the information knows best what kind of information he or she needs. However, also this proved to be difficult; a person would first need to know what kind of information exists before he or she can ask for it.

Furthermore, company borders and confidentiality issues prevented the companies from giving all relevant information to their partners. The companies e.g. did not want to reveal too much information about their new products or know-how to their partners. Instead, they often preferred giving a minimum set of information. Especially customer companies liked to follow this principle. Both studies found this problem relevant. The problem was called in Study 1 as "Lack of trust leading to the hiding of information" (Case 1 / PlastCo), and in Study 2 as "Company border restricts information flow for confidentiality reasons".

Informing requires more active effort in a distributed project, than in a collocated project, where the information can flow quite naturally. Since distributed partners or sites are out of sight, they are also easily forgotten to be informed. In Study 2, we named this problem as "Forgetting or disregarding the informing of distant sites and partners". In Study 1 several problems existed at least partly due to the lack of active informing efforts, such as "Slow arrival of change information to some internal functions" (Case 2 / PartCo).

In Study 1, a large part of the information flow between the companies was directed through the project managers. These persons informed their own personnel as well as their partner's project managers and even some other persons. It seemed that the projects relied too much on these individuals. When they were unavailable, on a business trip or sick, the information flow was almost blocked. Moreover, these persons had to use a lot of their time just for passing information. This problem was named as "A lack of common communication and information exchange mechanisms and an over-reliance on key individuals". In Study 2, the projects did not rely as much on a few individuals to do the informing, but had also other informing practices and channels. Even though the project managers were central persons, the situation was not felt to be as problematic as in Study 1.

Finally, in Study 1 "Non-working inter-organisational document management" was listed as one of the problems. Especially in the simulation sessions we discussed about the possibilities to build an inter-organisation document management system. Currently, the lack of that kind of a system meant that the projects did not have any one place where all the newest document versions could have been found. Instead, they were distributed to different companies and persons. Hence, informing the relevant persons, e.g. about new document versions, required active informing efforts which were easily disregarded, as mentioned earlier. In Study 2, due to a different kind of product, software, the situation was somewhat different. Instead of document management systems, version management systems are important for software development projects. Basically all companies had at

least internal version management systems. However, only a few projects had in use a version management system that the distributed sites or partner companies were allowed to access. This lack of a common version management system was identified as a communication problem that at least some projects were already planning to remove. Even so, for some reason our interviewees did not experience this as a very big problem, thus we did not name it as a problem in Study 2.

In summary, informing in a distributed project seemed to require more efforts than in a collocated project, thus it was easily at least partly forgotten or disregarded. Since the partners did not know each other's information needs or information generation, giving only the relevant information was difficult. Moreover, inter-organisational aspects caused the confidentiality issues to prevent free distribution of information.

6.2.2.4 Time-zone and geographical distances

In Study 2 some of the projects had time-zone differences between the distributed sites. This was felt to be problematic and thus named as a problem: "Time-zone differences limit synchronous communication". Even though the literature has discussed the possibilities to use the time-zone difference for working round the clock, none of our case projects had actually largely benefited from the difference. Instead, the difference had caused them problems especially by limiting the possibilities to communicate. The larger the difference, the less synchronous working time the distributed teams had. This e.g. limited the use of telephone calls and teleconferences, and lengthened the problem solving lead-time. In Study 1 no time-zone differences existed, since all the partners were located in Finland.

In Study 2 the geographical distances were quite large in many projects, since the partners and sites were located across country borders, and in some projects even across continents. In Study 1 the geographical distances were shorter, since all the sites were situated in Finland. The distances caused a lot of problems in Study 2 and was thus named as a problem: "Geographical distances limit informal communication and face-to-face meetings". The longer the distance was, the more difficult it seemed to be to arrange face-to-face meetings, since travelling took both time and money. The lack of face-to-face contacts, on the other hand, caused many limitations for the communication, e.g. informal communication suffered. Even though the distances were shorter in Study 1 than Study 2, at least some of the same problems existed. For example, all distributed team members did not know each other and informal communication between the companies was very limited. Thanks to the shorter distances in Study 1, the inter-organisational project meetings were always arranged face-to-face, which was seldom possible in Study 2. Thus, in Study 1 face-to-face meetings could normally be arranged whenever needed, but in Study 2, for most projects that was not possible.

To sum up, the time-zone differences seem to limit synchronous communication and geographical distances informal communication and face-to-face meetings. The larger the time-zone difference or the geographical distance is, the more limitations it seems to pose on the communication.

6.2.2.5 Motivational issues

Motivational issues were identified as one of the problem areas. The motivation of the project personnel to work and communicate in a distributed project seemed to be

important in order for the project to be successful. In Study 2, we noticed that "Lack of motivation to communicate" existed at both company and personal levels. For the companies, the policy was often to give the least possible amount of information to the collaborating companies, in order not to revel too much. At the personal level the motivation to help unknown, distant colleagues was sometimes very low, in particular, if those partners came from a distant country. Similar problems were found in Study 1, especially at the company level. Even though the companies had made agreements about what information the partners were allowed to get, the project personnel had not seen these agreements, and hence were afraid to give information to make sure that they would not give away too much. At the personal level, we did not notice similar problems in Study 1. Partly, this maybe due to the fact that the companies had positive experiences from earlier collaboration. In addition, all the partners were Finnish, not foreigners. However, in Study 1, the way of working in parallel and its communication requirements were still quite new. The problem mentioned earlier, "Slowness of organisational adaptation to new communication needs of parallel development" (Case 1 / PlastCo), is therefore related to the motivation to communicate, as well. Especially in the PlastCo case the personnel did not wholly understand the new situation, e.g. why there were so many changes and why it was important to communicate about the changes frequently and efficiently.

In Study 2, "Lack of feedback" was named as one of the problems by several interviewees working in the subcontractor companies or at the distant sites. These teams or team members were easily forgotten, thus the feedback was often insufficient, it came too late and was mainly negative. The lack of feedback lowered the motivation and caused e.g. unnecessary work. In Study 1, the lack of feedback did not seem to be a big problem. One reason for this difference might be the difference in the products; in Study 1 all partners were developing the same part of the product together, the customer designed the product and the subcontractor designed the mould for manufacturing it. Thus, the partners had to work in parallel and communicate when sending the designs and changes back and forth. Therefore, the partners got feedback on their work all the time. On the other hand, in Study 2 the partners sometimes worked longer periods of time on their own, designing or coding their own part of the product. The projects that used frequent deliveries and integrations in Study 2 normally got useful feedback after each build.

"Lack of transparency" was the third motivation-affecting problem encountered in Study 2. The project personnel in many projects experienced that they did not have as good a picture of the project situation as they would have liked to have. They hoped to get more information, e.g. about the project progress, changes, problems, and future directions. All that kind of information received was highly appreciated. It seemed that getting visibility raised the spirits and motivation, whereas the lack of transparency lowered those. In Study 1, the lack of transparency did not come up as a problem, but the feedback after the simulation sessions showed that one major benefit from the simulations was that the sessions gave a good picture of the whole distributed project to the participants. Hence, it seems that better transparency could have been beneficial for those projects, as well.

In summary, there are several issues that affect the motivation to work efficiently in a distributed project. Problems were identified regarding the motivation to communicate, the lack of feedback and the lack of transparency. Motivational issues could be important to consider when designing the communication practices for a distributed project.

6.2.2.6 Misunderstandings

We found a few misunderstandings in communication in Study 2. “Misunderstandings in electronic communication” were quite certain to occur, when a large part of the communication in Study 2 took place through electronic communication media. For example, when using email or chat for communication, the tone of the message could be interpreted wrong. Moreover, in electronic communication it was difficult to make sure whether the partner had understood the message correctly. In Study 1, telephone calls and face-to-face meetings were used quite a lot, thus the usage of other electronic communication media than telephone calls, such as email, was lower than in Study 2. Maybe for that reason misunderstandings were not mentioned as a problem. Still, discussing about 2D pictures was sometime difficult over the telephone or through email, since showing the exact points was impossible. Moreover, in Study 1 all projects participants were Finnish speaking, whereas in Study 2 the projects crossed country boarders and thus some project participants always had to use a foreign language.

In Study 2, “Differences in terms used” caused misunderstandings, as well. The terms used in the collaborating companies differed somewhat, and even when the same terms were used, their exact meaning could vary. When the terms were not defined in the beginning of the project, the differences sometimes came up only when facing problems. In Study 1, the problem was somewhat different. The companies used a lot of abbreviations, the meaning of which was not always entirely clear to all participants.

In summary, misunderstandings in electronic communication and differences in the terms used were minor problems that the distributed projects had in their communication.

6.2.3 Communication needs

The third research question was:

RQ3: What kinds of communication needs do geographically distributed inter-organisational product development projects have?

Material to answer this research question was collected mainly from Study 2. During Study 1 we already found this question as important and interesting to study in order to understand better the communication requirements of distributed product development projects and the communication practices used in those projects. During Study 2, this research question was paid more attention to. However, in the scope of this research we could only scratch the surface regarding this question. Our results regarding the communication needs mainly aimed to create some further understanding of the communication needs to build a basis for grouping and classifying the collected communication practices.

The most important communication needs that we recognized in the case projects of Study 2 between the customer and the subcontractor or subsidiary were: problem solving, informing, monitoring progress and providing transparency, giving feedback, and relationship building. When compared to the material collected from Study 1, these communication needs appear to be relevant also when regarding the communication needs of the projects studied in Study 1.

6.2.4 Social process simulation method

The fourth research question was:

RQ4: Is the social process simulation method a useful tool in studying communication practices in inter-organisational product development projects?

Material to answer this research question was received only from Study 1, since the method was used in Study 1, but not in Study 2. The reason we did not want to use it in Study 2 was that in that study we wanted to collect material from several projects, and due to time and resource limitations could not go very deep into detail. Thus, we chose a more effective interview method for collecting data from multiple cases for Study 2. The social process simulation method is more suitable for doing deeper studies of a few case projects.

We received very positive results from the usage of this method in the data collection. Actually, this approach includes several data collection methods. For example, in Study 1 we arranged simulation planning meetings, process description sessions and interviews, collected documents, collected data with questionnaires, and finally arranged simulation sessions. All the four first data collection methods were used to prepare for the simulation session and the questionnaires were answered in the end of the simulation day. Thus, by using this method we could collect rich data from several sources (triangulation of sources) and by using several data collection methods (methods triangulation), which provided us an opportunity to validate the findings. From the methodological point of view, this provided us a possibility for triangulation of both the data collection methods and data sources. The biggest benefit from the method was probably that it sparked interest in the participating companies. They gave us the possibility to collect data from their projects because they felt that they could get direct benefits for their projects from the usage of this method, in addition to the longer-term benefits of the research. After the simulations the participating companies and their personnel were very satisfied. In addition to receiving our research results, the companies got e.g. several improvement ideas and the participants got a broad overview of the inter-organisational development process. A downside of this method is that it requires quite a lot of preparation to be successful. Thus, it seems to be more suitable for in-depth case studies than for studying some specific issue from several cases. Moreover, the company participants have to feel that the participation is important for them, otherwise the simulation might not succeed.

As a research tool, the simulation method had several advantages, as described earlier. However, we wanted to evaluate the suitability of this method for studying inter-organisational communication practices. According to our experiences the suitability of this method for studying inter-organisational projects was very good. The simulation session and the preceding preparations gave a good overview of a distributed project that would have been otherwise quite difficult to observe.

Evaluation of the suitability of this method for studying communication practices is not easy. Studying communication practices is challenging, since a large part of the communication is not documented and the amount of communication in a large project is tremendous. Hence, getting a good picture of that communication and figuring out the communication practices is demanding. The social process simulation method helped us find out at least some of the most relevant communication practices with a reasonable amount of work, compared to the large possible amount of data. Since we did not record

the actual communication, but instead only discussed about it, there is, of course, a possibility that we did not catch all the relevant data. Probably some interesting practices were not mentioned, because the participants did not find them relevant or they just forgot to mention the practices. Thus, this method is not perfect for studying communication. For our purposes it was good enough, and we were very satisfied with the results. However, a more thorough comparison of this method with other communication research methods would be needed to be able say more about its suitability in studying inter-organisational communication.

6.3 Summary

In this chapter, we first compared the two studies regarding a few characteristics, such as local vs. global distribution, tangible vs. intangible products, and intra- vs. inter-organisational distribution. The ability and need to arrange face-to-face meetings was one of the recognized differences between the studies.

Secondly, we summarised and compared the results received from Study 1 and Study 2 to our four research questions, which concentrated on the communication practices, communication problems, communication needs, and the usage of social process simulation method. Our main research question about the communication practices received most attention. After comparing the communication practices found in both studies, it seemed that there were a lot of similarities; the encountered practices did not differ much between the studies, even though the developed products were different. Many communication problems were similar in both studies as well, even though also some differences were found.

Material for the third research question about the communication needs was mainly collected from Study 2, but the recognized communication needs appeared to be relevant also when compared to the results from Study 1. Finally, the fourth research question about the social process simulation method was answered based on the results from Study 1, where it was used and recognized as a quite useful tool to study communication in distributed projects.

7 Discussion

This chapter first discusses the results and compares them with the literature. Secondly, the contribution of the research is discussed. Thirdly, the limitations and evaluation of this study are presented. Finally, subjects for future research are proposed.

7.1 Comparison of the results with the literature

7.1.1 Practice vs. pattern

Our main research question searched for communication practices that are used in geographically distributed inter-organisational product development projects. In this study, we defined a communication practice as a practice in which communication has a central role and which is used at least a few time times in a quite similar form either in one project or in several different projects. Moreover, we presented some elements of organisational communication collected from the literature to help describe a communication practice: parties, direction, message, media, reason, and environment. We wanted to keep the definition quite broad, since the aim of this study was to explore what kind of practices existed. A very strict definition could have restricted the study too much. However, during the data collection and data analysis, this broad definition made it difficult to determine what can be called a practice and what cannot. In addition, we had to determine whether to call our practices practices or patterns.

Several communication researchers referred to in our literature study used the term communication pattern, e.g. Allen (1984), Gloor et al., (2003), Kidane and Gloor (2005), Pinto and Pinto (1990) and Wiesenfeld et al. (1999), when talking about recurring communication patters. Still, these studies did not present any specific definition for that term. Alexander (1977, 1979) and Coplien (1994, 1995) used the word pattern in a different context, Alexander wrote about architectural patterns and Coplien about organisational patterns. The work of both of these writers has largely affected this study. Alexander (1977) explained that a pattern "describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice". Coplien and Harrison (2005) applied Alexander's thoughts in describing organisational patterns of agile software development. Coplien's (1994) patterns are carefully described: every pattern has a name, describes the problem, gives the context of the problem, explains the forces or trade-offs affecting it, gives a solution to the problems, and explains the resulting context and design rationale. Coplien and Harrison (2005) marked the confidence level of their patterns by stars. They gave each pattern from zero to two stars depending on how often they had seen the pattern used and depending on their sense of confidence about the pattern's value. Both Alexander and Coplien use the word pattern when describing a solution that recurs at least as somewhat similar several times. But, how many times is enough to call a practice a pattern? We can e.g., decide that three times is enough. Is it then enough that a practice is observed to be used three times in one project or should it be used in three different projects? If we choose the latter definition, then we would have to decide when a practice is really the same practice, since of course the practices differ at least somewhat between the projects.

Even though both Alexander's and Coplien's work guided this study, we decided not to use the word "pattern" in this study, but use "practice", instead. The main reason for this choice was the small number of projects studied during this research. Moreover, since we did not have a perfect list of practices at the beginning of the research, but that was built during the research, we could not ask our interviewees whether they had used this specific practice in their project. Instead, we had to ask what kind of practices they had used. For this reason, some projects could have even used practices that we did not think about asking and the interviewees did not understand or remember to tell us.

When collecting and analyzing the data for Study 1, we had only a rough idea of how a communication practice could be defined. During Study 2, as our understanding developed, also the definition developed. In Study 1, the practices were named separately, regarding both case projects, whereas in Study 2, we identified and named the practices using the data from all case projects in Study 2. During that latter study we aimed to name and describe the communication practices on a quite general level. In that study we also used the rule of three, i.e. we named as a practice all communication-related practices that had been used at least in a somewhat similar form in the minimum of three different projects.

7.1.2 Communication practices

RQ1: What kinds of communication practices are used in geographically distributed inter-organisational product development projects?

The results showed that most of our case companies had not planned clear organisation-wide communication practices that would have been commonly used in their inter-organisational product development projects. The communication practices encountered were mainly project-specific and created by trial and error. The practices that our interviewees determined as successful were quite simple and most of them were not new creations, e.g. regular meetings or visiting engineers. Still, these practices were not used broadly in our case projects, which easily led to problems. Some of the practices were taken into use only in response to problems. On the other hand, when these simple practices were used, less problems were experienced. The state of the practice in our case companies seemed to be quite low, which surprised us to a certain degree.

Some of the literature related to communication in distributed projects emphasizes the development of tools to support communication. However, in our study, the practices, i.e. how the work and communication was arranged, seemed to be more important than the tools. Of course, new and better tools will probably help as well, but already the usage of currently available communication tools together with carefully designed and implemented communication practices could offer great improvements to many projects.

The advice given in the literature for arranging communication in distributed projects is often on a high level, even though very practical advice can be found, as well, e.g. from global software development literature. However, global software development literature does not offer extensive lists and descriptions of communication practices, instead, most studies are reports of case studies of one organisation or an organisation network, and report about communication only as one of the subjects. The book by Carmel (1999) offered quite a broad selection of communication-related practices and advice, many of which supported our findings. To complement the existing literature this study aimed to

collect and describe a broad set of useful low-level communication practices and describe how they really are used in the companies.

The practices and advice found during this study mainly supported the earlier findings reported in the literature as well as added more experiences and more detailed descriptions. In addition, we had some new findings. One of them was the huge need for problem solving communication and the lack of planned communication practices to support it, which was noticed especially during Study 2. The literature does not emphasize this communication need as much as our study, nor does it present supporting communication practices. Our study listed and described several suitable communication practices, some of which seemed to be new findings, such as "problem solving responsible".

Another communication need that came up as more important than the literature presents it was "monitoring progress and providing transparency". Especially the latter part, the provision of transparency of the project progress to the company's own distributed project team and the subcontractors, seemed to receive quite little attention in the literature, even though Moenaert et al. (2000) name network transparency as one of the requirements for effective and efficient communication in international product development teams, and Carmel (1999) mentions the importance of giving a 360 ° view of the project. Our results showed that distributed teams and team members desired more transparency to the project and its status than what they were usually given. Moreover, we recognized a few useful communication practices that can help in providing transparency.

The third finding that received more support from our study than from the earlier literature was the practice of using frequent deliveries of code and the iterative and incremental process model in distributed projects. The literature mentions this possibility, e.g., Battin et al. (2001), but does not emphasize it or describe properly its usage in distributed settings. Only a few recent research papers report successful usage of this process model in distributed development projects (Fowler, 2004; Simons, 2002). In our study, this practice called "frequent deliveries" was successfully used in seven case projects and our interviewees reported about its several benefits both to the projects and project communication. Thus, it seems that this practice might be well suited for distributed projects as well, and support their communication.

7.1.3 Communication problems

RQ2: What kinds of communication problems do geographically distributed inter-organisational product development projects have?

We identified several communication problems related especially to inter-organisational communication in distributed projects. Both projects had quite similar types of problems, which were grouped into six groups: change management, problem solving, informing, time-zone and geographical distances, motivational issues, and misunderstandings. Similar types of problems related to all these groups can be found from the earlier literature. Thus, the identified problems were not entirely new findings. However, we hope that by grouping, naming and describing the problems this study can bring some new insights.

The descriptions of many communication practices and interviewees' comments emphasized the need to communicate more and make the projects more transparent to

their participants compared to the current situation. However, there is certainly an upper limit in both the amount of communication and the level of transparency, even though reaching it did not yet seem to be a large problem in our case projects. Only in Study 1, in the PlastCo case a few persons found the "Misguided use of the information-push" as problematic. We can find suggestions to build a modular product structure and to distribute the development of these modules according to the distribution of the product development organisation in the software development literature (Hersleb and Grinter, 1999b). This would reduce the need to communicate between the developers of the different modules. Even in software development, the division of the product to this kind of separate modules did not seem to be easily done, especially when having a lot of uncertainties, like our case projects had. In other kind of development, e.g. plastic products development that was presented in Study 1, that kind of modularity might not have helped as much. Anyway, we must remember that increasing the amount of communication and the level of transparency cannot be the only solutions. Moreover, increasing them too much without proper plans might lead to problems, as well.

7.1.4 Communication needs

RQ3: What kinds of communication needs do geographically distributed inter-organisational product development projects have?

The most important communication needs that we recognized in our case projects between the customer and the subcontractor or subsidiary were: problem solving, informing, monitoring progress and providing transparency, giving feedback, and relationship building. This communication need classification arose from the data and was used to group the communication practices.

In the literature we found a corresponding classification presented by Stahl et al. (1998) on communication in distributed product development. Their classification included informing, information exchange and feedback, coordination and decision-making, and problem solving. Allen (1984; 2000) has made a well-known classification of technical communication in a single firm case. He divided the communication into three types: communication to coordinate work, communication to maintain staff knowledge and communication to promote creativity.

These classifications found in the literature differ somewhat from our communication need classification. The most striking difference is the need to coordinate the work, which does not appear in our classification, but is mentioned in both other studies. The reason for this is not that we would not have encountered this need for coordination, but instead, it is a part of other communication needs. Especially monitoring progress and providing transparency, but also informing include coordination aspects, since before you can coordinate you need to know the situation, and thus receive monitoring information. When defining our communication need classification at the same time we were identifying the communication practices, we noticed that actually none of the practices was merely about coordination. Decision making identified by Stahl et al. (1998) did not come up in our study as an important communication need either. One of the reasons might be that we looked at communication between the companies and quite often decisions are made inside the companies.

Relationship building and monitoring progress and providing transparency, were

communication needs identified in our study, but not mentioned in the other classifications found from the literature. However, according to our results both communication needs seemed to be very important for distributed projects.

7.1.5 Social process simulation method

RQ4: Is the social process simulation method a useful tool in studying communication practices in inter-organisational product development projects?

We did not find any other study where a similar type of simulation method would have been used as a tool to study communication. Our results showed that one of the main benefits of this method was that the companies were very positive about it, since they experienced that its usage would give their projects and personnel direct benefits. Thus, they willingly gave us this possibility to collect data from their projects. Earlier research studying the usage of this method as a process improvement tool has reported many of the same benefits as our case project experienced, such as: simulation participants get a good overview of the whole process, problems and improvement ideas come out, and communication and cooperation between the participants improves (Forssén-Nyberg and Luhtala, 1996; Forssén-Nyberg and Hakamäki, 1998; Smeds and Haho, 1995; Piispanen et al, 1996; Ruohomäki, 1995a).

7.2 Contribution of the research

The contribution of this research can be looked at in two ways: its practical contribution to the field of application and its scientific contribution.

7.2.1 Practical contribution

The communication practices used in distributed, inter-organisational product development projects started to interest us, since we had noticed communication to be a huge challenge in that kind of projects. Thus, the reasons to perform this study arose from the practice. Therefore, we believe that the results of this study, especially the collection of communication practices, will benefit inter-organisational product development projects in the future. The practical contribution of this research can be divided into two: first, the feedback to the companies that participated the study, and second, the benefits to future projects in the form of project type and communication need classification, and the collections of successful communication practices and the communication problems to be avoided.

Firstly, the companies that participated in our study found the participation to be a useful learning experience. During Study 1, we asked the participants to give improvement suggestions to their own way of working both during the interviews and the simulation sessions in addition to collecting communication problems and practices. After each of these first cases, we gave feedback to the participants in the form of a feedback report and a feedback session. In the report we presented the collected communication problems and practices, as well as the improvement suggestions. We hope that this feedback will help the participants improve communication and collaboration in their future distributed projects. Moreover, during Study 1 we had two simulation sessions, where a large number

of the personnel from each of these distributed projects participated. According to the feedback received from the participants, they had found the simulation sessions as very useful. The main benefit they mentioned was getting a good picture of that large project distributed across several sites and companies. In Study 2 the companies agreed to participate in this research with pleasure, since we had promised to present them the results received from this study. The participating companies felt that they themselves had problems with their distributed projects, thus they were eager to learn how other companies handled their distributed projects, and what kind of communication and collaboration practices they used. Even though we did not find any spectacular practices, we believe that even collecting these quite simple practices will give these companies a good starting ground for choosing and designing practices for their future projects. During and after Study 2 we gave to the participating companies altogether four feedback sessions where our results were presented.

Secondly, we hope that our results will benefit the future distributed product development projects. The results are and will be published in the form of both practical and scientific articles and presentations. We believe that especially managers planning and executing distributed projects will find the results useful. The project type classification can help them identify the subcontracting project types they are using, and thus recognise when specific practices are needed to be designed and used. The communication need classification can help them recognise the communication needs their projects have. Communication problems may be useful for identifying the possible problems that should be avoided. Finally, the collection of communication practices could be useful when choosing and designing communication practices for the projects.

7.2.2 Scientific contribution

When starting this study we searched for literature about communication and collaboration practices suitable for distributed product development projects. There was not much literature about this subject yet. Perhaps the reasons for this lack of scientific material was that distributed product development projects had not been as common in the past as they are now when companies need to introduce new products to global markets more quickly than ever. Thus, we hope that this study will offer a useful contribution to science as well. The scientific contribution of this research can be divided into three parts: firstly, we grouped and named the communication practices and problems, secondly, we made initial classifications of the software subcontracting project types and communication needs, and thirdly, we received positive experiences of using social process simulation as a communication research tool.

Firstly, this study produced new understanding of the communication practices used and the problems encountered in distributed product development projects. We see that the main scientific contribution of this study is the description, naming and grouping of communication practices. So far, we have not encountered corresponding and as broad efforts as this, even though many articles have described a few of the practices used. The description, naming and grouping of communication problems is a contribution, as well, even though not as broad and thorough as the description of the communication practices. The descriptions of the communication practices and problems, and the given examples provide deep insights into communication in distributed product development projects. The presented communication practices and problems could be used as a starting point for

many kinds of future research, as will be suggested in Section 7.4.

Secondly, the initial classifications of software subcontracting project types and the communication needs of the personnel working in distributed software development projects, is a minor scientific contribution. When we presented the subcontracting project type classification to the managers of our case projects, the feedback we received was very positive. They regarded it as truthful and useful. This project type classification was already used when choosing suitable case projects to Study 2. It helps understand the differences between the subcontracting project types, and find suitable communication practices for each project type. The communication needs classification was used when classifying the communication practices collected in Study 2. This classification, arising from our interview data, provides some new insights into the communication needs of these kinds of projects, and thus helps understand what kind of communication and communication practices are needed.

Thirdly, the positive experiences we got from using the social process simulation method as a communication research tool in distributed product development projects is another minor scientific contribution. Companies and their personnel found the process simulation method useful for them and their projects, since they got many benefits from this study. Thus, it was easier to persuade them to give their time to this research than when using other methods, such as mere interviews. Moreover, we got rich data using many data collection methods and sources, thus providing possibilities for triangulation. These positive experiences encourage us and hopefully also other researchers to use this method in the future as a communication research method, and to try it out in different kinds of research situations.

7.3 Limitations and evaluation of the research

The quality of the findings from this case study is evaluated and the limitations are discussed next. We have divided this discussion into five main issues as suggested by Miles and Huberman (1994); confirmability, dependability, internal validity / credibility, external validity / transferability, and application.

7.3.1 Confirmability

When examining the confirmability of a study, the emphasis is on the replicability of a study by others. We need to review whether the conclusions depend on the study subjects rather than on the researcher. (Miles and Huberman, 1994)

To ensure confirmability we have described our research methods, research process and data analysis explicitly and in detail. We have tried to state very clearly if some conclusion or suggestion does not directly arise from the data, but is a suggestion presented by the researcher. Data analysis steps, such as coding, grouping communication practices into categories and naming them is the kind of qualitative data analysis that depends quite much on the researcher carrying out the steps. In this study, only one researcher did the final data analysis, thus there are no differences between the analyses of the different data sets. Of course, the researcher's earlier experiences, etc. influence the analysis, thus a different analyst would have probably ended up with a slightly differently named and grouped set of practices. All the data used in this study is on file (e.g.

interview recordings, simulation session videotapes) and available for possible reanalysis by others.

7.3.2 Dependability

To assess the dependability of the study, we need to examine the process of the study, whether it is consistent and whether the study has been conducted carefully enough (Miles and Huberman, 1994).

The same researcher (the writer) designed and participated in all data collection, such as both simulation sessions and all interviews. Thus, the data collection was comparable and no problems related to multiple researchers could have occurred. Also, the data analysis was performed by only one researcher. On the other hand, multiple researchers could have provided different viewpoints to the data collection and analysis, which might have benefited the research.

Since the interview questions were semi-structured, and thus the interviews were quite conversational, the wording of some interview questions could have been somewhat leading, possibly directing the answers of the interviewees. Earlier data collection steps of the same case study also directed the next data collection phases, e.g. interview questions asked with the next interviewees, or conversation issues in the simulation sessions. This could have affected the results, even though it was partly beneficial for the research, because it directed our data collection to interesting themes.

Almost all the interviews were in Finnish, since most of the interviewees were Finns. This made it easier for them to understand and answer the questions. The direct quotations used in this report have been translated into English, which might have unintentionally changed the tone of the answers. In seven interviews the language used was English, since that was the only common language for the researchers and these interviewees, who were not native English speakers, however. This, of course, might have affected their understanding of the interview questions, their answers and the understanding of these answers by the researcher.

In Study 1, the interviews of Case 1 were not tape-recorded, which however could have been useful. From those interviews the only data that remained were the interview notes. In the next case studies all interviews were recorded.

7.3.3 Internal validity / Credibility

The internal validity and credibility evaluates the findings of the research; whether they make sense, seem convincing and are internally coherent (Miles and Huberman, 1994).

Using two forms of triangulation, i.e, methods triangulation and triangulation of sources (Patton, 2002; Yin, 1994), contributed to the validation and verification of the results. Methods triangulation means using multiple data collection methods and checking out the consistency of the findings generated by these different methods (Patton, 2002). In Study 1 several data collection methods were used: semi-structured interviews, process description sessions, simulation sessions, post-it notes and questionnaires all provided data about the communication practices and problems. The data collected by these different methods was compared and its consistency checked. The goal was, of course,

not to obtain entirely similar results from the data collected by different methods, but to try to get as complete and truthful a picture of the reality as possible. In Study 2 similar triangulation was not possible, since only one data collection method, interviews, was used.

Triangulation of sources means examining the consistency of the different data sources within the same method (Patton, 2002). This form of triangulation took place in both studies, e.g. we interviewed several persons from each case project and asked them similar questions. The communication practices described by both studies were the main practices which were confirmed from many sources in each case project where they were used, whereas some communication problems were mentioned by only a few respondents. The reason for this might be that the communication practices described facts that were familiar to everyone, whereas the communication problems were more related to special situations and concerned some persons more than the others. Moreover, some persons may feel that specific practices or situations are more problematic than how some other persons might experience them, depending e.g. on the age or the background of the persons. For these reasons, we can only state that the problems presented were real to those persons who described them, but we cannot say much about their importance.

After collecting data from each of the case studies, reports about the findings were written and feedback sessions given to all participants. In Study 1 the feedback reports were delivered to all simulation participants either before the feedback session or in the feedback session for those who had not received them earlier. The findings were presented in the feedback session and they were discussed together. No mistakes relating to the findings were found by the participants even though that was specifically asked for. The presented results mainly raised interest and even further suggestions about how to carry them out. Moreover, a research paper was written about the PlastCo case study presenting both the findings and suggested improvements. Representatives from both ElectroCo and PlastCo read this paper and accepted it without finding anything to comment. In Study 2, the findings were presented to the participants in four feedback sessions and the results were discussed there. The feedback we received was positive and no mistakes were mentioned.

7.3.4 External validity / Transferability

To assess external validity / transferability we need to study whether the results are transferable to other contexts, and how far they can be generalized (Miles and Huberman, 1994).

This research consisted of altogether twelve projects which were studied quite thoroughly. When choosing the research method we also had to choose between the scope and the depth of this study, i.e. either studying several cases more superficially or only a few cases in greater detail. Since we wanted to understand more about communication in distributed inter-organisational product development, studying only a few cases in greater depth seemed to be the right choice. Consequently, this choice affected the generalisability of the results. However, broad generalisability is not even a useful goal for qualitative research (Schofield, 2000). Instead, generalisability can be increased by providing contextual information about the case study. This way the results can be applied to understanding a similar situation deemed by the contextual information

(Schofield, 2000). Therefore, a substantial amount of information was provided about the projects studied.

The chosen projects developed two types of products, plastics and software, thus generalizing the results to different industries should be regarded cautiously. All the customer companies were from the same country, Finland, which can cause some bias, e.g. due to cultural factors. However, most of the projects had sites and subcontractors involved from other countries, too. Thus, international aspects were included in the results at least to some degree, though we did not explicitly focus on them. This weighting of one country may affect the generalisability of the results, as well. Moreover, the customer company in four of the projects was the same, thus this company had quite a large influence on the communication practices in these case projects.

This exploratory study has to be seen as a description of the communication practices in twelve projects, shedding some light on the communication practices used in distributed product development. Because the number of case projects was limited, this study can only give an idea of what kind of practices can be useful in inter-organisational product development projects. Studying another set of projects would probably have resulted in a slightly different collection. Therefore, we cannot say that these are the 'best practices', but only that they were useful according to the subjective opinion of the people we interviewed in those particular cases. When studying more projects, additional useful practices will certainly be identified. We reported the practices that were useful in the projects in which they were used. Of course, the success and usefulness of each practice depends on the specific project type in which it is used. For this study, we chose projects that demanded constant collaboration between the customer and the subcontractor and also between geographically dispersed sites, since all parties were developing the same new product at the same time and everything could not be specified precisely beforehand. Other practices might prove to be more useful for other kinds of projects. Moreover, the projects studied were all inter-organisational. Therefore, the practices identified are particularly suitable for these kinds of projects. However, we believe that most of the practices could be used in distributed intra-organisational projects as well.

The practices presented were subjectively determined as useful by the interviewees. We were not able to use any other measure of success, e.g. measuring the performance of a project would not have provided much added value since many other factors affect the performance, and all projects were one of a kind. Therefore, the best and easiest success measure seemed to be to rely on the subjective expert opinions of the interviewees.

Clearly, more research is needed to be able to make broader generalisations about the communication practices in distributed inter-organisational product development.

7.3.5 Application

Application of the findings discusses the effects of a study on its participants; researchers and research subjects, and the consumers of the research (Miles and Huberman, 1994).

The earlier section about practical contribution already discussed the effects of this study on our research subjects, i.e. the participating companies. There we presented also the possible benefits of this research for future projects. In the section on scientific

contribution we discussed how this study could advance scientific knowledge.

Miles and Huberman (1994) mention also questions of ethics. According to them, in addition to asking who benefits from a study, we should ask who might be harmed. In our research the participants of the study might also be harmed in addition to benefiting from the results. For this reason the identity of the interviewees and their responses are not combined in any reports, and the names of the participating companies are changed in all public reports. Thus, we believe that this research will not cause any harm to our research subjects.

7.4 Proposals for future research

The ideas for future research arising from the results of this study are presented next.

7.4.1 Quantitative studies about communication practices

When starting this research we could not find any lists or classifications of the communication practices suitable for distributed product development projects. Thus, this study was explorative in nature. When collecting the data we did not have any ready-made lists of communication practices that we would have searched for in the case projects. Instead, we asked the project participants to describe quite freely the communication practices they use. For this reason we cannot be entirely certain, whether some practice was not used in some specific project, or whether the interviewees simply did not mention it. Now that this collection of communication practices exists, future research can both improve it and include missing practices, and use it as a basis for quantitative studies. The quantitative studies could collect data about the usage of the communication practices from a large number of projects. Interesting questions to be studied are, e.g. how common the usage of each practice is and in what kind of projects the practices are used.

7.4.2 Link between communication practices and project success

In this study we tried to find especially successful communication practices. However, their usefulness and success could not be measured, but was based only on the subjective opinions and experiences of the case project participants. Project managers choosing and designing communication practices for their future projects would certainly benefit from the knowledge of which practices are the best ones and improve the project performance and success the most. Of course, the most suitable and successful practices for each project depend on many project characteristics. One set of practices cannot be the best for all distributed projects. Future research could study this very challenging problem. For example, which practices affect project success the most and are thus the most important to use in different types of projects could be studied.

7.4.3 Communication practices suitable to different project types and phases

In this study we already presented one idea about the project phases in which each of the communication practices (those collected in Study 2) could be used. It seemed to be the best idea to design most of the practices in the early phases of the project, whereas the

suitable phase for usage differs. For example, some practices need to be used during the whole project, whereas some are used in the initial phases and some in the final phases of the project. Future research could study these issues deeper. An interesting question to answer could be in which project phase each of the communication practices should be used. Moreover, different types of projects need different kinds of communication practices. Some practices are more suitable for one type of projects, whereas for other kinds of projects a different set of practices is better. Thus, finding out which communication practices are the most suitable for each kind of a project, is another future research topic.

7.4.4 Means to accomplish transparency

The lack of transparency inside a distributed project was one of the problems mentioned by the participants of our case projects. Both project managers and team members wanted to see, e.g. how the entire distributed project was progressing, what kind of information existed, what kind of problems the project had, who participated in the project and what were their roles and tasks. Accomplishing that kind of transparency seemed to be important, but at the same time quite challenging to achieve. If, e.g. problems and non-compatibilities cannot be noticed early enough, the project can even fail entirely. Moreover, in our case projects the transparency was important both for the team members to be able do their tasks and for their motivation to work. They wanted to know, e.g. what kind of a project they were a part of, where their own work had an effect, and what was the current situation, e.g. whether the project was late or on time.

However, accomplishing this kind of transparency seemed to be really challenging for our case projects. Both geographical distances and organisational borders limited the information flow and thus also reduced the transparency. Moreover, the challenge of balancing the amount of information the project participants were given was difficult. Even though information gives transparency, some of our interviewees complained that they got sometimes even too much information, and it was difficult for them to find the relevant and needed information. Interesting future research questions are: How to accomplish transparency in a geographically and organisationally distributed project? What kinds of practices are needed to accomplish transparency? What kinds of tools are needed to accomplish transparency?

7.4.5 The usage of social process simulation in future research

Social process simulation was used successfully as a research tool or method in Study 1. The simulation benefited both the participating companies and the researchers. The companies gained, e.g. new knowledge about their projects and process improvement ideas. The researchers received rich data collected by multiple data collection methods from many sources. Thus, all the parties were very satisfied after this experience. Therefore, we believe that this simulation method could be used in future research as well. The method seemed to be especially suitable for studying distributed organisations, since it gave a very good picture of large, distributed projects both to the company participants and to the researchers. Using this method it is possible to collect data from many people at the same time, and get a broad view of the situation. It can also bring visibility to complex systems and work processes that might be difficult to observe

otherwise. In the future, its usage might benefit the studies of other kinds of projects, as well as studies having some other research targets than communication.

7.5 Summary

This chapter first discussed the results and compared them with the literature. Secondly, practical and scientific contribution of the research was discussed. The practical contribution was divided into two issues: feedback to the companies that participated in the study, and benefits for future projects in the form of project type and communication need classification, and the collections of successful communication practices and communication problems to be avoided. The scientific contribution of this research was divided into three parts: we grouped and named the communication practices and problems, made initial classifications of the software subcontracting project types and communication needs, and received positive experiences of using social process simulation as a communication research tool. Thirdly, the limitations and evaluation of this study was presented. This discussion was divided into five main issues: confirmability, dependability, internal validity / credibility, external validity / transferability, and application. Finally, subjects for future research were proposed: quantitative studies about communication practices, link between communication practices and project success, communication practices suitable for different project types and phases, means to accomplish transparency, and usage of social process simulation in future research.

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Appendix 1

Study 1 - Discussion topics in the semi-structured interviews.

1. Background of the interviewee
   - Position / tenure in the company / tasks

2.Checking and correcting process description

3. Communication practices
   - What was agreed about communication practices in the beginning of the project?
   - Do you communicate with the customer / supplier? With whom? When? Why? Using what media? What information is exchanged?
   - Who else communicates with the customer / supplier? With whom? When? Why? Using what media? What information is exchanged?
   - What kind of information do you normally communicate with your customer / supplier?
   - What kind of practices do you have for meetings / change management / schedule management? How is informing about these arranged?
   - What other formal communication practices does your company / project employ internally?
   - What kind of informal communication do you employ company internally / externally with partners?
   - For what kind of communication do you use email / phone calls?
   - What other media do you use? For which purposes?
4. Communication problems
   - What kind of communication problems does your project have internally / between partner companies?
   - What other practices are problematic?
5. Improvements needs
   - What practices in your project could be improved?
   - How could the communication / information flow be improved?

Appendix 2

Study 1 - Questionnaire in PlastCo case.

Most of the closed questions were not included in this study; therefore these questions are not listed here either.

Closed questions (1 – I totally disagree,…, 5 – I totally agree, 9 – I do not know):

1. The simulation helped me build an overall picture of the simulated process
2. The simulation increased to my knowledge about co-operation needs / communication needs / time dependencies / interfaces / need for team work / documents / need for a common language / process milestones
3. The simulation helped to bring new operating principles to networked co-operation
4. I can make use of the lessons I learned from the simulation
5. The common process still needs development
6. The simulation was useful for ElectroCo / PlastCo / AutoCo / PaintCo

Open-ended questions:

1. What are the biggest deficiencies of project documents?
2. What are the most important improvement areas between these networked companies?
3. Which measures would best promote further development of networked co-operation?
4. What are the biggest hurdles for the development of networked co-operation?
5. What should be simulated next?
6. What did the process simulation give you? Why was it useful?

Study 1 - Questionnaire in PartCo case.

Closed questions (1 – I totally disagree,…, 5 – I totally agree, 9 – I do not know):

1. The simulation gave me a good overall picture of the whole project
2. The simulation increased my knowledge about the need for co-operation between companies
3. The simulation increased my knowledge about communication needs
4. The simulation increased my knowledge about documents used in the project
5. The simulation increased my knowledge about partner company's processes
6. The simulation increased my knowledge about my own company's processes
7. The simulation was very useful for me
8. The simulation was very useful for other participants
9. The simulation was very useful for developing ElectroCo's processes
10. The simulation was very useful for developing PartCo's processes
11. The simulation was very useful for developing a common process between companies
12. The simulation was very useful for developing communication and information flow between companies
13. The simulation brought out good development ideas
14. The simulation brought out the most important problems in ElectroCo's process
15. The simulation brought out the most important problems in PartCo's process
16. The simulation brought out the most important problems between companies
17. All the persons needed were present in the simulation session. (Open-ended: If not, who was missing?)
18. Similar simulations should be arranged in the future
19. The process area chosen was suitable for the simulation. (Open-ended: If not, which area would have been better?)
20. A project repository would be useful for networked projects
21. A project repository would speed up networked projects
22. A project repository should have / both common documents for the network and company internal documents / only common documents / common schedule / meeting memos / latest 3D and 2D pictures / product specifications / requests for proposals, offers and orders / reclamations / document template /

acceptance reports / change information / tool progress reports / measurement data / FMEA / visual quality requirements / production volumes

23. In the simulated project, the communication and information flow were very well arranged
24. Information flow is an important improvement area
25. PartCo should be taken to projects earlier that currently
26. PartCo's suppliers should be taken into projects earlier than currently
27. The communication and information flow should be improved especially between ElectroCo and PartCo / inside companies / between ElectroCo and PartCo's suppliers / between PartCo and its suppliers

Open-ended questions:

1. What was the biggest benefit of the process simulation in your opinion?
2. How could the simulation have been improved?
3. What kinds of benefits might a common project repository bring to a networked project?
4. Was the simulated project a typical project between the companies? If it was not, how did it differ?
5. How could information flow be improved in networked projects?
6. What kind of information would you need more of? How would you like to get that information?
7. What are the biggest problems in projects, such as the one we simulated today? How could these problems be removed?
8. What are in your opinion the most important improvements, that could shorten the lead-time from the first contact between the partners to the mass production release?
9. Other comments:

Appendix 3

Study 2 - Questions to project manager

(The initial questionnaire before modifications)

1. What kind of work have you done during this project?
2. Have your tasks/role remained the same during the project?
3. When did you join the project?

Before the project start-up

1. Project goals and boundary conditions
    a. What is the overall goal of your project (=inter-company project)?
    b. Has that goal changed during the project? (How? Why?)
    c. What is the size of the project (length, number of personnel)?
        i. In which stage is the project currently?
    d. Which boundary conditions are fixed (time, money, quality)?
2. Requirements specification: How well could the product requirements be defined in the beginning?
        i. Who participated in the definition?
        ii. How do you normally proceed in cases when detailed specifications or documentations are not available?
        iii. How do you document requirements specifications?
3. Uncertainty: Which issues were uncertain in the beginning in the project? Why?
    a. Which issues have brought most uncertainty during the project?
4. How is the work divided into the network between you and your partners?
    a. Why is this division chosen?
    b. Is the development work split into separate modules? How?
    c. Has the division caused any problems? What kind of problems?
5. Have you used some process model in this project? (if not, request to tell frely about the progress of project)
    a. Which model?
    b. Have you had in this project any special decision points / milestones before the project can move to the next phase?
    c. How often do you normally have milestones?
    d. What have been the most critical milestones in distributed projects according to your experience?
6. Do you know whether any written contracts were made between companies?
    a. If not made: why?
    b. Do you know the contents? (If no: Would you have needed to see it? Why?)

In the beginning of the project

1. Which issues were agreed with the participating companies in the beginning of the project? (Concerning what and content?)
    a. *Do you have any checklists on what should be agreed on? (Can we see?)*
    b. Were these agreements enough, or should something else have been agreed on also in the beginning of the project?
2. Project organisation: What kind of project organisation do you have in this project?
    a) What were the difficulties in creating a project organisation?
    b) How clear is the organisation structure of your projects?
        i. Do you have an organisation chart of your projects?
        ii. Do you define the roles and responsibilities for each project member? Who defines?

c) How do you choose / nominate resources to projects?
d) Project managers: Do you have one project manager in charge of the whole project? Why?
    i. Whose project manager will be in charge of the whole project? Why?
    ii. What is the suitable number of project managers in a distributed project? Why?
    iii. How is the work normally divided between the project managers?
e) How is the decision making arranged in the project?
f) How many teams do you have in this project?
    i. Why have you chosen this number of teams?
    ii. Do you have teams that include members from different companies?
        1. Why?
        1. Does that bring any special challenges?

3. Has there been a project kick-off meeting?
    a. Agenda?
    b. In which phase of the project was it arranged?
    c. Who participated? Who was missing?
    d. How long?
    e. Was it useful? Disadvantages? Benefits? Why?
4. Face-to-face meetings during the project start-up
    a. Has there been other face-to-face meetings during the project start-up?
    b. Do you think that face-to-face meetings in the beginning of a project are useful?
5. Project plan: What kind of a project plan do you make? What are the contents?
    a. Is it actively used during the project? How?
    b. Who can see the project plan? Why?
6. Was training arranged in the beginning of the project?
    a. What kind?
7. How successful was the project start-up in your opinion?
    a. What succeeded well during the project start-up, in your opinion?
    b. What failed during the project start-up, in your opinion?
8. Where the subcontractors taken into the project at a right time?

During project execution

9. Collocation vs. distribution: How much collocated work is required in a distributed project in your opinion?
    a. Which issues determine, how much collocated work you arrange in a project?
        i. How long are the periods?
        ii. Who travel?
        iii. Where are the collocated periods arranged?
10. Support for the supplier: What kind of support practices do you try to provide to the supplier?
    a. Do you have a resident engineer/liaison person in distributed projects? Why?
        i. How have you organized his/her work? What is his/her work description?
        ii. What have been the benefits of this arrangement?

b) How is answering to suppliers' questions /problems arranged?
c) How do you make sure that the supplier acquires enough product-related knowledge and information?

11. Project monitoring in networked projects: How do you monitor networked projects?
        i. What kind of information is collected (e.g. number of bugs)?
        ii. How do you use the collected information?
        iii. Would you need to know more? What kind of information?

a) Do you have any special monitoring on your partners?
b) Do you have any tools to follow the progress in the project? (e.g. time control)
(What kind of tools? Who uses them? Who inputs the information?)
c) What is most problematic in supplier monitoring in globally distributed projects? Why?
d) Do you inform the project members about project progress? How?

12. Document management: How do you take care of document management in a networked project?
    a. Did you have any common document management system between the companies?

b. How did the different companies access the documents? (How were the documents transferred between companies?)

13. Change management in networked projects: How do you take care of change management?
    i. How many changes have you had in this project? (How many changes do you normally have?)
    ii. Which partner (/role) is the typical source of changes?
    iii. Do you have / use official change request documents?
    iv. Did you feel that these changes were clearly communicated and understandable to you?
    v. Do you monitor the changes? How?

a) Who decides on
    1. Minor changes?
    2. Major changes?
    3. The priority of the changes?
b) Do you use any change management tools?
c) How do you take care of version control?
d) How do you take care of configuration management?
e) What is most problematic in change management in networked projects?
b) How do you inform the project members about the changes?

14. Builds and deliveries: Builds and deliveries: What kind of deliveries / partial deliveries do you prefer in the projects?
    i. How often are the deliveries made?
    ii. What is the content of deliveries?

f) Do you use builds in the projects?
    i. How often are they made?
    ii. Who makes (supplier/customer)?
    iii. What is the content of builds?

15. Testing: How is testing arranged?
    a. How often do you test?
    b. Who does the testing (supplier/customer)?
    c. How was feedback from the tests communicated to the partners?
16. Quality: How did you define the required quality in the beginning of the project?
    i. How?
    ii. What were the biggest problems in defining and negotiating the required quality?
    b. How was quality assured?
    i. Did you have reviews? (How often? Who participated?)
    ii. Did you have inspections? (How often? Who participated?)
17. Communication: What kind of communication is there between you and your partners during the project execution?
    a. What kind of formal meetings do you use in this project between companies? (e.g. weekly meetings, videoconferences, milestone reviews, other reviews, inspections, netmeetings, conference calls)
    i. Does the distributed project require different meeting arrangements compared to normal collocated project?
    i. How often do you meet face-to-face?
    ii. Do you think that is often enough?
    iii. Who participate?
    iv. Which issues are discussed in face-to-face meetings?
    b. In addition to meetings, which other issues need to be communicated between the companies?
    i. Who communicates?
    i. How often?
    ii. How do you choose which media you use for the purpose in question (e.g. questions/answers, change requests, informal communication)?
    c. How successful has the communication been between the companies in this project?
    i. Regarding the amount of communication
    ii. Regarding the quality of communication

   d. What are the most difficult problems in communication during a distributed project?
      i. Why?
      ii. How could communication be improved in your opinion?

18. Contacts across company borders: Do you feel you have enough contacts & communication with those members in other companies who are somehow important for your own working tasks?
   a. How have the contacts been created (kick-off / earlier projects)?
   b. *If you feel you don't have enough contacts, can you name some barriers for these contacts?*
   c. Can you imagine that cooperation with someone in the project could have helped you in managing the project?

19. Team relationships
   a. Teams and team borders
      i. Where do you feel that you belong to (e.g. this company/this project / project team inside your company / project team across company borders / technical expertise group)?
      ii. Which team(s) had the most power to control the project in your opinion? Why? (What was the path to this situation?)
   b. Inter-company cooperation
      i. *Do you prefer working in intra- or inter-company projects? Why?*
      ii. Do you get enough feedback across company borders?
      iii. Do you feel that your team's (company's) work was dependent on the work in other companies?
         1. How?

20. Differences in working practices between the companies (between departments): Have there been any problems in working due to the different working habits between the companies?
   a. What kind of problems; examples?
   b. Do you think it is important to develop common working practices between the cooperating companies?
      i. In what kind of projects are common practices needed most, in your opinion?

21. Responsibilities
   a. To whom do you feel that you are most responsible to?
      i. Do you feel that you have enough freedom and responsibility in your work?
   b. Can you describe a situation where the tasks have not matched your own ideas of your working role? (difference of work tasks to one's expectations)

22. Personal benefits*:* Do you feel that you have personally benefited from this project? How? (e.g. learning)

At the end of the project

1. How was the product/project assignment finally accepted?
2. Product-related knowledge transfer between customer and supplier: Do you transfer product-related knowledge and skills from supplier to yourself? How?
3. Did you have any project closure session?
   a. When? Where?
   b. What was the agenda?
   c. Who attended?
4. Did you do any "lessons learned" analysis of the project?

General evaluation of the project

5. How would you evaluate this networked project using a scale from 1 to 10)?
      i. What dropped the grade from 10 (if grade < 10)?
      ii. What was successful in this project?
6. Problems: What were the main problems during the project?
   a. What were the causes of these problems?
   b. How problematic did you see
      i. Geographical distances?
      ii. Crossing company borders?

iii. Cultural differences?

7. Do you have any suggestions for what could have been done differently to improve the project?
8. Please name the three most important issues that should be agreed on during the project start-up.
    a. Explain why.

Background information of the interviewee

- What is your education?
- How long have you been working in this company?
- How long have you been doing the current tasks?
- How long experience of software development projects do you have?
- How much experience of distributed projects do you have?
- Were you involved in other projects at the same time when working in this project?
- How much time did you spend on this project? Give percentage.

Study 2 – Questionnaire used in the semi-structures interviews of the two last case projects (Êta and Thêta)

(Questionnaire was shortened and modified during Study 2 according to the results received, as suggested by Miles and Huberman (1994).)

1. Interviewee
   - Role and tasks in the project
   - When did you start in current role / this project

2. Collaboration Background
   - Length and type of collaboration
   - Reasons for collaboration
   - Initiation of collaboration relationship
   - Vision of future collaboration

3. Project Background
   - Purpose of collaboration
   - Parties, roles, teams (number of persons), project managers
   - Why were these parties chosen?
   - Project type – uncertainty of environment / requirements
   - Contract type
   - Project plan (was it done / what included)
   - Schedule – planned/realised

4. Beginning of the project
   - How did it start?
   - Work division
   - Requirement specification (who participated)
   - Kick-off / meetings /training

5. Process model
   - Iterations
   - Delivery cycle, delivery chain
   - Feedback to deliveries - quality
   - Why was this process model chosen – training/understanding
   - Synchronization
   - Integration, frequency of builds,
   - Testing (who/when)
   - Problems/benefits

6. Data management
   - Versions, configurations management
   - Common repository between sites?
   - Change management

7. Monitoring
   - How is project progress followed / by whom
   - Transparency of the project/progress to team members - informing

8. Communication
   - Communicating roles / link persons /peer-to-peer links
   - Meetings
   - Informal communication
   - Media: email / phone /face-to-face (when / why /with whom)
   - Chat / messenger usage
   - Problem solving: how / responsible

- Major communication problems
- Improvement ideas

9. Trust
   - Getting help / how do you get answers
   - Making suggestions and getting response
   - Do you know enough people from other sites / well enough
   - Misunderstandings (why / when)
   - Style of communication
   - Openness – how easily are problems communicated / contacts initiated
   - Do you get enough information (for your work / about the whole project)

10. Distance
   - Cultural differences /time difference
   - Geographical distance
   - Power distance / hierarchical – egalitarian

11. End of project
   - Lessons learned

12. Problems / successes
   - What were the main problems in the collaboration
   - Improvement ideas
   - Successful practices
   - Challenges / benefits of distributed work compared to traditional collocated work

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