Abstract

This thesis investigates and discusses how workers in nomadic work environments communicate using genres of communication. Work praxis in several nomadic work environments is investigated with a focus on the use of Information and Communicational Technology (ICT). The use of these ICTs is analyzed using communication genre theory, and media richness theory to analyze the form of the genres, i.e. the media. In addition, Multimedia Messaging Services (MMS) is analyzed using the same concepts with the aim of investigating the possibilities of genres of multimedia messaging in the nomadic work environments that have been studied.

Five case studies, which investigate four blue-collar work environments and the work environment of soda salesmen, have been conducted. The investigation of the case studies follows the Computer Supported Cooperative Work (CSCW) 'tradition', focusing on the use of ICT services in collaborative activities. The work environments are all examples of typical service professions where the work tasks require that the workers travel to the customers' location. The results show that the workers use several different media (e.g ICTs) and that the media are better suited in some communication situations than in others. The mobility properties of the media that are used and in which way they support the mobility requirements of the workers influence the way they are used by the workers, the micro mobility properties are especially important while the local mobility properties are not utilized as intended by the administration. Another important result is that the introduction of a new media into a work environment has little impact on the use of the existing media. In general it can be stated that the media that are used are well-suited for the communication situations that they are used in.

The investigation shows that MMS messages have medium media richness. They have many of the same characteristics as SMS messages, but the ability to send pictures makes them appropriate to use for communication where SMS does not offer sufficient richness. MMS messages are best suited for communicating problems regarding task work and for documenting tasks that have been completed.

These findings suggest that the administration in nomadic work environments should reconsider the use of communication media to handle the flow of information to make sure that the media are well-suited for the communication situations they are used in. The aim of this thesis is also to increase the current understanding of the use of communication media and the importance of mobility of both people and technology in work environments.

Foreword

This thesis is written as part of my Candidatus Scientiarum degree in the study of information systems, at the Department of Informatics, University of Oslo. The work related to writing this thesis started in the fall of 2002 and has lasted for three and a half semester. The thesis is considered as two thirds of the Cand. Scient. curriculum. Several people have helped me by discussing the aim and content of this thesis and by giving me good advices, they deserve to be mentioned here.

First of all I would like to thank my guidance counselors Petter Nielsen and Kristin Braa for their thoughts and advices throughout the process of writing this thesis.

This thesis is based on data material collected from five case studies. Three other Cand. Scient. students, Hans Kristian Stavem, Kamran F. Mohammed and Line Starheim Johansen, and I have worked as a group in the planning of activities, and collection and treatment of the data material. I therefore want to thank them all for their participation in the case studies and for their insights and comments later on when we have been writing our separate thesis'. I also wish to thank all the people who have let us interview and observe them in their work environments.

In addition, I wish to thank Espen Hammond Moe for his help along the way, my mother who has helped me with word checks and Siv who has supported me throughout this process.

Oslo, April 30. 2004

Are Solberg

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Chapter 1

Introduction

1.1   Area of research

Studies from a diversity of research fields have taken interest in understanding how people carry out their daily work and how they interact with their social and technical surroundings in so doing. One of these fields is the Computer Supported Cooperative Work (CSCW) field (Bardram 1998 and Grudin 1994). Studies from the CSCW field focus on collaboration within work environments; "the implicit assumption in many of the ethnographic studies made within the realm of CSCW is to study the dynamics, and especially the breakdowns, in cooperative work as a way to understand the 'normal' flow of work" (Bardram 1998, p. 89).

For this thesis, five case studies, which in total investigate five work environments, have been conducted, following the CSCW 'tradition' and focusing on the use of ICT services in collaborative activities. In the investigation of work praxis the focus is on the use of communication genres to handle the information flow in the organizations. Genres are "socially recognized types of communicative actions – such as memos, meetings, expense forms and training seminars- that are habitually enacted by members of a community to realize particular social purposes" (Yates et al. 1999, p. 84). Genres are identified by two factors; their purpose and their form. The purpose of a genre is not one individual's intent of communicative actions, but a purpose that has been decided and is recognized by the organizational community within which it is used. The form of genres refers to the observable aspects of the communication; the medium which is used and its communicational properties. In this thesis, Daft and Lengel's (1986) concepts of media richness are used to classify the richness of the different communication media that are used in the work environments. Information richness can be defined as the learning capacity of a communication situation (ibid., p. 556). The richness of a medium determines which purposes it is suited for. Using the concepts of media richness and genre theory, the appropriateness of the use of specific media in various communication situations in the work environments can be discussed (Graveline et al. 2002).

The work environments that are studied are all examples of common service professions; professions where the work tasks require that the workers travel to a customer's location. We live in a "service society" and in such a society the use of ICT will increase and result in a more efficient service provision Dahlbom (2003). The work praxis of four blue-collar companies (a plumbing company, two electrical companies and a construction company) and the work praxis of soda salesmen have been studied. In the work environments, the mobility of the workers and the technology they use is important to the work praxis. "The ways in which mobility features in collaborative work has largely been overlooked within CSCW" (Luff and Heath 1998, p. 305). Some researchers, however, like Luff and Heath have done extensive research focusing on the mobility of both technology and workers.

Their results show that it is important to carefully consider mobility of both people and technology when studying work praxis in order to better understand them. Luff and Heath's concepts of different types of physical mobility are used in combination with Kristoffersen and Ljungberg's (2000) concept of mobile work to discuss the movement of people and the mobility properties of the communication media that are used in the work environments. The way in which the mobility properties influence the appropriateness of the use of specific media for the communicational purposes they are used for is also discussed.

In Norway, a project led by Telenor Research and Development called NOMADE 2007 (Julsrud et al. 2002) has studied the nature of nomadic work environments and the use of and need for ICTs in these environments. Their results show an extensive use of mobile technology like mobile phones. The work environments investigated in this thesis fit the description nomadic work environments, since the workers' work praxis requires that they travel between locations. This thesis is meant to continue the research initiated by the NOMADE 2007 project. This thesis investigates some of the same issues; however, the aim is to produce a more detailed description of the use of ICT (i.e. media) in nomadic work environments than what was presented by the NOMADE 2007 project.

1.2   The research problem

The blue-collars' and the soda salesmen's work environments are nomadic work environments where the workers need access to various ICT services while they are on the move. The results found by the NOMADE 2007 project (ibid., p. 54) indicate that multimedia messages (MMS), and especially the possibility to send pictures between mobile phones and between mobile phones and PCs, might be useful for communication among blue-collars. MMS is a relatively new service which expands the functionality of SMS. As with SMS, textual messages can be sent between a sender and a recipient. MMS, however, makes it possible to send much longer messages. In addition pictures, video clips, animation and sound clips can be included in MMS messages.

Since MMS is a relatively new service, the amount of research regarding the use of MMS is very limited. Koskinen et al. (2002) have studied the use of what they call "mobile visual messages" which similarly to MMS involves pictures being sent between mobile phones. They say that "[m]uch like the transition from radio to TV, the evolution from text messaging to multi-media messaging marks a whole new era of mobile communications, combining images with sound and text" (ibid., p. 105). Ling et al. and Julsrud et al. (2004) have investigated the use of genres of SMS and MMS communication in the work environments of blue-collars and salesmen in the MEMO (acronym for messaging services in mobile environments, translated from Norwegian) project which follows the work begun in the NOMADE 2007 project. Their findings indicate that MMS offers functionality which might be a fruitful addition to the communication media which are currently used.

This thesis has two main focuses; to investigate how communication media are used in nomadic work environments and to investigate how multimedia messaging can be used to

communicate in these work environments. Thus, two main problem statements form the basis of this thesis:

1   *How are communication genres used to handle the flow of information in nomadic work environments?*
2   *How can genres of multimedia messaging be used to handle the flow of information in nomadic work environments?*

To investigate the first research problem the work praxis of service workers, blue-collars and salesmen, working in several nomadic work environments is investigated in detail through five case studies. The investigation focuses on how service workers use communication genres in their work praxis. The context which the workers work in, i.e. the work environment which consists of the organization and its administration, the customers etc., is investigated and discussed in order to better understand how the workers use communication genres and why they use them the way they do. Since mobility of the workers and the technology they use is an important part of these environments, these aspects are discussed in detail and related to the use of communication genres.

The second research problem requires that the properties of MMS as a communication medium are investigated. Concepts from media richness theory (Daft and Lengel 1986) and communication genres theory (Graveline et al. 2000, Yates et a. 1999 and Ling et al.) are used to discuss which communication situations multimedia messaging is suited for. In addition, workers in nomadic work environments have been interviewed regarding the possible introduction of MMS communication in their work praxis.

Based on the discussion of these two problem statements, the aim of this thesis is to uncover the potential of genres of multimedia messaging in the work environments that have been studied.

1.3   Target group

The aim of this thesis is to increase the current understanding of the use of communication media and the importance of mobility of both people and technology in work environments. The work environments which are studied in the case studies are work environments that have been offered limited research focus so far. Researchers who are interested in the use of technology and mobility issues might benefit from this insight into blue-collar work environments. Mobile manufacturers, service providers and network operators are searching for new use areas for multimedia messaging. This thesis shed light to the possibilities of multimedia messaging in work environments and perhaps it will make the mobile phone industry expand their focus of MMS as an entertainment service to include the possibilities it offers for work-related communication as well. The administration in nomadic work environments should, based on the findings in this thesis, reconsider the use of communication media to handle the flow of information to make sure that the media are well-suited for the communication situations they are used in.

1.4   Research method in brief

Five work environments have been studied to get a detailed impression of the normal flow of work activities, i.e. the work praxis. This thesis is based on an interpretivist world view. The data material is influenced both by the social surroundings that it was collected from and by the way it has been collected, analyzed and presented in this thesis. A qualitative study has been performed to gather as rich research data as possible. The work environments have been investigated as five case studies, where all of which represent typical service professions. The data material has been collected using semi-structured interviews and observation of work praxis. In addition, existing research has been consulted. Technology testing of MMS messaging has also been performed to better understand this service.

1.5   Structure of the thesis

This thesis is structured so that the Universe of Discourse (UoD) and methods used to investigate it are presented first, then the theoretical framework and related literature is presented, then the work praxis of the in the work environments is presented, and finally, the theoretical framework is used to discuss the work praxis in relation to the research problem.

Chapter 2 presents the UoD for this thesis. Each of the five work environments is presented briefly, to give an impression of the size of the organizations and the main work tasks in the work praxis.

The research approach is presented in chapter 3. The world view represented in this thesis and the methodology used to collect and analyze the data material is presented. A detailed description is given of how the work environments and the workers within these were chosen as research objects, and how the actual data collection was carried out. The chapter also includes a discussion about the generalizability of the research findings.

In chapter 4, theoretical concepts and previous research findings are used to construct a theoretical framework for this thesis. First, the handling of the flow of information in work environments is discussed, using existing theory of genres and media richness. Then an introduction to CSCW and the study of collaboration in work environments is presented.   Concepts of mobility of people and technology are related to these concepts. Then the use of ICTs in general and MMS in particular is discussed. Finally, the concepts are presented as a theoretical framework.

Chapter 5 gives an introduction to some of the aspects of MMS. Both hardware, i.e. mobile phones with cameras, and software issues, i.e. programs for creating, sending and receiving MMS messages, are discussed.

In chapter 6, some of the collected data material from the case studies is presented. The work praxis in each of the work environments is described. The focus is on the use of ICTs and the mobility of both people and technology.

The work praxis presented in chapter 6 is discussed in relation to the theoretical framework and the research problem in chapter 7. First, mobility of both people and technology in the work environments is discussed. Then the use of communication genres in the work environments and their appropriateness in the communication situations they are used in is discussed. After that, the media richness of multimedia messages and which purposes they are suited for is discussed. Finally, the results of these three discussions are discussed in relation to each other.

Chapter 8 offers some conclusions based on the discussion of the research problem. In addition, the implications of the findings and recommendations for future research are presented.

Chapter 2

The universe of discourse

The research problem for this thesis is to investigate how communication genres are used to handle the flow of information in nomadic work environments and to investigate how genres of multimedia messaging can be used in these environments. The original idea was to study the use of communication media in work praxis in general. However, nomadic work environments were chosen, due to the high level of mobility of people and artifacts and frequent use of mobile ICT services (Julsrud et al. 2002). Since the main new possibility that MMS offers is to communicate pictures between mobile phones, it seemed interesting to investigate its potential in nomadic work environments where mobile phones are used frequently.

Nomadic work praxis is a phenomenon that occurs in several different professions and segments within the working life (ibid.). The NOMADE 2007 project studied three different types of work environments, based on the assumption that increased mobility within the working life often is based on different motives and has different explanations in different work environments (ibid.). In this thesis, two of these types of work environments are investigated and discussed; handymen, called blue-collars in this thesis, and salesmen. Both of these types are examples of service professions where the workers need to travel to the customer's location to perform some tasks. The primary focus, and hence majority of collected data, is the blue-collars' work environment. A short presentation of the blue-collars' work environment is given in section 2.1. The companies investigated in three of the companies uses an application called Blueapp in their work praxis, Blueapp is described in section 2.2. The five companies which were investigated are presented in section 2.3.

2.1   The blue-collars

Blue-collars is an expression used to gather a wide range of professions under one label. The professions are all what one would call typical 'handyman professions'. Blue-collars' work praxis is centered on producing or fixing various objects and constructions. Most of the work tasks are practical in nature, i.e. they are performed by using the hands. The skills needed to perform the tasks are mostly learned through experience. Most blue-collars have completed theoretical and practical education at college-level. In Norway, 11 % of the active work force are blue-collars and the majority of these work in private enterprises (230 000 out of the total of 250 000 blue-collars work in private enterprises). A vast majority of the workers are men; 92 % (230 000) men and 8% (20 000) women[1]. Because of this fact and the fact that all the blue-collars that participated in the case studies were men, the workers in this thesis are referred to as males.

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1 Statistisk Sentralbyrå: http://www.ssb.no (in Norwegian)

Compared to other occupations, e.g. white-collar occupations, the amount of information which needs to be handled is relatively small for each assignment. The main reason for this is that the assignments in the work environments that were studied mostly involve practical tasks. E.g. a plumber travels to a customer's location and fixes his leaking faucet. The work of e.g. stock brokers, on the other hand, require that large amounts of information is handled in order to create new knowledge, e.g. that a stock broker gathers a lot of information about the market, analyze this and buys new stocks based on this new knowledge. However, the blue-collars need to handle information to coordinate assignments, to solve different work tasks etc. In the case studies this is investigated in detail.

2.2   Blueapp

Blueapp Corp. is a small software company based in Oslo, Norway. It was founded in 1985 and has developed applications for handheld PCs since 1996. Currently, the company has 15 employees. Blueapp Corp. has developed an application called Blueapp (acronym for blue-collar application) aimed at the blue-collars' work environment.

Blueapp is designed to meet the needs of organizations where the work environment requires a high degree of mobility and where there is a need to keep track of hours spent on a job, parts (e.g. pipes, screws, bolts etc.) used, task information etc. Blueapp organizes all data connected to work assignments and provides the necessary documentation when the assignment is finished. The application contains an application that runs on pocket PCs or PDAs (Personal Digital Assistant), an administrator program and a central database. In typical organizations that use Blueapp, the blue-collars are equipped with pocket PCs or PDAs, while the administrator program and the database run on a computer at the organization's office. Blueapp is usually not a stand-alone application; it is connected to the organization's economy system, the inventory database, the bank (to BBS - Bankenes BetalingsSentral in Norway) etc.

Blueapp Corp. aims at being the largest distributor of this kind of applications in Scandinavia. Currently more than 200 organizations with a joint total of more than 1000 employees use Blueapp in their daily work. The use of Blueapp in blue-collars' work environments is studied in three of the case studies. The focus is, however, not on Blueapp but on the work praxis in general and on the use of mobile ICT solutions in general. The three case studies are the Plumbcomp, Elcomp A and Elcomp B case.

2.3   The case studies

The Universe of Discourse (UoD) for this thesis consists of five separate case studies; Plumbcomp, Elcomp A, Elcomp B, Constructcomp and the Brewcomp case. The Plumbcomp, Elcomp A, Elcomp B and Constructcomp case are all studies of the blue-collars' work environment. In the first three case studies the use of an application called Blueapp in the work praxis of blue-collars is studied. The Constructcomp case is a more general study of work praxis at a construction site. In the Brewcomp case the work praxis

of soda salesmen is studied. The names of companies, persons and some of the computer systems mentioned in this thesis are pseudonyms.

The case studies investigate a selection of different nomadic work environments. The blue-collar cases and companies within these have been chosen due to them being examples of typical blue-collar work environments; a plumbing company, two electric companies and a construction company. The brewery case was chosen since it is a typical salesmen work environment. These cases should therefore offer a representative picture of work praxis among blue-collars and salesmen. The collected data is, however, limited in both scope of professions and amount of interviews etc., due to the time constraints of this thesis. White-collars' work environments, like that of consultants, are some of the nomadic work environments that have been offered most attention, e.g. the NOMADE 2007 project investigated their use of mobile ICT services (ibid.). The reason for omitting white-collars from this thesis is mostly due to the time constraints of this thesis, but also due to the wish of investigating work praxis that differs from that in regular office environments in more detail.

2.3.1 Plumbcomp

Plumbcomp is a medium-sized plumbing company located in a medium sized Norwegian city. It was founded in 1961 as a small family-owned company by a plumber and his wife. Today, the company is owned by 4 equal partners; the founders and their son and daughter. The son, also a plumber by trade, is the head of the plumbing department. The plumbing department is the main department in the company, offering plumbing services like maintenance and installation. Most assignments are small assignments at private homes requiring a small amount of work from one plumber, but the company also has some large contracts like installing the plumbing for factories etc. that require several plumbers over a longer time period. The daughter is the head of the store where bathroom appliances like toilets, shower cabinets etc. are sold. The wife (co-founder) is responsible for calculating salaries and generating invoices. Her husband is retired, but still does some administrative work for the company. The company has a total of 17 employees, 10 of which are plumbers working on assignments. The other employees work as clerks / salesmen in the store or in the administration.

In the case study, the main focus in on the plumbing department and on their work praxis. The department has 50-70 assignments each week, which require one or several plumbers to travel to a location and fix or install the plumbing. The assignments are mostly for customers in and around the city where the company is located, but the company also has customers further away, i.e. other cities in the county and in the surrounding counties.

2.3.2 Elcomp A

Elcomp A is a medium-sized electric company with its base in a medium sized Norwegian city. It was founded in 1918 and has been a considerable factor in the evolution of the city and its industry for nearly one hundred years. The company consists of several departments; however, the focus of the case study is on the service department.

The service department's business is centered on mobile service units; service electricians who travel by car to customers. The service units are equipped and qualified to handle assignments relating to heating systems, lighting systems, engine installations, alarm systems, telephone- and computer installations etc. The electricians also perform internal controls (Norwegian: "internkontroll") and write situation reports (Norwegian: "tilstandsraporter") for electrical systems. The department currently employs 65 service electricians. The department also has a regional office at another location in the county. The service department currently has 65 regular customers. Most customers are companies, e.g. schools and industrial companies, within and near the city where the company's base is. The department also has customers in other parts of the county, and in the surrounding counties. The department also has some assignments in private homes. The assignments vary in length and need of manpower; some take just a few hours and one electrician to complete while others requires as many as 15 electricians for several months to complete. The number of active assignments varies from week to week.

2.3.3 Elcomp B

Elcomp B is a medium-sized electric company in Oslo, Norway. The company was founded in 1950. The company employs 15 electricians working on assignments for customers. The assignments consist of installation and maintenance of electrical systems. Most of the customers are various kinds of companies and institutions. The assignments vary in length from a couple of hours to a year, and require from one to several electricians to be completed. The number of active assignments varies from week to week.

2.3.4 Constructcomp

Constructcomp is a medium-sized entrepreneur company with its main office in a small Norwegian town, and which operates in all parts of the surrounding county. The company was founded in 1949 by two brothers and was a family owned until it joined a chain of similar companies in 2000. The company's business is centered on large construction projects which require many different kinds of workers, e.g. carpenters, masons etc., to be completed. Currently the company employs approximately 130 employees. The company usually has several active assignments at any given time. The workers work on each assignment for a period of time only, since e.g. masons are not needed throughout the whole construction project, before starting to work on another assignment. In this case, the focus is on the work praxis in general at a construction site.

2.3.5 Brewcomp

Brewcomp is one of the largest brewery corporations in Norway with breweries at several different locations. The company was founded in 1876 as a single brewery and has grown into a chain of breweries since then. The company's sales department is divided into several regions; the focus in this case study is the sales department for the Oslo region. More precisely the focus of this case is on the salesmen responsible for ordering beverages (e.g. soda and beer) and displaying these on shelves and in refrigerators in

grocery stores in Oslo. The sales manager for the Oslo region is in charge of sales in 580 grocery stores. The sales manager of the Oslo region has four district managers working below him. Each of these district managers has eight salesmen working for him / her (one of them has nine). The salesmen have a number of regular grocery stores which they visit several times a week. In this case study, the focus is on the work praxis of the salesmen.

Chapter 3

Research approach

In chapter 2, the Universe of Discourse (UoD) was presented. In this chapter, the research approach used to investigate the UoD is described. Firstly, in section 3.1, two different world views are presented, and reasons are given for choosing the one that is represented in this thesis. In section 3.2, some methods that can be used gather research data are presented, with a focus on the ones used for data collection in this thesis. Section 3.3 contains description of how the data material was collected in the case studies. The technology test which was carried out for this thesis is described in section 3.4. In section 3.5, the literature study is described. The analysis of the data material is described in section 3.6. Finally, in section 3.7 the generalizability of the research findings is discussed.

3.1   World views

Research, and thereby researchers, can be categorized to represent either a positivist or interpretivist (anti-positivist) world view.

> "Positivists believe that all true knowledge we may obtain is based on the observation or experience of real phenomena in an objective and real world. Accepting this, positivist research aims to give rise to objective facts that cannot be disputed. More particularly, the facts produced are seen to have no social values encoded in them and are timeless. [...] An anti-positivist [(interpretivist)] position is one that cannot accept the clear distinction between facts and values and rather sees them as intertwined. […] [A]ll knowledge, including scientific knowledge, is socially constructed and is therefore conditioned by the values of the society that gives rise to them."
>
> (Cornford and Smithson 1996, pp. 37-38)

It is beyond the scope of this thesis to include a thorough discussion about the two world views; however, the research approach used for this thesis will be discussed in relation to these world views. Interpretivism is increasingly expressed in the field of information system research. This thesis is based on the same basic believes as that of interpretivism. The UoD for this thesis consist of nomadic work environments, i.e. work environments where people interact with other people using ICT solutions in a mobile environment. The research findings found while investigating the UoD are not considered as objective facts, but rather as data material that might expand the understanding of the UoD. The data material is strongly influenced by the social surroundings from which they were collected. The data material has also been influenced by the way in which it was collected and in the way it has been analyzed and presented in this thesis. The collection and analysis of the research findings is presented in the following sections.

3.2   Investigating the world

When researchers set out to investigate the world, the way in which they do so is affected by their world views. There are two general types of research approaches; quantitative and qualitative. Quantitative research usually involves a large UoD, i.e. many companies and / or persons are investigated. "Quantitative research relies on developing metrics (numbers) that can be used to describe phenomena (objects and relationships under study)" (Cornford and Smithson 1996, p. 40). Positivists tend to use quantitative methods and they aim at finding universal 'truths' that can be said to be statistically correct with a given confidence level, e.g. 95 %. (Usually this is denoted as a level of statistical significance at 0.05). Qualitative methods on the other hand, usually involves a small UoD where e.g. each person or company is thoroughly investigated.

> "Qualitative methods […] eschew metrication and seek other means of capturing and analyzing (understanding) data. [Qualitative methods] generally implies that the researcher must spend substantial time 'in the field' collecting unstructured and 'real time' observations, and then work to make some sense of them."
>
> (Cornford and Smithson 1996, p. 41)

Interpretivists tend to use qualitative methods in their research. In general, positivists can be said to prefer quantitative methods while interpretivists can be said to prefer qualitative methods. However, interpretivists also use quantitative methods, and positivists use qualitative methods. As mentioned above, this thesis is based on an interpretivist world view. Qualitative methods have been used in the collection and analysis of the data material. The UoD for this thesis has been investigated as five case studies.

> "A case study is an in-depth exploration of one situation. […] The great strength of the case study is in the richness of data that can be obtained by multiple means when researchers restrict themselves to a single situation. This leads some people to recommend the case study approach for topics and areas of study which are novel or which have little theory as yet. […] Limitations of the case study approach include the lack of control of individual variables and the difficulty of locating causality."
>
> (Cornford and Smithson 1996, p. 49)

The ability to get an in-depth understanding of the UoD was the primary reason for using case studies in this thesis. Nomadic work environments and specifically the potential of MMS communication in work environments has not been a big research issue, according to Cornford and Smithson (ibid.) case studies is well-suited for investigating new topics. The cases that were selected and reasons for choosing these specific cases are presented in the following section.

When investigating case studies different methods can be used. Silverman's (2001) overview of methods and their use is presented in table 3.1. The four methods presented are usually combined to obtain more and richer information from the UoD. The methods

can be used in both quantitative and qualitative research studies, and they have different meaning in each of these research categories (ibid., p. 11). Observation and audio and video recording is similar in intent. These methods are used to see how the subject(s) under study behave in their social surroundings and how their actions affect and are affected by these surroundings. Textual analysis is used in several different ways in research, e.g. to get and overview of prior literature about the case or type of case, or to examine textual documents that are used in the cases. Interviews are common in case studies and they can be used to gather rich data material from the cases. The richness of the data obtained from interviews depends upon the degree of structure in the interview. Structured interviews are based upon questions that are though up in advance and that are followed strictly. Questionnaires / surveys are structured interviews. Un-structured interviews are interviews where the interviewer asks questions based on previous questions in order to investigate matters more deeply. Such interviews can gather richer data. On the other hand, such interviews requires more effort per interviewee, which in turn results in that usually only a relatively (in relation to e.g. questionnaires) small number of interviews are conducted. Semi-structured interviews are based on some general questions, but the interviewer can ask follow-up questions to 'dig deeper' and get a better understanding.

Method/Methodology	Quantitative research	Qualitative research
Observation	Preliminary work, e.g. prior to framing questionnaire	Fundamental to understanding another culture
Textual analysis	Content analysis, i.e. counting in terms of researchers' categories	Understanding participants' categories
Interviews	Survey research: mainly fixed-choice questions to random samples	Open-ended questions to small samples.
Audio and video recording	Used infrequently to check the accuracy of interview records	Used to understand how participants organize their talk and body movements.

Table 3.1: Different uses for four methods (Silverman 2001, p. 12).

3.3 The case studies

In chapter 2, the five case studies conducted in this thesis were described. The methods used to collect data from these environments are described in this section. With an exception of video recordings, all of the methods in table 3.1 were used to gather the data material for this thesis.

Early on in the work of this thesis, a research group was formed. This group consisted of four cand. scient. students (including the author of this thesis). The group's intent was to be a forum where all the phases of the thesis-work could be discussed. All of the cand. scient. students have the same guidance counselor, and he has also counseled the group as a whole throughout the existence of the group. The group shared a research interest in the use of ICT services in work environments. Due to similarities in research interests, it was

decided that the whole group should study the same UoD and participate in the same case studies. The choosing of the case studies, collection of data material and analysis of these data, has been a joint group activity. The UoD was investigated as five case studies. The choosing of these cases was done based on a discussion about possible cases. For a majority of the data collection all group members were present, for the rest two group members collected data together. The data was collected through interviews and observation sessions with employees in the companies selected for the cases. Prior to interviews and observations as much relevant information about the companies as possible was gathered, e.g. through phone inquiries with representatives from the companies and searching the companies' Internet pages. Based on the problem statements for the thesis' of the research group's members and the information gathered about the companies, interview guides (i.e. a list of questions to be asked) were made. These guides were similar for the different companies; however, they were changed at times due to differences in the work praxis of the companies that were to be investigated and due to experience obtained from previous usage of the guides. As mentioned, at least two of the group's members were present at the interviews / observation sessions. One person was assigned the role of interviewer and one person took notes of what was said. At some of the interviews sound recording equipment, a minidisc player with a microphone, was used. The interviewer used the interview guide when asking questions. However, this guide only included general questions. The interviewer and the other group members present asked follow-up questions based on the answers given by the interviewee. The interviews can therefore be said to be semi-structured. This made it possible to investigate subjects fully and to get a better understanding of the work praxis in the companies. After the interview, the person that had taken notes was in charge of writing a summary of the interview. The interviews that had been recorded on minidisc, were transcribed to paper by one or two group members. The summaries and transcriptions were then discussed at group meetings, for some of which the guidance counselor were present. In some cases this discussion resulted in follow-up interviews and new interviews with other employees.

While searching the Internet for information about the use of mobile services in work environments, one of the group's members came across the MOWAHS[2] project. A research report by two of the members of the MOWAHS project presents Blueapp[3]. After a brief discussion it was decided that a case study concerning the use of Blueapp in blue-collars' work environments should be conducted.

In order to gain a better understanding of Blueapp, Blueapp Corp.'s homepages were studied. Based on this information a presentation of Blueapp was written and discussed in the group. Simultaneously, one of the group's members (the author of this thesis) had a meeting with two of the managers, the founders, of Plumbcomp, who he is related to, because he knew that Plumbcomp uses Blueapp in their work praxis. A report was written based on the information obtained through this meeting, which was discussed in

2 MObile Work Across Heterogeneous Systems is a research project at NTNU, Norges Teknisk Naturvitenskapelige Universitet, in Trondheim. MOWAHS homepage: http://www.mowahs.com/
3 The report is not referenced here, because it included the real name of Blueapp. Blueapp is a pseudonym used in this thesis.

the group. It was then decided that Blueapp Corp. should be contacted in order to get a more thorough understanding of Blueapp. An interview was conducted with the CEO of Blueapp, where all group members were present. The CEO then offered to provide contact with companies which currently use Blueapp in their work praxis. The CEO provided a list of some companies that could be used, along with a brief description about their use of Blueapp. It was then decided in a group meeting which companies that should be contacted. Since most of the companies that use Blueapp are electrical companies, it was decided that some electrical companies should be investigated. One medium sized electrical company that had used Blueapp for some time, Elcomp A, and a medium sized (although considerably smaller than Elcomp A) electrical company that was about to start using Blueapp, Elcomp B, were contacted. In addition, it was decided to investigate Plumbcomp further.

In addition, two other case studies were agreed upon. Constructcomp was chosen as a case study in order to get another perspective of blue-collars' work praxis, i.e. work praxis which involved assignments which required more workers than those of the companies in the Blueapp case. Brewcomp was chosen as a case mostly because it seemed interesting to investigate the work praxis of soda salesmen. A similar case study had been performed in the NOMADE 2007 project (Julsrud et al.2002).

In total, 16 interviews and 3 observations were conducted for this thesis. The majority of the collected data was collected in Plumbcomp, Elcomp A and Elcomp B who all use Blueapp in their work praxis. Qualitative research methods were used to gather as rich information as possible from each of the work environments. The following subsections describe how the data material was collected in each of these companies.

3.3.1 Plumbcomp

Plumbcomp was visited twice, each time several interviews were conducted. During the first visit, the head of the plumbing department, P-chief, was interviewed about the work praxis in the company in the past and now, and about the introduction and use of Blueapp. During this visit an administrative employee, P-admin, who is partly responsible for calculating salaries and invoicing customers, was interviewed as well. One moth later, Plumbcomp was visited again. The primary goal of this visit was to observe actual work praxis. A plumber, P-observe, was observed as he received an assignment and carried it out. During and after the observation, P-observe was interviewed as well. It was P-chief who decided which of the plumbers that should be observed. This might have influenced the observed view of the work praxis, i.e. P-chief might have chosen a plumber which showed 'correct conduct'. However, it is unlikely that this had any significance in this case, P-observe was chosen randomly based on who was available. During this visit, P-chief was interviewed again, with questions based on the last interview and what was observed when P-observe carried out his assignment. At this interview the three other owners of the company, P-owners, who also work in the administration, and P-admin were present. They all participated in a discussion based on the questions that were asked. Also, during the lunch-break, P-observe and four other

plumbers, P-plumbers, were asked a series of questions which they discussed and answered.

3.3.2 Elcomp A

Elcomp A was visited once, three interviews were conducted. First, the chief of the service department at Elcomp A, E-A-chief, was interviewed. He was interviewed about work praxis in the company in the past and now, and about the introduction and use of Blueapp. E-A-chief then chose two electricians who could be interviewed regarding their work praxis. These were chosen randomly based on availability and a wish from the interviewers of interviewing one worker with long experience in the company, E-A-electrician1, and one worker who had started working in the company after the introduction of Blueapp, E-A-electrician2. E-A- electrician1 and E-A- electrician2 were interviewed separately, however, the same interview guide was used.

3.3.3 Elcomp B

Elcomp B was visited twice, first prior to the introduction of Blueapp and then 2 months after the introduction. During the first visit the chief of Elcomp B, E-B-chief was interviewed. He was interviewed about current work praxis and the reasons for wanting to introduce Blueapp. During the second visit two electricians, E-B-electrician1 and E-B-electrician2 were interviewed about their work praxis. They were interviewed together. It was E-B-chief who decided which electricians should be interviewed. During this visit a follow-up interview of E-B-chief was also conducted. He was asked questions regarding the introduction of Blueapp and the experiences so far.

3.3.4 Constructcomp

One representative from Constructcomp was interviewed. The interviewee is a construction site chief, C-chief, and he is in charge of the construction which occurs at his site. C-chief was interviewed regarding work praxis at construction sites.

3.3.5 Brewcomp

Several interviews were conducted with Brewcomp employees, on different occasions. The first interview was with the sales manager of the Oslo region, B-chief, and his (subordinate to the B-chief) sales planner, B-planner. They were interviewed about the work praxis of themselves and the soda salesmen that worked for them. After this interview B-chief selected two salesmen which could be observed and interviewed while they worked. The research team was divided into two pairs which observed one of the salesmen each. The salesmen, B-salesman1 and B-salesman2, were observed while they visited grocery stores which they were responsible for. They were interviewed while they worked.

3.4 Technology test

The initial aim of this thesis was to study actual usage of multimedia messaging in nomadic work environments. However, due to time and resource constraints, this was not possible. In order to better understand the technology investigated in this thesis, some of the devices and services were tested first hand by the author. Primarily this involved the use of MMS-enabled mobile phones and the service itself. Pictures were taken both with phones with external ('click-on') and integrated cameras. MMS were both sent to mobile phones, using mobile phone numbers, and e-mail addresses. Regular e-mails with pictures attached were also sent to compare the experience.

During the time it has taken to write this thesis, the author has bought and tested two different MMS-enabled mobile phones in actual use. This has made it possible to better understand the technology. Some of the aspects of mobile phones and MMS messages that were found are described in chapter 5. One of the phones was also used to take pictures during one of the observations, the observation of P-observe at Plumbcomp. This was done to investigate the picture quality. Some of these pictures are included as figures in this thesis, figure 6.1-6.8 in section 6.1.1 and figure 7.7-7.8 in section 7.1.1.2.

3.5 Literature study

A large amount of literature has been studied during the thesis work. Some of the literature is presented and discussed in chapter 4. Other articles and books than those referenced in this thesis have also been studied, but they were omitted due to lack of relevance. Since the focus of this thesis, MMS, is a new service which receives much media coverage, several newspapers have been checked daily for articles about the evolvement and use of MMS. A list of the newspapers articles that are referenced in this thesis is located in appendix A.

3.6 Analyzing the collected data

The collected data material for this thesis consists primarily of literature, transcriptions of interviews, field notes and various written information about the companies that were investigated. The data material has been discussed with several people in different fora. The primary forum is the research team and the guidance counselor. However, most of the analysis has been done independently with supervision from the guidance counselor. In chapter 6, the collected data from the case studies is presented. In chapter 7, it is discussed in relation to research problem presented in section 1.2 and the theoretical framework presented in chapter 4.

3.7 Generalizing

Generalizability is an important and much debated concept in research. Generalizability refers to the possibility of using the results from research findings to explain other situations or phenomena than those that have been studied. In positivistic research generalizability is a key feature (Lee and Baskerville 2003, p. 229). Quantitative methods

are used to examine large samples of data which can be said to be representative for a larger population. Statistical methods are often used within quantitative research to legitimate the generalizability of the research findings. Generalizing from qualitative research, however, is more troublesome, because qualitative research usually involves investigating a few cases thoroughly.

> "A typical and legitimate endeavor in interpretive research is the study of a single setting. [...] Generalizing within a setting stands in contrast to the positivist conception of generalizability, which pertains to generalizing a theory across different settings [...] [G]eneralizing within a setting is not better or worse than, but simply different from, generalizing across settings for a positivist researcher."
>
> (Lee and Baskerville 2003, p. 231)

In this thesis, five case studies have been investigated, with only a small number of blue-collar workers being interviewed. According to Lee and Baskerville (2003), it is important that the research samples (i.e. the workers that are interviewed) are selected randomly in order to ensure that they are representative of the population. As described in section 4.3.1, the companies to be studied were selected based on some predefined attributes, e.g. number of employees and the way Blueapp was used in the company. However in most cases there were several companies fulfilling these attributes which could have been chosen. The same applies to the interviewees that were chosen. Lee and Baskerville (ibid., p. 227) further say that a larger sample size increases generalizability to other samples, but it is impossible to generalize to the population as a whole logically.

Silverman (2001, p. 249-254) asks the question "How to generalize from qualitative research?" He gives three answers; combining qualitative research with quantitative measures of populations, purposive sampling guided by time and resources and theoretical sampling. The research in this thesis has been performed in such a way that generalizability is more likely according to Silverman's answers:

1   Statistics about the work of Blue-collars and the use of mobile phones and MMS has been collected from polls and newspaper articles and discussed in relation to the collected data material.
2   Several people cooperated in a research team in order to collect and analyze a larger amount of research-data than would have been possible for an individual on his/her own.
3   The parameters of the population under study were discussed and guided the choice of cases.
4   The cases were chosen based on the problem statements in such a way that they would ease the answering of them.

This thesis will not make absolute claims that the results apply to the population, nomadic work environments. However, the aim of this thesis is to inform about the findings in these specific cases and see how they are similar and different. It will also be suggested that it is likely that similar findings might be found if other cases, i.e. companies or professions, are investigated. The generalizability of the findings in this thesis will be discussed further in the conclusion chapter, chapter 8.

Chapter 4

Theoretical focus and related literature

In this chapter, theoretical concepts and previous research findings which can be related to the research problem are presented and discussed. A theoretical framework which will be used to analyze the use of ICT in work environments is constructed.

In the first section, 4.1, theory related to the use of communication genres to handle the flow of information in work environments is presented. In section 4.2, the CSCW tradition is presented and discussed. The term mobility and its importance in work environments is discussed in section 4.3. In section 4.4, previous research on the use of mobile ICT services is presented and discussed. Available studies of multimedia messaging and thoughts about its potential are presented in section 4.5. Finally, in section 4.6, the concepts that have been presented are combined in a theoretical framework.

4.1 Communication in work environments: Handling the flow of information

In this section, concepts which can be used to describe how the flow of information is handled in work environments are presented. The work environment consists of the organization, i.e. company, and the surrounding environment, including customers / customer organizations, physical environment etc. which the workers interact with in their work praxis. "Organization structure and internal systems facilitate interaction and communications for the coordination and control of organizational activities" and "organizations are open social systems that must process information [...], but have limited capacity. Information is processed to accomplish internal tasks, to coordinate diverse activities and to interpret the external environment" (Daft and Lengel 1986, p. 555). In other words, organizations are social structures that have been formed to serve some purpose, e.g. offer plumbing services to other organizations and individuals. The focus of this thesis is the work praxis of nomadic workers, i.e. service workers who travel to customer locations and work on assignments. The administrative personnel, customers, locations and technologies which are parts of this work praxis are only discussed in relation to their interaction with the nomadic workers.

In order to administrate an organization and do business, information needs to be handled. In this thesis, the word 'handling' is used to describe the process of creating, communicating, interpreting, storing etc. information. The word 'processing' used by Daft and Lengel (ibid.) gives the impression that information is treated by a predefined plan, e.g. by a computer. The flow of information, however, is influenced by and influences its surroundings. In order to avoid misinterpretations, the word handling is therefore used instead. The volume of information which needs to be handled can be immense, and it differs in both content and form. Examples of content are; a job

application, an order from a customer for work to be done, invoicing information and a personal message between co-workers. Form refers to the way in which it is presented and communicated; the medium. Examples of media are face-to-face communication and written documents.

In organizations, information is handled both at the individual and the collective level. "Information processing at the organization level must bridge disagreement and diversity quite distinct from the information activities of isolated individuals. [...] [O]rganization level information processing is influenced by the organizational division of labor" (ibid., p. 556). In this thesis, both information handling at the individual - and collective level is investigated and discussed in the case studies, i.e. the handling of information by individual workers, a group of workers and the organization as a whole is investigated. However, as mentioned, the focus is on how the information handling at these various levels influence the work praxis of the nomadic workers.

According to Daft and Lengel (ibid.), the reason why organizations handle information can be summed up to be to "reduce uncertainty and equivocality". The two terms are quite similar in their meaning, especially in common speech. However, Daft and Lengel (ibid., p. 556) have given them the following meaning; "uncertainty has come to mean the absence of information. As information increases, uncertainty decreases. [...] Equivocality means ambiguity, the existence of multiple and conflicting interpretations about an organizational situation". Graveline et al. (1999) says that there are three types of communication situations; equivocal, uncertain and situations that are socio-emotional or interpersonal in nature. In the discussion of the cases the handling of the flow of information in work environments is related to these types of communication situations. In addition to dividing the handling of information into three categories in this way, Graveline et al. (ibid.) say that different media is suited for each of these situations. The richness of a medium determines which situations it is best suited for. Media richness theory is a theory developed by Daft and Lengel (1986). This theory discusses richness of information and richness of media. Information richness is defined as "the ability of information to change understanding within a time interval. [...] In a sense, richness pertains to the learning capacity of a communication" (ibid., p. 560). The media used to communicate information vary in their capacity to handle rich information, thus the media can also be said to have a degree of richness.

> "Media richness theory suggests that different media will be chosen for different tasks because of varying characteristics of the media. Media Richness Theory defines several characteristics of media that are relevant to differentiating among the teaming technologies available: [feedback capability, availability of multiple cues, language variety, and personal focus]."
>
> (Graveline et al. 2000, pp. 382-383)

Feedback capability refers to the level of synchronicity, i.e. how quickly the sender can expect an answer. Multiple cues means different communication channels, e.g. spoken words, gesturing etc. The language used to communicate can e.g. include words and / or numbers and be spoken or be written in a document. Media also offer different

possibilities for communicating personal or social-emotional content. These characteristics which are used to determine the richness of media do not, however, give a complete picture of the properties that determines why specific media are used in the communication situations that they are. Contextual elements in the work praxis' also influence why the workers use specific media, e.g. habits, the use of other media, the mobility properties of the media and the requirements for the workers themselves to move. In this thesis, the characteristics introduced by Daft and Lengel (1986) are used to investigate the appropriateness of the media which are used in the situations that they are used in. In addition, contextual properties like the mobility properties of the media and the workers are used to investigate why specific media are used the way they are. The media richness of multimedia messages is also discussed, using these characteristics.

Numeric documents	Impersonal documents	Personal documents	Telephone	Face-to-face
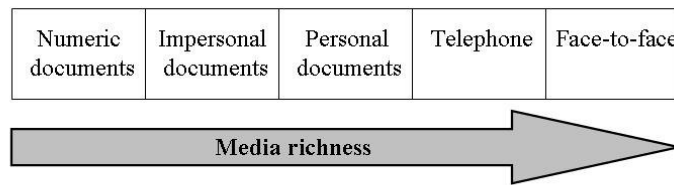
Media richness →

Figure 4.1: Daft and Lengel's (1986) classifications of media richness.

Daft and Lengel (1986, p. 560) introduced 5 classifications of media richness, they are depicted in figure 4.1. The media depicted in figure 4.1, have different characteristics, e.g. their level of synchronicity, and vary in richness based on these characteristics. When a medium is to be chosen for communicating information within an organization, the medium should be chosen based on the situation at hand: "Media Richness Theory claims that rich media, synchronous and multi-channel media, are best for equivocal communication situations [... and] that lean media, asynchronous and single-channel media, are best for both uncertain and certain communication situations" (Graveline et al. 2000, pp. 383).

Graveline et al. (ibid., p. 384) say that media richness attempts to answer the question; "which medium should I use for the communication situation I find myself in currently?" The nomadic workers in the work environments that have been investigated face this choice when they need to handle information. Based on Daft and Lengel's (1986) media richness theory, Graveline et al. (2000) say that there are four categories of communication and that there are different media that are best suited for each of these. These categories are presented in table 4.1. The media which are used in the work environments and MMS messages are related to figure 4.1 and table 4.1 in chapter 7.

Category of communication	Description	Choosing the right medium
Interpersonal communication:	The 'social glue' of the organization, e.g. personal conversations between co-workers	Socio-emotional content; use a rich, synchronous, multi-channel medium.
Group management:	E.g. planning of activities.	The aim is to reduce uncertainty of e.g. division of labor; use a lean, asynchronous, single-channel medium.
Task work communication:	Communication regarding how a plumber is to solve the task of installing a toilet.	The aim is to reduce equivocality; use a rich, synchronous, multi-channel medium.
Tool/media communication:	Communication related to how to use a tool or medium.	If the need is to reduce uncertainty, large amounts of data should be communicated using an asynchronous single-channel medium. If there is a need to discuss the problem at hand, i.e. reduce equivocality, a synchronous, multi-channel medium should be used for communication.

Table 4.1: Categories of communication and the appropriate choice of medium

Media richness theory has been criticized for not discussing how the handling of the flow of information in organizations influences and is influenced by the context in which it occurs. Yates et al. (1999) have introduced the concept of genres or recognizable types of communication within organizations. Genres are defined as "socially recognized types of communicative actions - such as memos, meetings, expense forms and training seminars - that are habitually enacted by members of a community to realize particular social purposes" (ibid., p. 84). Yates et al. say that "genres both shape and are shaped by individuals' communicative actions" (ibid., p. 83). Genres may be identified by two factors: their purpose and their form. The purpose of a genre is not one individual's intent of communicative actions, but a purpose that has been decided and is recognized by the organizational community within which it is used. E.g. the purpose of a staff meeting may be to discuss the organization's economy situation. The form of a genre refers to observable aspects of the communication, including the medium, and structural - and linguistic features. Yates et al.'s (ibid.) concepts about use of genres and the implications on the context in which they are used, are based on concepts from structuration theory (Giddens 1984). It is, however, beyond the scope of this thesis to use structuration theory to describe the organizations and the work praxis within them.

Genres can be directly related to media richness theory. Both concepts describe types of communicative actions within organizations. In this thesis the concepts of genres will be used to describe communication in the work environments that have been studied. The medium used to communicate, which is the essence of the form of the genre, is similar to the concept of media in media richness theory. In the discussion of media use in the work

environments, the concepts of richness of media are used to investigate the richness of the media that are used in the work environments and how appropriate these media are for the communication situations they are used in. Genres can also be related to the four categories of communication, presented by Graveline et al. (2000). The purpose of the use of a genre is to fulfill the aim of a communication situation which in turn belong to a communication category. In this thesis these four categories will be used as genres of communication. These genres will be used to categorize the communication which occurs in the work environments studied in the case studies. In addition, these genres will be used to investigate the possibilities of genres of MMS communication (e.g. group management). Since genres are identified by their purpose and their form, it is important to note that e.g. group management using SMS messages and group management using face-to-face communication is two distinct genres. The reason for this is that although the purpose, group management, is equal, the medium, SMS or face-to-face conversations, is different.

Considering genres of multimedia messaging in the cases means that both the form and purpose of MMS should be discussed in order to understand the potential of the service in work environments. The form of MMS is determined by the device that is used to create, send, and read them; the mobile phone. The form therefore consists of both the hardware, e.g. the camera, and the software, i.e. the program used to create, send and read MMS messages, of mobile phones. The richness of MMS as a communication medium is discussed in detail in section 6.4. MMS messages can be sent to people (almost) anywhere, anytime since it is a mobile phone service. The feedback capability of MMS is in this thesis considered to be medium. MMS offers the possibility to answer a message right away; however, the level of synchronicity in a communicational situation is dependent on if the person who receives an MMS chooses to answer immediately or answers at a later time. MMS offers multiple cues which vary in 'language'; they can contain both pictures, text and sound. MMS messages are sent to one or several individuals and can be personalized by the sender. In the discussion chapter, chapter 7, possible purposes for MMS use in organizations is discussed in order to investigate the potential use of the service.

4.2   Collaboration in work environments

Researchers from a diversity of research fields have studied work praxis. This thesis follows the CSCW 'tradition'. In this section, the theory of communication genres and the richness of media are related to CSCW theory in order to better understand how the workers use communication genres in their work praxis.

> "Ten years ago, Paul Cashman and Irene Grief organized a workshop of people from various disciplines who shared an interest in how people work, with an eye to understanding how technology could support them. They coined the term "computer- supported cooperative work" to describe this common interest. Over the past decade thousands of researchers and developers have been drawn to it. [...] CSCW started as an effort by technologists to learn from economists, social

psychologists, anthropologists, organizational theorists, educators and anyone else who can shed light on group activity."

Jonathan Grudin (1994, p. 19-20)

Within the CSCW research field, there exist a diversity of both research focuses and research methods. Some researchers focus on understanding work praxis and develop theoretical models about collaboration and work praxis, e.g. Strauss' theory of articulation work (Schmidt and Bannon 1992), while others focus on designing computer-based solutions that support the work praxis. The research is also focused on various contexts; the individual worker, small groups, projects or organizations as a whole (Grudin 1994). In this thesis, some of the terms that have been developed through CSCW research or adapted to the CSCW field from other research fields are used to describe the work praxis in nomadic work environments. The contexts described by Grudin can be related to Daft and Lengel's (1986) concepts of the individual and collective level of information handling in organizations. In this thesis the contexts are used to describe the work praxis, since they offer the possibility of investigating issues which might be different in the small group context, compared to the whole organization context. The way the flow of information is handled is different in each of the contexts. E.g. in the individual context the information handling is influenced by other circumstances than in the organizational context. All the contexts are investigated and discussed in relation to the case studies. The focus is on how the information handling in each of these contexts influences the work praxis of the nomadic workers. Most of the workers are part of all the contexts in their daily work praxis; e.g. they work individually, they interact with a small group of co-workers, they are part of a large construction project and they are employed by a company.

> "Similar to communication, collaboration is a cornerstone of group activity. Effective collaboration demands that people share information. Unfortunately, current information systems [...] go to great lengths to insulate users from each other. [...] The effectiveness of communication and collaboration can be enhanced if a group's activities are coordinated. Without coordination, [... a team of workers] will often engage in conflicting or repetitive actions."
>
> Ellis et al. (1991, p. 40)

In this thesis, communication between workers in nomadic work environments is the main focus. Both vertical and horizontal communication is investigated in the cases. Communication between co-workers, horizontal communication, is used to coordinate activities in the small group or project context. Communication between the management and workers, vertical communication, is used to coordinate activities in the context of the whole organization as well as the activities in small groups or projects. This thesis investigates the current use of communication genres and the potential of genres of multimedia messaging for both vertical and horizontal communication.

The contexts can be related to the concept of genres. E.g. the four communication categories presented by Graveline et al. (2000, p. 384) occur within the different contexts. The individual work context is a special case, since e.g. interpersonal communication

does not apply to an individual. Various media of varying richness are used for different communication purposes, i.e. the four categories, within the contexts. The use of genres for these purposes in different context will be discussed in section 7.2. The theoretical framework presented so far is depicted in figure 4.2.
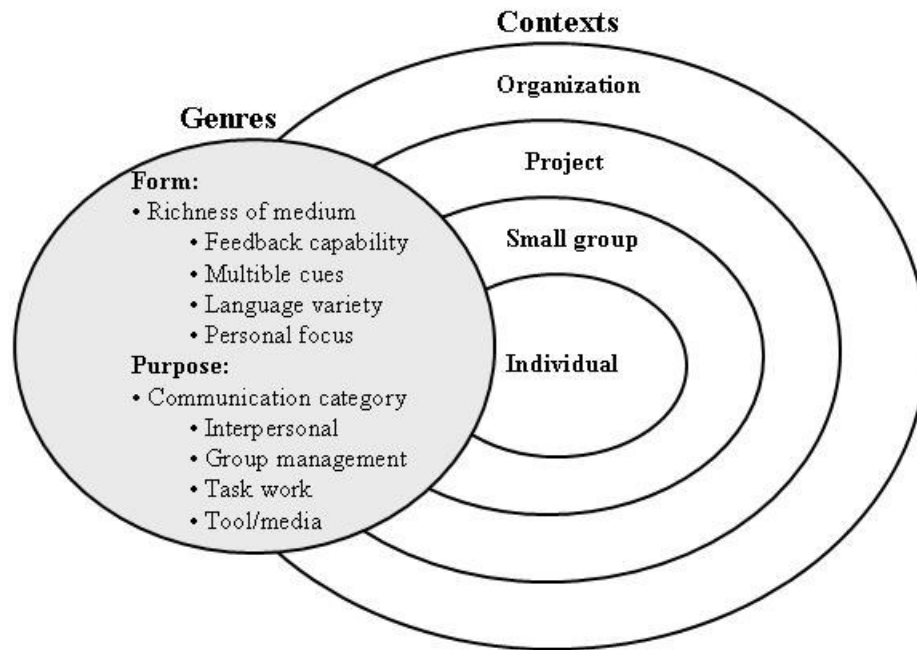
Figure 4.2: The use of genres of communication in communication contexts.

Several different theoretical perspectives of work are used by researchers within the CSCW-field. The most dominant are structuration theory (Giddens 1984), grounded theory / Strauss' theory of articulation work (Schmidt and Bannon 1992) and Activity Theory (Bardram 1998). The discussion of the work praxis in the work environments is in this thesis based on some of the concepts of Activity Theory (AT). AT will not be described in detail, nor will the concepts be used as an analytical tool in the discussion of the case studies. However, since some of the concepts are used throughout this thesis, they will be described briefly here.

According to Bardram (1998), describing the nature of cooperative work has been a persistent problem within the CSCW-field. He says that "this problem is a direct result of not looking at the dynamic aspects of work - i.e. that cooperative work is not one thing, but different things at different times and in different places" (ibid., p. 89). In his paper, Bardram says that AT can help in understanding the dynamics of collaborative work activities. Kuutti (1991, p. 253) defines AT as "a philosophical framework for studying different forms of human praxis as developmental processes, with both individual and social levels interlinked". In this thesis, the work praxis of the nomadic workers is investigated in detail focusing on their use of communication genres to coordinate their activities with other workers and the administrations wishes. The use of the genres vary depending on which communication context they are in, the physical location (i.e. at the office) and purpose for communicating. AT focuses on activities as basic units of analysis. An activity is defined as a minimal meaningful context for individual actions.

With such a definition it is possible to analyze individual actions and still maintain some contextuality. Activities are carried out by an individual or a collective of individuals to perform some purpose. Activities are influenced by the community they are performed in, the tools which are used to perform, the division of labor between those who participate in the activity and rules of conduct. In this thesis, the study of the work praxis of the nomadic workers has been influenced by this way of studying the actions of people. The work praxis in all the work environments is centered on assignments; assignments are received from customers, delegated to the nomadic workers, completed by the nomadic workers etc. The assignments can be considered to be individual activities which consists of several actions, e.g. that a plumber fixes a faucet at a customer's location. This is the viewpoint which is used when the work praxis is described in chapter 6 and discussed in chapter 7.

4.3   Mobility in collaboration

In this section, the term mobility is presented and discussed in relation to this thesis. Prior research findings of how mobility factors influence work environments is also presented and discussed. The reason for this is the high level of mobility of both workers and technology in the nomadic work environments that have been studied.

4.3.1 Mobility: Who / what is mobile when and where?

 In common tongue, mobility usually refers to someone or something that can move or be moved physically from one place to another. In this thesis, this kind of mobility is called physical mobility. Luff and Heath (1998) identify three types of physical mobility; micro, local and remote mobility. Lyytinen and Yoo (2001) describe these types:

> "Micro mobility refers to the way in which small artifacts such as [documents or mobile phones] can be moved and manipulated "at-hand" and how they relate to our bodily experience. Local mobility involves real-time interactions between people and technologies in the same "location" or "site". Finally, remote mobility supports both asynchronous and synchronous collaboration and information sharing among individuals who move around distant physical locations."
>
> (Lyytinen and Yoo 2001, p.5)

These types of mobility can be related to the different contexts in work environments. All these types of mobility can occur in all four contexts described by Grudin (1994). E.g. in the individual worker context the worker is at the office dialing a number on his mobile phone (micro mobility), since it is a mobile phone the worker can pace his office while talking to someone (local mobility), and the conversation the worker is having might for instance be with a customer in another city (remote mobility). Physical mobility can also be related to genres and media richness. Different media support different kinds of physical mobility, e.g. documents are usually used for tasks that require their micro or local mobility properties, while telephone conversations are usually used for communication between people who are not co-located. The mobility characteristics of media can be related to the feedback capability of media. E.g. mobile phones have made

it possible to talk to someone that is not co-present (remote mobility). The remote mobility properties of mobile phones enhance the medium's feedback capability. In the investigation and discussion of the work environments in the case studies, the physical mobility of people and communication media is a key issue.

Lyytinen and Yoo (2001, p. 5) also say that it is important to consider social mobility in work environments. "Social mobility refers here to the ways in which and the ease with which individuals can move across different social contexts and social roles". The notion of social mobility can be directly related to the four contexts; social mobility is to go from one social context to another, e.g. to go from working individually to working in a team. In this thesis going from e.g. one individual context to another individual context is also considered as social mobility; the person goes from one role to another. Social mobility can also be related to the purpose of genres; media can be used for different purposes in different social contexts or roles. For the case studies in this thesis, social mobility is important. The use of media in different contexts and in different social roles is discussed in chapter 7.

Kristoffersen and Ljungberg (2000) has a slightly different view on mobility, firstly they state how difficult it is to define it:

> "Mobility is one of those words that is virtually impossible to define in a meaningful way. You either develop a definition that excludes obvious instances, or the definition is too vague and subsequently fails to shed light on important aspects of the concept. At the same time we all intuitively 'know' what the concept means; the postman and the traveling salesman are mobile, the secretary and the cook are not. Thus, we seem to be able to conceive of typical situations in which people are mobile and when they are not."
>
> (Kristoffersen and Ljungberg 2000, p. 140)

Kristoffersen and Ljungberg relate their concepts about mobility to mobile work. They say that it is possible to distinguish if a worker is mobile or not, in addition, there are different types of mobile modalities; traveling, visiting and wandering.
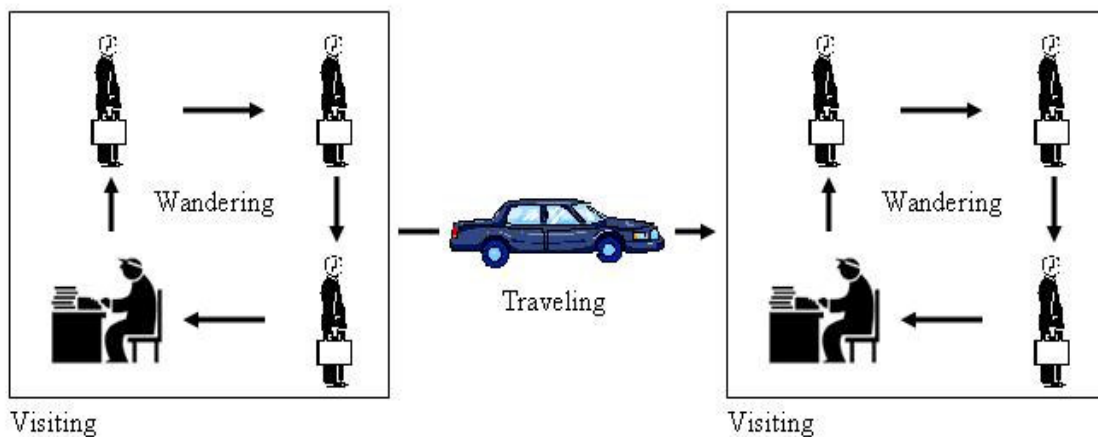
Figure 4.3: Types of mobile modalities: Traveling, visiting, and wandering (Kristoffersen and Ljungberg 2000, p. 141).

Traveling is the process of moving from one location to another using a vehicle. The traveler can either drive the vehicle or be a passenger, e.g. a construction worker can drive his car to a new construction site or ride along with a co-worker. Visiting is to spend a period of time at one location before going to another location. An example of visiting in work environments is construction workers who work at one site until their tasks are done there before moving on to another site. "Wandering is extensive local mobility in a building or local area. A wandering person spends a considerable amount of time walking around" (ibid., p. 142). An example of wandering in work environments is the foreman in Luff and Heath's (1998) article, whose work tasks require him to walk around a construction site. The three types of mobile modalities are depicted in figure 4.3.

Kristoffersen and Ljungberg's types of mobile modalities in mobile work can be related to the concepts of social and physical mobility and contexts. When a mobile worker travels somewhere, he goes from one social context to another (e.g. from an individual context in one organization to an individual context in another) and spends a period of time visiting in each context. While visiting the worker wanders around, going from one social context to another, e.g. from working individually at his desk to attend a meeting with co-workers. The three types of physical mobility occur in all of the types of mobile modalities. In the example with the foreman taken from Luff and Heath's (1998) article, the foreman uses a notepad computer to record data while he is wandering the construction site. His actual handling of the computer is an example of micro mobility, him moving around a room showing the computer screen to co-workers is an example of local mobility, and him transmitting data to the office building from the computer is remote mobility. All of this occurs while the foreman is visiting a construction site. When he travels between sites all these forms of physical mobility can occur as well. If he travels by car, local mobility can be difficult, however, if he travels by bus or train local mobility can occur with ease.

Modality / Technology	Mobile	Portable	Desktop
Wandering	V		
Traveling	V	V	
Visiting	V	V	V

Table 4.2: Modalities and technologies (Kristoffersen and Ljungberg 2000, p. 142).

The different types of mobile modalities offer different opportunities for the use of ICT (i.e. communication media). Table 4.2. shows the situation with three types of ICT; mobile -, portable - and desktop technology. The three types of technology have different physical mobility properties. E.g. a mobile phone is easier to move 'at-hand' (micro mobility) in order to show the display to someone near you than a monitor of a desktop computer is. The concepts of mobile modalities and the use of media to support social and physical mobility in work environments will be used to discuss the work praxis in the work environments.

4.3.2 The importance of mobility in work environments

In the previous section, some of the aspects of mobility were presented and discussed. In this section, the importance of mobility in work environments is the focus. "The ways in which mobility features in collaborative work has largely been overlooked within CSCW [...]. It has neither formed the focus for developing innovative mobile technologies, nor featured in empirical studies of work and communication" (Luff and Heath 1998, p. 305). Since Luff and Heath (ibid.) wrote their article in 1998, mobility in work environments has been paid more attention to. This thesis aims at expanding the understanding of mobility and the importance of it in work environments through empirical study and analysis of this data using existing theory.

Luff and Heath say that the mobility of people and artifacts is crucial for communication and collaboration, and that it is important to consider this in order to be able to understand the work environments better and enhance support for collaboration. In their work praxis, the workers use many different artifacts to support them. It is important to understand how these artifacts are used and how they support mobility. E.g. if one study the work praxis at a construction site, it is important to understand how e.g. paper documents are used if one aims at replacing them by a computerized system (ibid.). The aim of this thesis is to investigate some work environments and gain an understanding of the use of communication genres, in order to uncover the potential of MMS if it is to replace one or several of these genres.

Kristoffersen and Ljungberg (2000, p.138) have introduced the concept Mobile Informatics, this is a relatively new research field "concerned with equipping the mobile society with innovative and useful services and applications". They further say that "the organization of work and leisure is moving towards increased mobility, due largely to the arrival of high-performance wireless networks and portable - even wearable - computers, it is time for traditional IT research to "move on or move over"" (ibid., p. 137). In their article they ask "why is the world such a mobile place?" They give the following answer.

> "[Because] work in the modern corporation is becoming increasingly cooperative. Cooperation leads to increased use of IT such as email and conferencing, which bridge distance, but it also leads to mobility; once 'dis-located' workers get to know each other, they often travel to meet physically. Another important factor is the emergence of service work as the main occupation in western society. […] A service encounter, however, takes place where the customer is, which may differ over time[. …] Therefore, most service workers are inherently mobile. Thus the increased amount of service workers in society has made society as a whole more mobile. Yet another important explanation is the adoption of the mobile phone. The mobile phone is designed to enable people to be mobile without being disconnected. New ways of working have therefore emerged in many organizations where people are assumed to be accessible regardless of their physical location."
>
> Kristoffersen and Ljungberg (2000, p. 143)

Kristoffersen and Ljungberg say that increased cooperation in work environments is one of the reasons why mobility has become so important. In this thesis, mobility in collaboration is one of the key issues in the discussion concerning work praxis in the case studies. All the companies studied in the case studied are service providers, whose occupation require the workers to travel to the customer to carry out the service (see chapter 2). The primary focus of this thesis is the potential use of the mobile phone service MMS in work environments. The mobility aspects of the service, the mobile phones and the workers will be discussed.

Sherry and Salvador (2002, p. 108) say that new forms of connectivity in work environments requires the workers to master "what is going on "here and now" and the ongoing flow of activities that are outside the immediate physical context but which still require attention" at the same time. They say that there are two key elements of mobile work that can be separated; "remoteness" which means that the worker is away from the central office and "truly mobile work" which involves both remoteness and movement. These elements can be related to the mobile modalities presented above. Visiting is similar to remoteness and wandering is likewise similar to truly mobile work. Sherry and Salvador say that the main problems with being away from the central office are; fewer resources, more difficult to coordinate activities with others, more difficult to collaborate 'ad-hoc' with others and it is more difficult to communicate with others. Sherry and Salvador say that in order to cope with these problems it is important to have well-suited ICTs that support the demands of the work praxis. They say that one ICT in particular is important to consider; mobile phones. Mobile phones have made it possible for mobile workers to be available "anywhere, anytime". According to Sherry and Salvador the mobile phone has changed the working life. The use of mobile phones by mobile workers is investigated in the case studies and the use of mobile phone services to support the work praxis is discussed in chapter 7.

4.4   The use of ICT services in work environments

ICT - information and communication technologies; what does this concept include and how are these technologies used inside work environments? Daft and Lengel (1986, p. 563) say that "[t]echnology is the knowledge, tools, and techniques used to transform inputs into organizational outputs". In this thesis, however, the ICT concept means communication devices and the infrastructure that connects the devices that are used to communicate information between individuals or to make information accessible for individuals. Mobile phones 'connected' to a network (e.g. GSM) is an example of an ICT that can be used by individuals to communicate. The Internet and a central database are examples of ICTs whose purpose is to make information accessible to individuals. In this thesis the use of ICTs will be divided into to distinct types; communication technology, ICTs used for communicational purposes, and information technology, ICTs used to transmit information. The concept of communication technology is used to describe devices and services used to communicate and where it is likely that sending information will result in a response. An example of the use of communication technology is a mobile phone conversation. When the caller (i.e. sender) calls someone and starts talking there usually will be an (immediate) response from the person that is called (responder),

resulting in a dialogue where the roles shift. An example of the use of information technology is searching the Internet for information. The search for information only requires the one person (i.e. sender) to be active, there will be no answer from another person. The distinction between communication and information technology will in this thesis be used to discuss the ICTs used in the case studies and to discuss the potential of MMS. In addition, in section 7.3, it is discussed whether multimedia messaging is just transmission of information from one person to another, or if MMS messages result in an active dialogue between people.

> "In the last decade recently introduced communication technologies [...] have proliferated in the workplace, significantly altering ways in which people in organizations communicate. These changes have made more pressing the attempt to understand the role of these media in communication within organizations."
>
> Yates et al. (1999, p.83)

> "Two types of collaboration situations utilize communications technologies. The first type is a situation in which co-located team members use computer-mediated collaboration to supplement their face-to-face interaction. The second type is a situation in which team members are not co-located; they are collaborating at a distance. These two types of collaboration involve different communication patterns and different communication needs."
>
> (Graveline et al. 2000, p. 283)

The use of ICTs in the case studies will be considered using the concept of genres. The purpose and form (i.e. ICTs) of the genres and how their use influences the work praxis will be discussed. The two types of collaboration situations described by Graveline et al. (2000) can be related to the mobile modalities and types of physical mobility described above. Co-located team members are in need of ICTs that support micro and local mobility, while team members that are not co-located require ICTs that support remote mobility. The use of ICTs in different situations and how appropriate they are for the situations they are used in is discussed in section 7.2.

The use of ICTs in work environments has been studied by many researchers, e.g. Julsrud et al. 2002 and Luff and Heath (1998). Especially the work praxis of office personal, white-collars, have been studied. The use of ICTs that support mobility, and in particular mobile phone services have, however, not been a big research issue. The aim of this thesis is to expand the current understanding of the use of mobile ICT in work environments.

Lyytinen and Yoo (2001, p. 1) have introduced the concept of nomadic information environments, "a heterogeneous assemblage of interconnected technological and organizational elements, which enables physical and social mobility of computing and communication services between organizational actors both within and across organizational borders". This concept seems to cover many of the aspects of the nomadic work environments which are investigated in this thesis. However, this concept will not be used as a framework in this thesis, i.e. the nomadic work environments are not

investigated as nomadic information environments. One of the concepts that Lyytinen and Yoo (ibid) discuss, however, will be used in this thesis; the concept of technological drivers. Lyytinen and Yoo say that there are three technological drivers which are changing work environments into nomadic information environments. For the purpose of this thesis, these drivers are used to discuss how ICTs evolve and are introduced into work environments.
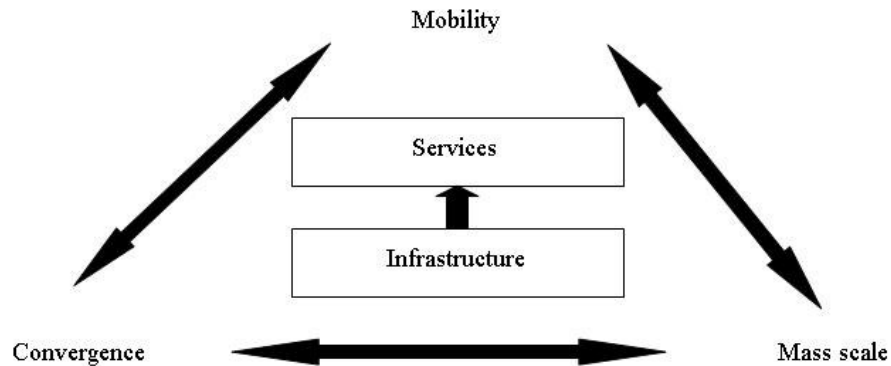
Figure 4.4: A framework of nomadic information environments (Lyytinen and Yoo 2001, p. 4).

Lyytinen and Yoo (2001) choose to analyze nomadic work environments based on their features of mobility, digital convergence and mass scale. They do this because they believe that these features are technological drivers that "underlie most developments in future computing technology" (ibid., p. 3). Figure 4.4 shows how the infrastructure (e.g. mobile phone networks) and services are influenced by these technological drivers, and how these drivers also influence each other. Lyytinen and Yoo use Luff and Heath's (1998) concepts of mobility, mobility issues have already been discussed in this chapter. "Evolution of computing in the 90's has made the computer a universal media machine thanks to an increased convergence of all physical medial to digital form" (ibid., p. 6). In chapter 7, the concept of digital convergence is used to discuss how the communication media that are used have evolved and how new media that are introduced often are a digital convergence of existing media. Regarding multimedia messages, it can e.g. be stated that they are a result of the digital convergence of mobile phones and cameras. Lyytinen and Yoo further say that since most information is digitalized, it can be stored in, transmitted by, and displayed using many different technological devices, e.g. mobile phones and PC's. The way information is handled using different communication media in work environments is the focus of this thesis. Mobility and convergence will result in an "unforeseen massive scale in service volume, service types and number of users" (ibid., p. 6). In Norway, mobile phone services like SMS has literally resulted in an "unforeseen massive scale in service volume". The way mobility properties and the digital convergence that have 'shaped' the modern mobile phones will influence the mass scale of MMS use is discussed in chapter 7 as well.

4.5   Multimedia messaging

Multimedia Messaging Services (MMS) were made available in Norway by the two network operators, Telenor and NetCom, in the beginning of 2002. MMS is still considered to be a new service in Norway at the time this thesis is written. In chapter 5, some of the aspects of the hardware (i.e. display and camera) and the software (the program which let you create, send and read MMS messages) of MMS-enabled phones and how they have changed since the introduction of the service is discussed. When the service was first introduced, SMS messaging was already well-adopted and much used by the mobile subscribers. MMS was introduced through marketing campaigns as the new version of SMS; messages could now include pictures in addition to text. Even though MMS enables the sending of sound clips, video clips and animations as well, the focus of the marketing campaigns has been on the ability to send pictures. This is also the focus of this thesis. After a 'slow start' in adoption, probably mostly due to the time it has taken for people to replace their old mobile phones with MMS-enabled phones, MMS seems to have become popular and the number of MMS messages that are sent each has month is still increasing.

The focus of MMS messages in marketing campaigns and media has been entertainment purposes. The service has not been presented with the possibility of being used for anything else but sending pictures as if to say "see how much fun I'm having". This thesis aims at uncovering other possibilities for this service. In the case studies, the work praxis of service workers and their use of communication media has been investigated with the intent of uncovering in which ways MMS messaging could be used to support the work praxis.

MMS is still in its early adoption, therefore the research concerning the possibilities the service offers and actual investigations of the use of the service is very limited. Some researchers in Finland have studied the praxis of sending images between mobile phones (Koskinen et al. 2002). The study was performed prior to the introduction of MMS in Finland, but the images were sent in a very similar way to how MMS messages are sent now. In the study, Nokia Communicator mobile phones were connected to digital cameras. The images were combined with textual descriptions and sent as e-mails between the mobile phones. One of the primary findings of Koskinen et al. (ibid.) is that pictures should have captions, i.e. that textual descriptions should be included for the pictures. Ling et al. and Julsrud et al. (2004) have in the MEMO project, which followed the work of the NOMADE project (Julsrud et al. 2002), studied the use of genres of SMS and MMS messaging in work environments share this view; captions are needed to explain the context of the picture. The workers that were studied in the MEMO project are blue-collar workers, soda salesmen and real-estate brokers. These workers were given MMS-enabled mobile phones and were studied using qualitative methods, e.g. interviews and observations. The results of the MEMO project indicate that there are five genres of multimedia messaging that are used in these work environments: visual documentation, explanations and illustrations, snapshots, chain messages, and vacation pictures and greetings (Julsrud et al. 2004). These genres will be related to the genres presented in section 4.2, in section 7.3 of the discussion chapter. Other findings of Ling et al., Julsrud

et al. (2004) and Koskinen et al. (2002) will also be discussed and related to the case studies of this thesis in section 7.3.

Pedersen et al. (2003) have studied adoption issues of MMS, i.e. which issues are important for people when they consider using MMS. They have developed an adoption model for the adoption of mobile phone services. The adoption model will not be used to discuss the adoption of MMS in detail in this thesis; however, some of the main findings of Pedersen et al.'s study is used in the discussion of the adoption of MMS. Some of the parameters which Pedersen et al. use to discuss adoption issues are based on media richness theory, and can therefore be related directly in this thesis. Pedersen et al. also compare the characteristics of MMS and SMS, table 4.3 shows some of Pedersen et al.'s findings. Pedersen et al. (ibid., p. 5) say that "the main objective difference between traditional text messaging and multimedia messaging is channel capacity". In section 7.3 these characteristics of MMS and SMS are discussed in relation to the findings of this thesis.

Dimension	Peer SMS	Peer MMS
Channel capacity	Low	High
- Cue variety	Low	High
- Language variety	Medium	Medium
Interactivity	Interactive	Somewhat interactive
- Participation	Participation	Somewhat participating
- Mediation	Mediating	Mediating
- Contingency	Contingent	Contingent
- Propinquity	Distributed	Distributed
- Synchronicity	Somewhat synchronous	Asynchronous
- Identification	Fully identified	Fully identified
- Parallelism	Mostly serial	Mostly serial
- Anthropomorphism	Unanthropomorphic	Somewhat anthropomorphic
- Interaction involvement	Involved	Involved
- Mutuality	Mutual	Somewhat mutual or mutual
- Individuation	Somewhat individuated	Individuated
Adaptiveness	Somewhat adaptive	Adaptive
- Personalization	Somewhat adaptive	Adaptive
- Situatedness	Somewhat adaptive	Somewhat adaptive
- Timeliness	Adaptive	Adaptive

Table 4.3: Comparison of SMS and MMS characteristics (Pedersen et al. 2003, p. 6).

Regarding the adoption of MMS, one of the key findings of Pedersen et al. is that "[e]xpressiveness and enjoyment are the main motivations for using, whereas usefulness and attitudes are not" (ibid., p. 56). Since the aim of this thesis is to investigate the "usefulness" of MMS, i.e. how MMS can be used to handle the flow of information, in nomadic work environments, this finding should be discussed. Pedersen et al.'s study involved a web questionnaire at web sites that are mostly visited by young people and the

study "sample consist of more young and low income users than the general user population" (ibid., p. 24). The nature of the study, i.e. a web questionnaire open to everyone who visits the web pages and the subjects who answered the questionnaire, might have influenced the result. In the case study, for this thesis, qualitative methods are used to investigate nomadic work environments; environments where it is perhaps more likely that people will see ways to use MMS that are useful, i.e. that support their work praxis. These issues are discussed further in section 7.3

4.6 Theoretical framework

In this thesis, five nomadic work environments, presented in chapter 2, will be analyzed using theory of communication genres, media richness theory and mobility theory. CSCW concepts, e.g. the concept of contexts, and related literature will also be used to discuss the data material collected in the case studies. The key concepts that will be used when discussing the use of communication genres in work environments and the potential of genres of multimedia messages are presented in figure 4.5. By combining these concepts, this thesis aims at expanding the current knowledge about the use of communication genres to handle the flow of information in nomadic work environments.
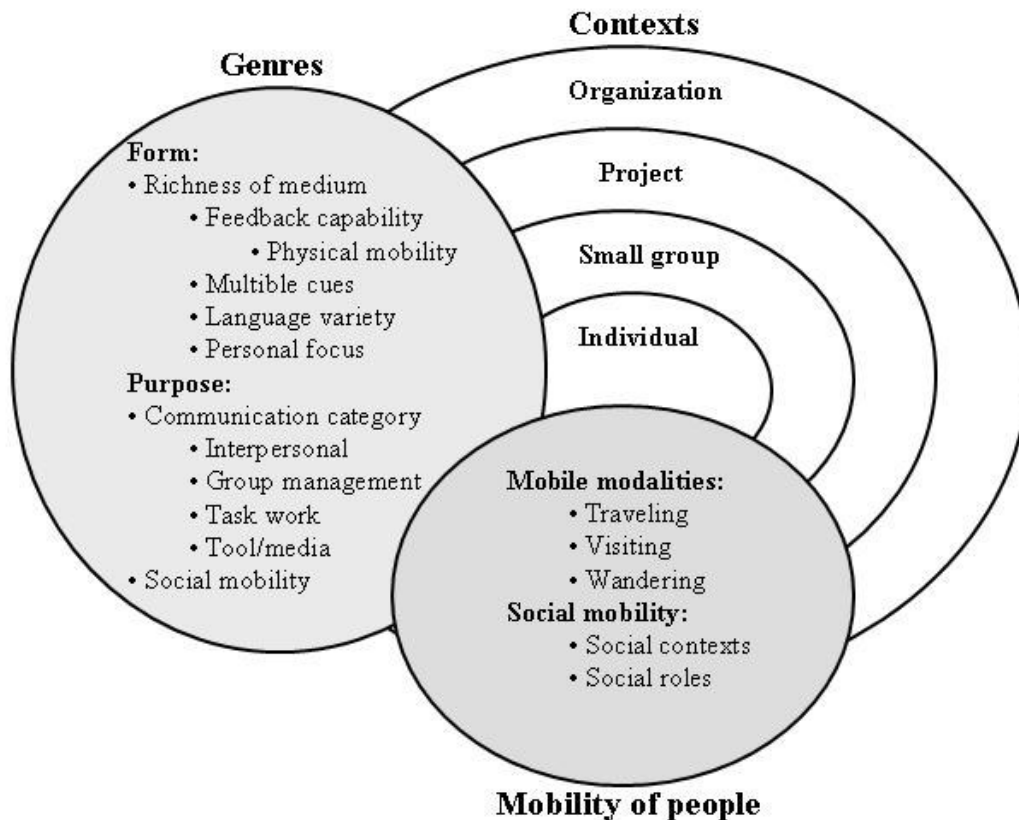
Figure 4.5: Theoretical framework for the thesis.

Chapter 5

Multimedia Messaging Services

The MMS service was introduced in Norway by the network operators, Telenor and NetCom, in the spring of 2002. Since then, most of the 'childhood diseases' have been found and 'cured'. Hence, the service has evolved into a more stable service where the users can expect the same quality of service as they do with SMS. Some of the problems that have been fixed are; the previous long delay between a MMS was sent and received, hand-over between operators (i.e. that a Telenor subscriber can send an MMS to a NetCom subscriber) and the price has been set to a more reasonable level.

Since the network operators opened their networks for 'MMS traffic', there has also been an evolution in the mobile phones themselves. The mobile phone manufacturers have edited both the hardware and the software of mobile phones due to MMS. This is discussed in the subsections below. This discussion is partly based on the author's first hand experience, i.e. technology testing, of MMS-enabled phones and the MMS service.

5.1   Camera phones: Mobile phones with cameras

Most of the first MMS-enabled phones that were introduced to the market just prior to and shortly after the introduction of MMS did not have integrated cameras. Some of these phones could not be equipped with external cameras either. Nokia 7650[4] was the first phone with an integrated camera which was introduced in Norway. Even though it was criticized for being large and expensive, it was popular since it offered functionality which was totally new. The other phone manufacturers soon introduced mobile phones with either integrated cameras or which could be equipped with 'click-on' cameras. The Sony Ericsson T68i[5] can be equipped with 'click-on' cameras. Figure 6.10 shows pictures of Sony Ericsson T68i. With the exception of Nokia 7650, the first MMS-enabled mobile phones all had relatively small displays. The displays were the same size as the displays on the phones that had existed the last 2-3 years. Sony Ericsson T68i has a display with 101 x 80 pixels while Nokia 7650 has a display with 176 x 208 pixels.

Until late 2001 / early 2002, the mobile phones in Norway didn't have color displays. Most phones had a green backlight with black writing / symbols. Just prior to the introduction of MMS, mobile phones with color displays were introduced. Nokia 7650's display has a color-depth of 4096 colors. Sony Ericsson T68i's display could show 256 colors. The color-depth of the display is a very important factor for the clarity of the pictures. Although Nokia 7650 had a many advantages in its hardware compared to Sony Ericsson T68i, larger and clearer display, and an integrated camera, T68i was more popular among the consumers. One of the main reasons for this is probably size. Consumers had been getting used to that mobile phones were becoming smaller and

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4 Nokia 7650 homepage: http://www.nokia.co.uk/nokia/0,,137,00.html
5 Sony Ericsson T68i homepage: http://www.sonyericsson.com/T68i/

smaller for several years, and they could easily fit them in their pockets. Nokia 7650 was much larger in size than the other phones on the market, while T68i was the same size as or smaller than most phones. Another factor was price; when it was introduced Nokia 7650 cost approximately 1-2000 kr more than T68i, placing it in the 'upper price group'. T68i, however, did not have an integrated camera, and the consumers needed to buy this in addition to the phone in order to take pictures. The cameras were relatively expensive at first, the author of this thesis bought an MCA-20 camera for 1850 kr, but soon dropped to a more reasonable level. Figure 5.1 shows the T68i with and without the MCA-20 camera.

Figure 5.1: Sony Ericsson T68i with and without 'click-on' MCA-20 camera (Pictures taken and permitted by Sony Ericsson).

Soon after these mobile phones were introduced other manufacturers, e.g. Siemens, introduced mobile phones with MMS-functionality also. Nokia and Sony Ericsson also soon introduced new MMS-enabled phone models into the Norwegian market. Some of these phones had integrated cameras, while others needed to be equipped with a 'click-on' camera in order to take pictures.

During the two years since MMS was introduced in Norway, and in fact the time it has taken to write this thesis, there has been an evolution in the mobile phones of Norwegian customers. Most of the mobile phones that are introduced into the market by the phone manufacturers have color displays and are MMS-enabled. Almost all new MMS-enabled mobile phones have integrated cameras. The reason for this has not been investigated, but it is likely that it is due to new technology which make it cheaper to include integrated cameras in mobile phones without having to make them very large, and that the sale of 'click-on' cameras has been very low. Sony Ericsson T610[6] was one of the mostly sold MMS-enabled phones in 2003 (it was released in the autumn of 2003). It has won several tests of MMS-enabled mobiles in Norway and it has won the price for "best mobile terminal, handset or device" at the 3GSM World Congress in February 2004[7]. T610 has an integrated camera and a display with 65k (65 536) color depth which is much clearer than its predecessor T68i. Figure 5.2 shows a picture of T610.

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6 Sony Ericsson T610 homepage: http://www.sonyericsson.com/t610/
7 3GSM World Congress 2004: http://www.gsmworld.com/news/press_2004/press04_12.shtml
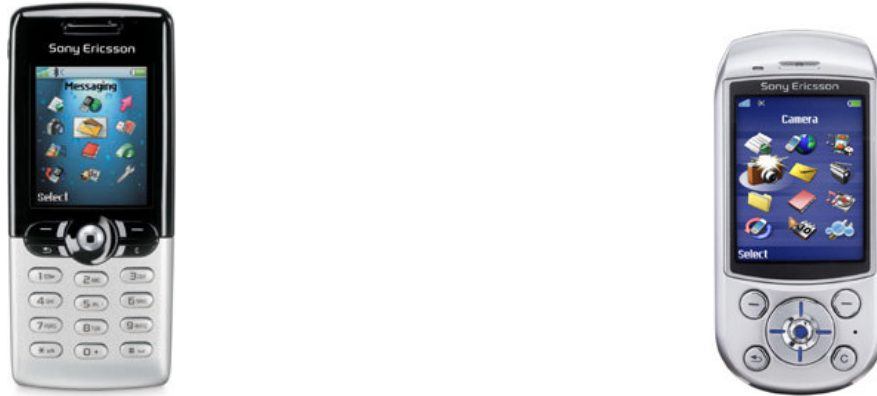
Figure 5.2: Sony Ericsson T610 (left) and S700 (right) (Pictures taken and permitted by Sony Ericsson).

As a part of this thesis, two mobile phones have been tested in order to get a better understanding of MMS and the MMS-enabled mobile phones. Sony Ericsson T68i and its 'heir' T610 have been tested in common use and for taking pictures and sending these; T68i was tested from December 2002 to august 2003 and T610 was tested from august 2003 to present day (ultimo April 2004). T68i was tested with a MCA-20 'click-on' camera. The picture quality of the pictures was the primary focus of the testing. When the pictures are viewed on the display of the phone the quality is limited by the resolution of the display i.e. number of pixels, not by the resolution of the pictures since this usually is higher than the resolution of the display. Both phones support that the pictures' resolution can be changed so that pictures that are only meant to be viewed on the phone display can have low resolution while pictures which are meant to be viewed on a larger monitor, i.e. a PC monitor, can have larger resolution. The choices between resolutions varies; the MCA-20 camera offers three different resolutions and the max resolution is 640 x 480 pixels (i.e. VGA quality), while T610 offers two different resolutions and the max resolution is 288 x 352 pixels. The test shows that the pictures are clearer on the display of T610, the main reason for this is that T610 has a color-depth of 65k while T68i has a color depth of 256 colors. In addition, the T610's display of 128 x 160 pixels is much larger than T68i's display with 101 x 80 pixels. T68i's max resolution of 640 x 480 pixels is what is most usual for current MMS-enabled phones. Because of the max resolution of the pictures, the pictures taken with the T68i are better than those taken with T610 when viewed on a PC monitor. Some of the pictures taken with the T68i have been used in this thesis; figure 6.1 – 6.8 in section 6.1.1 and figure 7.7 - 7.8 in section 7.1.1.2. (In the electronic version of this document the pictures can be viewed in max resolution by clicking them).

Light is another factor which influences the quality of the pictures. Both of the tested phones required that the pictures were taken in environments which were well-lit. If not the pictures become very dark, making it impossible to see details in them. Thus the use of the phones for taking pictures is limited to daytime outdoors, and well-lit rooms indoors. Some mobile phones have an integrated flash; others can be equipped with one. E.g. the T610 can be equipped with a MPF-10[8]. Neither mobile phones with flash nor 'click-on' flash been tested. The phone displays are also sensible to light; it is difficult to

see what is displayed on them in direct sunlight. This is a common problem with mobile phones and PDAs. Newer mobile phones have displays which are less sensible to sunlight, these phones have, however, not been tested in this thesis.

Currently, there seems to be a 'race' between the mobile manufacturers about who can produce the phones with the best displays and the best cameras. E.g. Sony Ericsson has announced that they will release a mobile phone with a 1.3 mega pixel (1280 x 960 pixels) camera, S700[9], it is depicted in figure 6.11. This phone will also has an integrated flash. The increase in picture quality which these phones will introduce will have a strong influence on the usability of these pictures. There is also a trend that new phones come with much larger displays. This does not mean, however that the phones necessarily are bigger; many of the phones have a 'flip-cover' where the keypad is on the inside of the cover and can be hidden when it is not used. The S700 will also be the first mobile phone with a display with a color-depth of 262k colors. This issue will also have a strong influence on the use of mobile phones to take and communicate pictures, since pictures can be viewed in more detail on the mobile phone display. One of the problems with previous and current camera phones, e.g. T610, is that the display is 'shy to light', the display of new camera phones like S700 will be much better in sunlight than their predecessors.

The focus of this thesis is the potential use of pictures sent between workers in nomadic work environments. MMS does, however, make it possible to send text, sound clips, animations and video clips as well. Many of the mobile phones on the market and mobiles which have been announced, e.g. S700, can record short video clips. This functionality has not been tested. The case studies didn't either uncover a need for such functionality. Both of the mobile phones which were tested could be used to record sound clips. This functionality was tested, but not investigated in the case studies.

The Gartner research agency predict that by the end of 2006, more than 80 % of the mobile phones that are sold in USA and Western-Europe will have integrated cameras[10]. The CEO of NetCom, Barbara Thoralfsson, believes that the use of MMS will really 'take off' when more than 80% of the mobile phones have integrated cameras[11]. In addition to MMS-enabled mobile phones, it will soon be possible to send MMS messages with landline phones as well; Siemens have recently announced a wireless landline phone with an integrated camera and functionality which allows sending and receiving MMS messages[12].

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8   Sony   Ericsson   Phone   flash   MPF   –   10:
http://www.sonyericsson.com/spg.jsp?cc=gb&lc=en&ver=4000&template=pp4_1_1&zone=pp&lm=pp4_1&pid=10059
9 Sony Ericsson S700 homepage: http://www.sonyericsson.com/s700/, Dagbladet article (in Norwegian): http://www.dagbladet.no/dinside/2004/03/09/392942.html
10 According to Nettavisen: http://pub.tv2.no/nettavisen/it/article194789.ece (in Norwegian), Gartner's homepage: http://www.gartner.com
11 According to Dagens Næringsliv: http://www.dn.no/forsiden/article66148.ece (in Norwegian)
12 Newspaper article (in Norwegian): http://pub.tv2.no/nettavisen/it/article194484.ece

In section 7.3, the evolution of mobile phones will be discussed further using the concept of digital convergence. The mass scale of mobile phones, mobile phone services and multimedia messaging will also be discussed.

5.2   Creating, sending and receiving multimedia messages

MMS messages are created through combining pictures, text and sound clips into one message. An MMS message is meant to be a presentation where pictures, sound and text form a whole; the elements are presented together not as separate elements. However, the focus of this thesis is not on how such messages are created and sent, the focus is on the potential of MMS messaging in work environments. The investigation of the work environments in the case studies show that the ability of sending pictures between mobile phones and from a mobile phone to a PC is the functionality which has the greatest potential. Therefore this is the focus of this discussion as well.

The process of creating an MMS message is dependant on which mobile phone is used. The mobile manufacturers have designed slightly different software for creating multimedia messages. The software has also been updated or changed several times to make it as easy as possible to create and send an MMS. The phones that were tested for this thesis, Sony Ericsson T68i and T610, have very similar ways for creating MMS messages. The T68i software has been used to create QuickShare. QuickShare is an updated version of the MMS software in the T68i and is used in T610 and in the future S700 phone. The idea is that it should be as easy as possible to send an MMS.

The phones that have been tested offer two ways of sending MMS messages; 'the old fashion way', and QuickShare. 'The old fashion way' means that a message is sent similarly to the way an SMS or an e-mail is sent; the message creator program is opened, picture, text and sound elements are added, the recipient(s) are chosen, and the send command sends it. The message creator program is opened by going through the menus; first go to main menu, then messaging menu, then picture menu, then 'create new' is chosen. QuickShare makes it possible to send a multimedia element directly without going through the menus. When a picture has been taken with the camera, two alternatives are given on the display; 'save' and 'send'. To QuickShare is to choose the send command directly. When send is chosen the message creator program is opened with the picture already inserted. It is then possible to add additional elements or just proceed to choosing the recipient and send the message. All pictures are stored in the 'My pictures' catalogue (a menu item) and can be sent directly using QuickShare as well, i.e. a picture is opened and you can choose the send command which opens the message creator program with the picture inserted in the message. QuickShare can be used in the same way to send a sound clip when it has been recorded or from the 'My sounds' catalogue.

When the recipient receives an MMS it can be opened instantaneously, just like with an SMS; i.e. when a new message arrives the display prompts "New message <Senders name> Read now?" and gives the possibility to choose 'yes' or 'no'. If 'yes' is chosen the

message is displayed, if not it can be opened at a later time by going to the picture message menu (described above) and choose 'Inbox' and then 'Read'.

Chapter 6

Work praxis in the work environments

"Taking a closer look at all the tasks which may be involved in mobile work involves, amongst other things, detailing the actual practices of traveling, habits around acquiring and analysing [sic.] particular types of information, considering the specific features of the spaces in which people are mobile, and the nature of people's communication ties."

Churchill and Wakeford (2001, p. 165)

In chapter 3, the research approach and a detailed description of the data collection phase for this thesis was presented. In this chapter, the work praxis in each of the case studies is described. The descriptions are aimed at giving an overview of the key aspects of the work praxis in the companies which are part of the case studies. The focus of the descriptions is on the work praxis of the nomadic workers and their use of communication media to handle the flow of information. Other people and technology is only mentioned when they influence the work praxis of the nomadic workers. In the discussion chapter, chapter 7, these descriptions are used as a basis for the discussion.

6.1 Working with pipes and screws

Plumbcomp has its office building at the center of a medium-sized Norwegian town. The store where bathroom appliances etc. is sold is located in the same building. A warehouse where parts like pipes and screws are stored is also located in the office building. The work praxis at Plumbcomp is centered on assignments which involve installing or fixing plumbing at private residences. Most assignments require only one plumber working for one or a few hours. Some assignments, e.g. installation of plumbing at a new factory, involve several plumbers working for at prolonged period. The work carried out by the plumbers, however, is only one of the aspects of the assignments. Assignments are received, delegated, carried out, priced and invoiced. Below is a description of the 'lifecycle' of an assignment. The description is based on the observation of work praxis and on several interviews. The figures that are used to illustrate the work praxis in the description are pictures[13] that have been taken during the interviews and observation[14]. A Sony Ericsson T68i mobile phone with a 'click-on' MCA-20 camera was used to take the pictures.

6.1.1 Work praxis at Plumbcomp

Most assignments are received by telephone calls to the office. Some are received when customers call or visit the store; others are received by the plumbers by calls from customers who they have worked on assignments for on previous occasions. New orders

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13 Click the pictures to enlarge them (electronic version of this document only).
14 A thumbnail gallery of the pictures can be found here: http://folk.uio.no/aresolbe/Plumbcomp_pictures/.

are registered in the economy program, figure 6.1, on a computer in the office by one of the foremen when the customer calls or when the foremen receive the assignment description from someone else, e.g. a shop clerk or a plumber. Foremen are plumbers themselves, but they have additional administration responsibilities. The foremen print out an assignment note, figure 6.2, a piece of paper with assignment information like the name, address and telephone number of the customer and an assignment number. This note is then assigned to a plumber by placing it (the foreman places it) in the 'slot' with that plumber's name on the assignment board, figure 6.3 and 6.4, in the office (same room as the above-mentioned PC). The assignment board is a matrix with the plumbers' names as rows and working-days as columns. The assignment board can hold assignments for three weeks. The PC that is used to register orders is linked via LAN to the PC in the stock room and the PCs used by administrative employees in charge of generating invoices and calculating salaries.
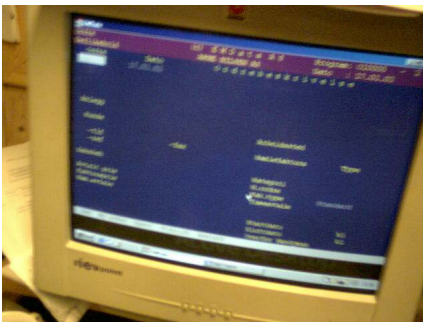
Figure 6.1: PC with economy program for registering new assignments.

Figure 6.2: Assignment note.

Figure 6.3: Assignment board.   .

Figure 6.4: Assignment board (close-up).

Before and after each assignment all plumbers stop by the office. There they look for assignments in their 'slot' on the assignment board. Sometimes they also receive assignments 'ad-hoc', i.e. directly from the foreman when the costumer calls or if the foreman chooses to re-assign the assignment (take it from the 'slot' that belongs to another plumber). The foreman then describes the details of the assignment to the plumbers. Sometimes if something is unclear, e.g. the address, the plumber phones the customer using a fixed line phone. The plumber then enters the information on the assignment note, e.g. assignment number, name, address and telephone number of the

customer, into the Blueapp application on his personal pocket PC using the keyboard or the 'touch-screen pen'.

Then the plumber goes to the stock room to get the parts needed to complete the assignment. In the stock room, all the parts are stored in boxes on shelves. Each box has a description of its contents, its price per piece and a barcode on them. The plumber attaches a barcode scanner to the pocket PC and scans the barcodes of the parts he will need, all the parts needed are thereby registered to the right assignment in Blueapp, figure 6.5. Prior to the introduction of Blueapp the barcode scanner was connected directly to a PC connected to the LAN, and the parts were registered directly to an assignment in the economy program.

The plumber then drives to the customer, all plumbers have their own company car, and completes the tasks. The nature of the tasks varies from e.g. fixing a faucet that is leaking to installing a new toilet. When the task is completed, the plumber has to complete a checklist in the Blueapp application in order to say what has been done. One of the issues on the checklist is to register hours spent on the assignment and the kilometers driven (to get there and to get back to the office), another is to register that the rules and laws that regulate the tasks that have been performed have been followed. The customer then signs his/her name in Blueapp, i.e. on the touch-screen, to document that the job has been done. When the plumber returns to the stock room the barcode scanner is used to subtract the parts that were not used from the registered amount in Blueapp. For small jobs the plumbers sometimes register the assignment in Blueapp after they return to the office. This they do because it is easier just to register the few parts used when they return instead of registering and then subtracting parts not used afterwards. If this is the case, the customer signs the assignment note instead of signing in Blueapp.

Figure 6.5: Pocket PC with scanner attached, in use in the stock room.
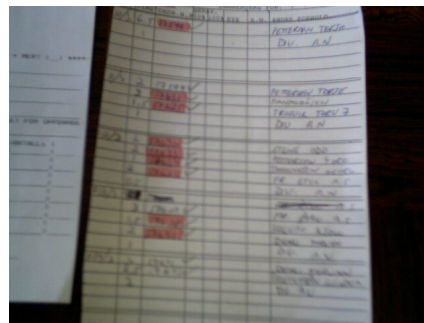
Figure 6.6: Week summary.

After each assignment, the plumbers write the number of hours spent on the assignment and kilometers driven by car to get to the customer on the assignment note, if the customer signed the assignment note the hours and kilometers are already on it. In addition to the assignment number, name of the customer and the number of hours spent on the assignment is written on the week summary document, figure 6.6. These two documents are kept in the plumber's shelf in the office (blue shelf on the left of figure 6.3). Each Friday, all the information in Blueapp on the pocket PCs is transferred into the economy program. This is done by docking the pocket PC, the docking stations are

located on a shelf below the order board, figure 6.3 and 6.7. In order to assure that the information in the pocket PCs is 'assigned' to the right assignment in the economy program, the assignment number and name of the plumber assigned to the assignment has to be registered first in the economy program on the PC where the assignment was registered, figure 6.1. This process usually requires both the plumber and the foreman to be present, and it creates a queue in front of the PC each Friday afternoon.

Figure 6.7: Docking station.
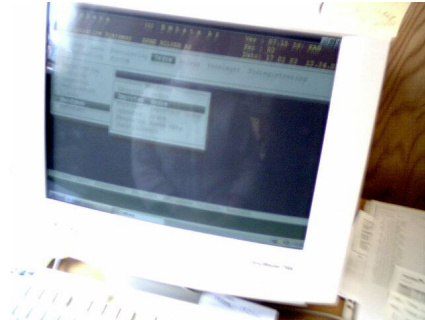
Figure 6.8: PC with economy program for invoice generation and salary calculation.

The administrative employees can then generate invoices and calculate salaries based on the hours, kilometers and parts registered in the economy program, figure 6.8. Before the introduction of Blueapp, the assignment notes and week summaries were used to keep track of the hours spent on each assignment and that each employee had full working weeks (e.g. 37,5 hours). This information is now available through the economy program, however, the administrative employees still use both the assignment note and the week summary to double-check that the registered information is correct.

6.1.2 Comments to the work praxis at Plumbcomp

Even though it is more than 3 years since Blueapp was introduced, the work praxis at Plumbcomp has been subject to only small changes. In order for Plumbcomp to be able to utilize more of Blueapp's potential for rationalizing, the work praxis should have been (or should be) changed. E.g. one of the main complaints by the management is that the plumbers often record information to the wrong assignment, i.e. they record hours spent on an assignment and the parts used on the wrong assignment number. One of the reasons for this is that the plumbers often register the assignment information in Blueapp after they have completed the assignment. This problem can be solved if the assignment information is registered directly in the economy program when it is received by the foreman, and delegated to a specific plumber. This plumber can then just upload the information about the assignment directly by docking his pocket PC when he is to start working on a new assignment. This would make the assignment note obsolete. The need for the week summary note would also be much less, meaning that they probably would stop using them. After the assignment is completed, it would also be easier to upload the assignment information from the pocket PC to the computer, since there will be no need for checking which plumber the assignment is assigned to in the computer before uploading it. This would reduce the time requirement of this process considerably, i.e.

eliminate the queue in front of the computer each Friday. These changes to the work praxis would also make it easier (i.e. encourage) docking the pocket PC more often, e.g. after each assignment or at the end of each working day. This would make it possible to send out invoices to customers faster, and could possibly improve the income of the company. If the assignments are delegated to a plumber when they are received and the plumbers upload information (i.e. dock) their pocket PC more often, the plumbers would also have a better overview of their work schedule since they would have information of several assignments recorded in Blueapp on their pocket PC. Further, this would make it easier for the plumbers to complete several assignments in a row without going by the office between each one. This requires that they bring along the parts needed for each assignment in their car. These thoughts have been presented to the management, however, they still do not want to change the handling of orders in such a way. The main reason for this is that the assignments are very often assigned to someone else, i.e. put into another 'slot' on the assignment board. The management believes that it would be troublesome and time consuming to change which plumbers is assigned to an assignment in the Blueapp application. However, Blueapp is designed for doing so, and it would require little effort.

6.2 Being an electrician: Part A

The service department of Elcomp B has its central office in a medium-sized Norwegian city. The work praxis in the service department is centered on assignments. The assignments differ in both size, manpower required and time to complete, compared to Plumbcomp's assignments. Most assignments are for companies or public institutions, and they usually require several electricians for a long time period. The assignments involve either installation or service related to electronic equipment, e.g. light switches, heating systems, computer installations etc. A description illustrating the 'lifecycle' of an assignment is presented below. The description is based on the interviews of E-A-chief (the chief of the service department), E-A-electrician1 and E-A-electrician2.

6.2.1 Work praxis at Elcomp A

Most assignments are for returning customers, the service department currently has 65 regular customers. New assignments are either phoned to E-A-chief or directly to the electricians. Some electricians have worked on assignments for the same customer for many years and it is therefore more natural for the customer to contact them than the Elcomp B office. When an electrician receives an assignment, he phones E-A-chief. Electricians are not allowed to register assignments in Blueapp themselves. The reason for this is that E-A-chief does not want assignments that might be faulty in the system. While E-A-chief is on the phone with the person phoning in a new assignment, either the customer or an electrician, he registers the assignment information in the economy system in his PC. In most cases, E-A-chief starts the registration by entering the unique customer number (numeric value) of the customer, which he knows by heart or is given from the customer, the electrician or by searching for it in the economy program. Entering the customer number automatically updates the name, address etc. of the customer. If the customer is new, the customer information must be entered manually and

a customer number is generated by the economy system. A unique assignment number is generated by the economy system; this number is used to identify the assignment in the system. The economy program is linked to the Blueapp administrator program so that updates in the economy program immediately are available in the administrator program. The administrator program is used to assign the assignment to one or several electricians. E-A-chief enters the employee number(s), unique numeric value for each employee, which E-A-chief knows by heart or can lookup in a table. E-A-chief completes the assignment registration by pressing a button in the economy application window. The assignment now lays dormant in the system until the electrician(s) which it has been assigned to synchronizes his PDA the next time, then the assignment is loaded into the Blueapp application in his PDA.

The electricians synchronize by first 'connecting' their PDA to their mobile phone using a Bluetooth connection and then information is uploaded from and downloaded to the company's Blueapp server using a GPRS-connection. When an electrician synchronizes, he receives all new assignments which he has been assigned to, this gives the electrician an overview of the assignments he will be working on in the immediate future. Since most assignments require several days (and sometimes weeks and months) to be completed, the electricians usually continue working on the assignment they were working on the previous day when they go to work in the morning. Therefore, they usually start their work-days at the customer's location, i.e. they do not stop by the office first. The actual work done by the electricians each day are task that are needed to be performed in order for the assignment to be completed. Since most assignments involve several electricians working at the same location, there are many tasks that are worked on each day. Some tasks require several electricians, e.g. installing large / heavy electrical systems, others, e.g. installing a light-switch, require only one.

All assignments require the use of parts, e.g. light-bulbs and wires. The parts are obtained from the wholesaler, which is located next to Elcomp A's office building. Each electrician has his own company car which is built to transport and store various parts in. In the Blueapp system, each car is considered to be a 'stock room'. The electricians stock parts that are common in use in their car so that they do not need to travel to the wholesaler each time they are needed in assignments. The content of the cars stock of parts is registered in the Blueapp system, and each electrician is responsible for making sure that the registered information is correct. When parts other than those available in the car are needed for an assignment the electricians visit the wholesaler to buy them. The parts are registered to the assignment number for the assignment they are needed for in the wholesaler's computer system. The parts are invoiced to Elcomp A using an electronic invoicing system, i.e. information about the price, name etc. of parts that have been bought and which assignment they are registered to is sent electronically from the wholesaler's computer system to Elcomp A's economy system. The electronic invoice automatically updates the information in Elcomp A's economy system and the Blueapp application, and an amount equal to the price of the parts is transferred from Elcomp A's bank account to the wholesaler's bank account. When the electrician who bought the parts synchronizes his PDA the next time, the information about the parts are uploaded to Blueapp in his PDA (Elcomp A receives the electronic invoice 1-2 days after the parts are

bought). If some of the parts that have been bought are not required for the assignment, the electrician subtracts them from the amount in Blueapp. If parts are used from the car's stock, they are added to the assignment number in Blueapp and consequently subtracted from the car's stock. Occasionally the car's stock has to be refilled. The parts are then registered to the electrician when he buys them, i.e. his car, and consequently the information about parts available in the car's stock is updated in Blueapp application in the electricians PDA.

The electricians are supposed to register the parts they use in Blueapp when they use them, so that they do not forget to register parts and so that Blueapp is up to date. Each electrician is also supposed to register the hours spent on each assignment each day, to ensure that the hours registered each day is correct and that Blueapp is up to date. The information registered is uploaded to the Blueapp server when the electricians synchronize their PDA using GPRS. E-A-chief wants the electricians to synchronize as often as possible, preferably each day in order for the information in the Blueapp system (i.e. centrally) and the economy system to be as up to date as possible. However, the actual use of the Blueapp system varies from this. Prior to the introduction of Blueapp, the electricians carried with them a note book which they used to register parts used and hours worked each day. This note book is still in use. According to E-A-electrician2, all the electricians carry a notebook and a pen while they are working, and use this for registration. Blueapp is updated with the information from the note book at the end of each working day, meaning that the electricians usually do this after their working day is over, at home.

Both the electricians that were interviewed say that they use the note book for safety reasons; they are afraid that information might be lost from Blueapp. This has happened to them both several times. Information related to an assignment can be lost in Blueapp if the PDA's battery runs empty. There is a backup mechanism that ensures that all new registrations are copied to a Flash memory card when the electrician turns off the PDA, however, backup is not taken when the power is lost due to an empty battery. E-A-electrician2 says that he has experienced that not all information that has been taken backup of is recovered when the PDA is recharged after the battery has run empty. E-A-electrician1 has turned off the backup feature on his PDA, because it takes longer to turn off (backup is taken) and on (Flash card is checked for new data) the PDA. The use of the note book is not new to the work praxis; prior to the introduction of Blueapp the information was registered here as well, before it was reported to the office, e.g. the work-hours were registered in the note book before they were registered on a registration form for work-hours.

The electricians have different habits for synchronization, however, one thing is equal; they all synchronize at least once every other Friday, i.e. biweekly. This they do because they are obliged to submit the hours they have worked for the last two weeks every other Friday in order to receive their salary. Salaries are calculated once every two weeks by the economy department at Elcomp A. Before the introduction of Blueapp the work-hour form was filled out and delivered to the economy department every other Friday. Both the interviewees give the same reason for not synchronizing every day; synchronization

causes all active assignments to 'freeze' in Blueapp on the PDA. It is no longer possible to remove information that is registered to an assignment, e.g. parts used or work-hours. If the parts used that has been registered and 'frozen' needs to be changed, the only way to do so is to subtract an amount that will make the total amount registered correct, i.e. register a negative value in front of the part that is frozen. E.g. if an electrician has registered that he used 60 cm of a specific wire and this information is 'frozen' and he later finds that the correct amount is 30 cm, he must register -30 cm of that specific wire. New registrations of work parts can, however, be performed as usual. E-A-electrician1 says that he always waits 3-4 days before synchronizing, in order to be absolutely sure that the registered amount of parts is correct. E-A-electrician2 was displeased with the fact that all information about work-hours for active assignments were removed (i.e. no longer available) from his PDA when he synchronizes. He therefore has no possibility for checking or editing the registered information in Blueapp. Therefore he feels the need to use the note book to keep track of his work-hours. E-A-electrician2 only use Blueapp to register the hours he work, because he is an apprentice electrician without responsibility of his own assignments and since he does not have to register parts used. He only synchronizes every other Friday, which he must do in order to receive his salary.

When an electrician is finished with an assignment he registers the hours worked on the assignment that day and the parts that have not be registered (if there are any). Then a declaration about which rules and laws apply to the assignment (Norwegian: samsvarserklæring) is filled out. The electrician then has to go through a checklist where he declares what has been done in the assignment, e.g. which tasks have been completed. Finally, the electrician signs his name using the 'pen' on the 'touch-screen'. The next time the electrician synchronizes, all assignments that are completed, i.e. where all the above mentioned steps have been performed, are uploaded. These assignments are no longer available in Blueapp on the PDA. The economy department then uses the assignment information to generate invoices to customers. The economy department used the information about work-hours to calculate the electricians' salaries every other week.

6.2.2 Comments to the work praxis at Elcomp A

Blueapp was introduced at Elcomp A in 1999. The reason for the introduction, according to E-A-chief, was to cut the costs related to the calculation of salaries. This was done by replacing the work-hour forms with the Blueapp system where work-hours can be registered electronically by the electricians on their PDAs and uploaded to the economy system. According to E-A-chief this has proven to be a success, since the economy department's work-load related to the calculation of salaries has been reduced considerably. Additional uses of Blueapp, like registration of parts used on assignments, have also proven to be beneficiary for the administration.

The work praxis at Elcomp A is close to identical to what it was prior to the introduction of Blueapp; before Blueapp work-hour forms were delivered every other Friday, now the electricians synchronize their PDAs every other Friday. The electricians synchronize because they have to do so in order to receive their salary. Based on experience they know that synchronizing involves the possibility of transmitting faulty information (e.g. a

wrong number of parts) and removing the recorded work-hours. Therefore the electricians still feel the need to first register assignment information in their note book and make sure that it is correct before uploading it. Most electricians register assignment information in Blueapp after working-hours, this also causes some frustration. Elcomp A might benefit from examining the actual work praxis of their workers closely and try to change the work praxis. Especially they should encourage, or perhaps demand, that Blueapp is updated each time new assignment information is available, e.g. if a part is used. This would reduce, or possibly, remove the need for the note book. Elcomp A might also need to contact Blueapp Corp. and ask if they can improve the aspects of the application which the electricians find problematic, e.g. that active assignments 'freeze' when the electricians synchronize. If these aspects are improved the administration, i.e. E-A-chief, could demand that the electricians synchronize more often, e.g. each day. This would make the information in the Blueapp system more up to date, making it possible to generate invoices to customers quicker. In addition, the electricians will receive new assignments which have been delegated to them earlier, which will give them an overview of their future work schedule.

The fact that most electricians only synchronize every other Friday also results in additional problems. All electricians synchronize at the end of their work-day every other Friday in order to receive their salary. This results in a queue on the server when everyone is synchronizing using GPRS. This might be fixed by implementing more 'threads' on the server. A few of the electricians, e.g. E-A-electrician2, have not been given mobile phones which can be used for synchronization (i.e. with GPRS- and Bluetooth-functionality). These electricians, mostly apprentices, have to travel to Elcomp A's office building and synchronize using a cable or a docking station. E-A-electrician2 finds this very frustrating, especially if he is working on an assignment in another city. There is usually also a queue for using the docking station. They feel that is it unfair that they have not received their own phones for synchronization, giving this to them would eliminate some of their synchronization problems.

Some of the electricians have found ways to ease the use of Blueapp. E-A-electrician1 is considered to be a 'power-user' by E-A-chief and the other electricians. He has e.g. made several lists in Excel which he uses to reduce the time it takes to registers parts that he uses in assignments. He also has created several shortcuts and habits for 'cut and paste' which ease the use of Blueapp. Elcomp A might benefit from having some meetings where the electricians can discuss their experiences and thoughts about the system.

6.3   Being an electrician: Part B

Elcomp B has its office building in Oslo. Similarly to the Plumbcomp and Elcomp A case, the work praxis at Elcomp B is centered on assignments. The assignments vary in duration and size, i.e. electricians needed. Some assignments require only one electrician for less than an hour, while other assignments require several electricians for a year. Elcomp B's customers are companies, e.g. a law firms, and institutions, e.g. a public school). Most customers are located in Oslo or the surrounding area; however they also have customers in other parts of the country. The nature of the assignments is equal to

Elcomp A's assignments; installation or service related to electronic equipment. In fact, the work praxis is very similar to that of Elcomp A. Therefore the focus in this subsection is on the differences, issues that are equal to what has already been described in section 6.2.1 is not described in detail here.

The work praxis at Elcomp B was investigated a short time before the introduction of Blueapp and 2 months after the introduction. This made it possible to discover some of the problems which can occur when a new medium introduced in a work environment. Below is a description of the 'lifecycle' of an assignment. The description is based on interviews with E-B-chief, the chief of Elcomp B, both prior to and after the introduction of Blueapp, and an interview with two electricians about their work praxis before and after the introduction.

6.3.1 Work praxis at Elcomp B

New assignments are received at the office by administrative employees, who also are responsible for updating the economy program (i.e. type inn all assignment information). When the assignment information has been entered into the economy program, an assignment note is printed out. This is also the same as what happened prior to the introduction of Blueapp. Now, in addition, the assignments are assigned to one or several electricians using the Blueapp administration program.

Most electricians come by the office each morning to receive new assignments. Some electricians are working on long-term assignments, and therefore do not need to stop by the office. The ones that stop by the office synchronize their PDAs each morning, wirelessly, inside the office. By doing this they receive (download) new assignments and send (upload) assignments which have been completed. When they synchronize information about hours worked on assignments and the parts used is uploaded from the PDAs to the Blueapp server, and can be used to calculate salaries and generate invoices. The process of synchronizing each morning is new after the introduction of Blueapp, prior to the introduction the electricians only received the assignment notes for the assignments that they had been assigned to. Now, the electricians can choose if they want to receive the assignment note for the new assignments in addition to downloading the information to their PDAs. Most electricians do this in order to have a physical representation of the assignments. Occasionally, the electricians receive new assignments while they are out in the 'field', i.e. not at the office, by telephone calls from an administrative employee at the office. The electricians are in these cases given an assignment number which they register as a new assignment in Blueapp. They also receive information about the nature and location of the assignment. They do not, however, register this information into Blueapp, this is updated automatically when they synchronize the next time.

The electricians have company cars. They have different types of cars; some electricians who mostly work on service assignments have cars with a large stock of parts, however, most of the electricians' cars have only a basic selection of parts. For small assignments, the electricians often only need parts that they have in their cars, for larger assignments

additional parts must be bought from the wholesaler. The electricians travel to one of three wholesalers, which are all situated in Oslo. After they have picked / asked for the parts they need, the wholesaler registers this information to the assignment number in their computer system. An electronic invoice is sent to Elcomp B, resulting in that the assignment information in Elcomp B's economy system is updated. In addition, information about the parts that have been bought is transmitted from the wholesaler's computer system to the electricians' PDAs using a wireless connection.

Both E-B-electrician1 and E-B-electrician2 say that they update assignment information in Blueapp after the assignment is finished for short assignments and at the end of their work-day for assignments that last several days. When parts are used during an assignment they either memorize it or write it on the assignment note. When assignments are completed the electricians register work-hours and parts not yet registered and complete the declaration and checklist, as described in the Elcomp A case. Information about completed assignments is uploaded to the Blueapp server the next time the electrician synchronizes his PDA. All electricians, even those who do not stop by the office each morning, must go to the office each Monday to synchronize. The electricians' salaries are calculated and the customers' invoices are generated by the administrative employees using the assignment information in the economy system.

6.3.2 Comments to the work praxis at Elcomp B

All in all, the work praxis is very similar to the work praxis at Elcomp B. However, not all the problems that were mentioned by the electricians at Elcomp A as were mentioned by the electricians at Elcomp B. In particular E-B-electrician1 and E-B-electrician2 did not mention problems relating to assignment information 'freezing' or disappearing when they synchronize. One of the reasons for this may be that they synchronize more often than what is the case at Elcomp A, something that results in the system being constantly updated. The electricians at Elcomp B did, however, mention having problems when the battery of the PDA runs empty. If this happens they usually need some of the software to be re-installed, an administrative employee helps them with this. They did not mention problems related to information disappearing when the battery ran empty, the reason for this may be that the amount of information only stored in the PDA is much smaller since they synchronize every day.

6.4   Working at a construction site

Constructcomp has its main office in a small Norwegian town. The work praxis is centered on large construction assignments which require many different kinds of workers, e.g. carpenters, masons etc., for a long time period to be completed. The company usually has several active assignments at any given time. The workers work on each assignment for a period of time only, since e.g. masons are not needed throughout the whole construction project, before being relocated to another assignment. Most workers seldom stop by the office. They start and end their work-days at the construction site.

Below is a description of the work praxis. Since all the assignments requires the workers to work on the same assignment for a long period of time, a general description of the work praxis is more suited than a description of the 'lifecycle' of an assignment. The description is based on the interview with a construction site chief, C-chief.

6.4.1 Work praxis at Constructcomp

Quite different from the other cases, there exists a clear, multi-layer hierarchical organizational structure at Constructcomp. The organizational structure is illustrated in figure 6.9.
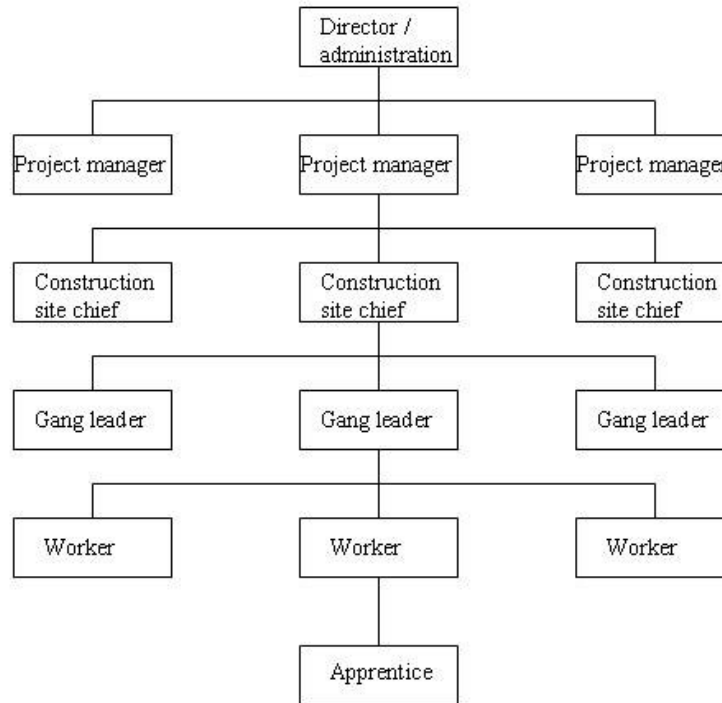
Figure 6.9: The organizational structure of Constructcomp.

The director and the administrative employees are responsible for issues that relate to the administration of Constructcomp as a whole, they are not directly involved in the specific assignments. The project managers are in charge of securing new assignments for Constructcomp. When a new, large construction project, e.g. the building of a hospital, has been decided by a company or institution, a description of the project is sent to the leading entrepreneur companies in that region. When Constructcomp receives a project description, a project manager makes an offer (Norwegian: anbud) to the company or institution. This offer includes the price Constructcomp will charge for completing the construction project and an estimated timeframe. If Constructcomp's offer is chosen by the company or institution, hereafter called the customer, Constructcomp assigns a construction site chief to the project. The construction site chief receives all plans and drawings related to the assignment and most of the responsibility for completing the assignment is given to him. The construction site chief then assigns workers to the assignment. Constructcomp employs different types of blue-collar workers, e.g. masons and carpenters. They do not, however, employ all kinds of workers that are needed for the

construction projects. Some workers, e.g. plumbers and electricians, are only needed for a short time period at a time, therefore Constructcomp hire these workers from other companies when they need them. Some of the workers at Constructcomp have an apprentice. The employees are paid by month, and therefore they do not need to fill out work-hour forms.

Constructcomp has contracts with wholesalers which deliver all the materials needed to construct the building(s) in the assignment. Most of the materials are delivered directly to the construction site, e.g. large concrete elements for walls, toilets and screws.

The work-days at the construction site usually differ from day to day. What is done one day determines what can be done the next, since all tasks usually have a set of requirements before they can start. E.g. the walls have to be put in place before the roof. The construction site chief has a number of gang leaders (Norwegian: bas) working for him. They are in charge of different aspects of the construction assignment. E.g. one gang leader is in charge of the second floor of the building under construction, while another is in charge of the third and fourth floor. Each gang leader has a number of workers and apprentices working for him. How many workers a gang leader has working for him varies from gang leader to gang leader. The gang leaders are also responsible for making sure that additional workers are hired by C-chief, e.g. electricians, and for supervising their work tasks.

According to C-chief, his days are not filled with routine; his tasks vary from one day to the next. Most of his tasks are performed in his office at the construction site. His main tasks are: to be up to date on the events on the construction site, to plan what needs to be done next and to adjust these plans when needed, to document the work that has been done, to make sure that laws and regulations are followed, to report the progress to his superiors, to order material and to make sure it has been received, and to check the work-hour forms for hired (external) workers. C-chief has regular meetings with the gang leaders every other week. At these meetings overall progress is discussed and the work plans are adjusted if needed.

The workers and the gang leaders work in teams at relatively small spaces. Hence, they mostly communicate orally without the need for ICT. If they need to use ICT to communicate, they usually use mobile phones or walkie-talkies. SMS is also used quite often. The C-chief and the gang leaders have all been offered PDAs to support them in their work. Few of them use the PDAs regularly in their work praxis. C-chief uses his quite often; however, he usually prefers to use his laptop.

Because of strict laws and regulations regarding the construction of buildings, one of the most important aspects of the work tasks of all workers at a construction site is documentation. All the workers have to go through a checklist every day where they register what they have done and that the applying laws and regulations have been followed. This usually requires 10-15 minutes at the end of each work-day for each employee.

6.4.2 Comments to the work praxis at Constructcomp

The work praxis at Constructcomp is quite different from the work praxis in the other blue-collar work environments. These differences are discussed in chapter 7.

6.5   Soda salesmen

Brewcomp's sales department for the Oslo region has its office building in the Oslo region. This department currently is in charge of beverages (e.g. beer and soda) in 580 grocery stores in the Oslo region. To manage this large quantity of stores a hierarchical organizational structure is used, this is illustrated in figure 6.10.
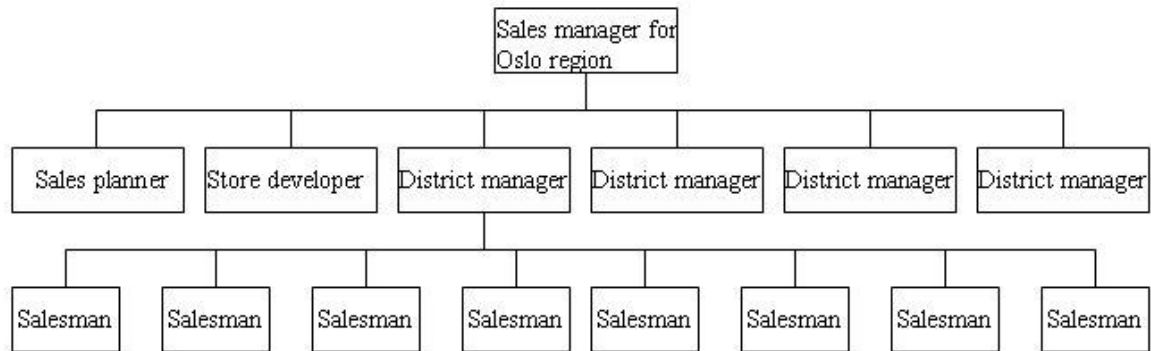
Figure 6.10: The organizational structure of the Oslo region sales department.

> "I use a lot of time on employees, employee conflicts, supervision, you are supposed to have summaries of everything ... sales statistics, keep track of them, guidance, where the district mangers are, coordination with the store chains, also with the logistics department, who delivers where" (B-chief)

The sales manager's, B-chief's, work praxis is mostly concerned with administration. He says that "everything concerning employee issues is my responsibility". He has delegated the responsibility of sales in the stores to four district managers who is each in charge of one area within the region. Further, he coordinates with the store chains, e.g. REMA 1000 and Rimi, regarding the stores. B-chief makes plans for when each store shall have beverages delivered, e.g. Rimi Stovner has deliveries on Mondays, Wednesdays and Fridays. He also has to coordinate regularly with the logistics department in order to make sure that the beverages are delivered to the stores according to these plans. In addition, he must make plans for how large quantities of each beverage he will need each week, e.g. how much Sprite his region needs in July, and contact the production department to make sure these quantities are produced in time. B-chief also has a secretary, a store developer and a sales planner working for him. The secretary helps him with the administrative work load. The store developer is in charge of building the beverage department when new stores are built. They receive drawings of the layout of the stores with indication of where the beverages will be from the store chain. Based on this, they plan how the beverages should be displayed and implement these plans in the stores together with the respective district manager and the salesman who will be in charge of the store.

The sales planner, B-planner, is in charge of planning the activities for the 33 salesmen. He does this using the PLAN[15] system. B-planner shares an office with two other sales planners (for the Østfold and Hamar regions) in Brewcomp's office building. PLAN has been designed and implemented for Brewcomp. B-chief says that "I believe that [Brewcomp] have patented I, I am a little uncertain regarding that, I would be surprised if they have not patented it". PLAN is used to organize all factors relating to the sale of beverages at Brewcomp. All the grocery stores, Brewcomp's customers, are registered in the system with standard information about address, phone number etc. In addition, specific information for each customer is registered, i.e. that the elevator that the drivers use to deliver the beverages at ICA Linderud takes approximately seven minutes to call and ride from the basement to the ground floor. In the logistics department, PLAN is used to organize transportation of beverages to the stores. All the drivers and their trucks are registered in the system. The sales planner at the logistics department (not the same person as B-planner) use PLAN to organize the amount of beverages that the drivers need to bring to the grocery stores each day. This use of PLAN has, however, not been investigated in detail and is not the focus of this case.

B-planner, who works in the sales department, has registered all the salesmen in PLAN. Information such as mobile phone number, home phone number, company car etc., is registered for each salesman. All salesmen have a series of grocery stores registered to them, these are the stores which they are in charge of. B-planner updates PLAN with information about the salesmen's availability, e.g. if they call in sick this is registered in the system. When a salesman is missing, e.g. sick or on vacation, B-plan needs to replace him. Brewcomp has a contract with a temp / human resources agency, TEMP. Temps, temporal employees hired from TEMP, are all trained in the salesmen's work praxis prior to being hired as substitutes. All the temps are registered in PLAN. When a temp is needed to replace a salesman, B-planner assigns him to grocery stores in the same way he does for the salesmen.

B-planner is the person who plans out the work days for the salesmen, he does this basically based on two factors; the plans for which days each store receives beverages and the orders for beverages for each store. The plans for when each store receives beverages are made by the B-chief. The orders are faxed from the grocery store's fax machine to the order department at Brewcomp by the salesman when he visits a store. The order department is in charge of receiving orders sent by e-mail or fax, and orders that are phoned in, however, most orders are received by fax. The order department employees register all orders received as faxes from the salesmen in PLAN. Hence, the information about orders is available in the system for B-planner to use. Based on these factors, B-planner sets up a work schedule for each day for every salesmen. Some of the grocery stores that sell large quantities of beverages need their salesman to stop by once or twice each week, even though a new supply of beverages has not been delivered, in order to re-fill the shelves and refrigerators in the store. B-planner also needs to schedule these 're-fill visits' to the grocery stores. The number of stores assigned to a salesman

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15 The PLAN system is a pseudonym for the (specific) resource planning system which Brewcomp use to organize the sale of beverages to their customer.

each day varies based on how long time he will need at each store. PLAN automatically calculates this using the order information and pre-defined times in the system. It is estimated that a salesman uses 90 seconds to empty a case with 24 bottles of beverage and display them in a shelf or refrigerator. The number of cases a store receives is multiplied by the time per case, e.g. if the store receives 30 cases it will take the salesman 45 minutes to display these cases. 'Re-fill visits' have predefined times for each store. B-planner usually schedules the salesmen to visit only their regular stores each day. However, sometimes, e.g. when one salesman needs long time at one store to display a large delivery, the salesmen are scheduled to other stores than their regular ones to help out. When B-planner has finished the schedule for the next day, usually around 3 PM, he uses PLAN to send out the schedules to the salesmen. Each salesman receives an SMS message on his mobile phone describing his work schedule for the following day.

The work praxis of the salesmen is described below. The description is based on the observation of the work praxis of B-salesman1 and B-salesman2. The description of the work praxis of B-chief and B-planner presented above is based on an interview with them.

6.5.1 Work praxis at Brewcomp

The salesmen have regular working-hours from 7 AM to 3 PM. However, they are relatively free to adjust their work days as long as they complete their work schedules, i.e. visit all the grocery stores they are in charge of regularly and make sure that the beverage departments are satisfactory filled up at all times. This means that the schedule which they receive from PLAN is not mandatory; however, the administration wishes for the schedules to be followed as much as possible. The schedules for when different stores should be visited are based on when the beverages will be delivered to the stores. B-salesman1 says that for new employees and temps it can be hard to know when the drivers (who deliver the beverages) come to the different stores, therefore they would gain from visiting the stores in exactly the way the schedule says.

B-salesman2 says that he usually start his work days at 7 AM. When he wants to get off work earlier he starts at 6 AM. His days vary in length based on the work load; some days he is done by 1 PM, other days he is not finished before 7 PM. B-Salesman1 has chosen to start his work days at 6 AM each day. He does this because he wishes to be done in the stores before they are too crowded by customers. This has an impact on his work schedule since some stores open at 7 AM, while other stores do not open before 9 AM. He knows that the grocery store employees start working one hour before they open, so he starts his work-days by visiting one of these stores at 6 AM.

B-salesman1 does not follow the schedule which he receives from PLAN. He has worked as a salesman for over two years. Based on his experience with his regular grocery stores, knowledge about when the drivers come to each store and knowledge about the situation (i.e. fill-level) in his stores, he determines his own work schedule. He usually looks through the schedule he receives as an SMS message each afternoon to check if he has been assigned to other stores than his regular ones. B-salesman2, who has been working

as a salesman for nine years, follows the schedule loosely. When needed he alters his work schedule to cope with the situation at hand, i.e. if a driver is late he goes to another store where he only needs to re-fill the display of beverages while waiting for the delivery of beverages.

The salesmen are in charge of approximately 8-10 stores each. E.g. B-salesman1 is in charge of 9 stores. He visits 4-5 stores each day. Some of the stores he visits twice a week, others he visits three or four times, depending on how much beverage is sold in the store. Some of the visits are 're-fill visits' while others are to manage new deliveries. The number of deliveries each week varies from store to store, based on the sales. When the salesmen visits the stores they check the stock of beverages and order more if needed. They do this by sending a fax to the order department at Brewcomp. They use the store's fax machine for this.

All salesmen have company cars which they use to travel between the stores. They go straight to one of the stores when they start their work day, they do not stop by the office. Unlike B-salesman2 and most other salesmen, B-salesman1 usually do not use his car when he travels between stores. He said that because his stores are located in close proximity of each other he prefers to roller-skate between them. His stores are all located in the centre of Oslo, and he therefore experiences problems with traffic jams and finding a parking spot. "Roller-skating takes less time", he said. When he goes to work in the morning he usually parks his company car in a parking garage close to his stores, and put on his skates. This praxis is of course season-based, during winter he uses his car as everyone else.

All the salesmen have been given mobile phones which they use to communicate with co-workers and customers. It has been estimated that they will use 5000 kroner a year each on mobile phone use. If they use more, the amount is subtracted from their salary. They usually talk with their district manager once a day on the phone. They also try to meet with him face to face regularly. Once every other week all the salesmen, the district managers and the region manager have a meeting at the office. For many of the salesmen this is the only time they stop by the office. There usually is not any other need since they are paid per month and therefore do not need to register work-hours.

The PLAN system is meant to make sure that each of the salesmen's work-days is filled, i.e. that they have tasks that require them to work 7.5 hours each day. According to B-salesman1, the schedule he receives from PLAN gives him some 'slack', i.e. the time estimated is usually much longer than the time he actually uses. E.g. the system estimates that it takes 90 seconds to empty and display a case of beverages; B-salesman1 thinks that this must be an estimate of how fast it takes if one use one hand and take one bottle at a time. He takes four bottles at a time and therefore uses far less time. When the salesmen are done with their work-load for a day early, they usually call B-planner to ask if someone needs their help. Likewise if a salesman needs help be able to visit all the stores, he contacts B-planner to see if someone can help him. Some of the salesmen help each other out regularly and contact each other directly when they need help. B-planner

either calls the salesmen or uses an Internet service to send out SMS messages to the salesmen when someone needs help, and to give other immediate messages.

6.5.2 Comments to the work praxis at Brewcomp

The sales department started using PLAN to organize the work-days of the salesmen in the summer of 2002. The logistics department started using PLAN to organize the work of the drivers in 2000. Both B-salesman1 and B-salesman2 have been working as salesmen since before the introduction of PLAN. The PLAN system has to little or no extent changed the work praxis of the salesmen. B-salesman1 said that the work praxis is identical to what it was prior to the introduction. He says the reason for this is that most of the salesmen pretty much choose to work by the schedule which they think is the best.

Prior to the introduction, the salesmen were given schedules as paper documents. The introduction of the PLAN system has not changed the work praxis of the salesmen noticeably. The administration, i.e. B-chief and B-planner, is aware of this and wishes that the schedules would be followed by the salesmen. PLAN is intended to make the work-load of the salesmen as fair as possible, i.e. that the salesmen have the same work-load and that one salesman's work-load does not vary from one day to another.

The old system, the paper document version of the schedules, is the backup system if PLAN should malfunction. The district managers have paper copies of the schedules for each salesman which can be used in case of e.g. computer failure.

A new computer system which will co-exist with PLAN is under development. This system is meant be an 'add-on' to the functionality in PLAN; the most important addition is that the salesmen should be able to order beverages for a store electronically. This would make the order department obsolete. B-chief said that: "the goal is that all salesmen should have their own PDA. It is a bit awkward the way it is now; they get SMS messages on their mobile phone. Then we will send the work schedule, information about campaigns [e.g. a summer campaign for Pepsi where advertisements etc. will need to be put up in the store], and they will be able to send the order using the PDA [and a GPRS connection]".

Chapter 7

Discussion

In this chapter, the collected data material, presented in chapter 6, is discussed in relation to the research problem for this thesis. The theoretical framework presented in chapter 4 is used to analyze the data. In addition, related literature is discussed in relation to the findings of this thesis. The chapter is divided into sections were mobility issues, the use of communication genres, and multimedia messaging is discussed in separate sections. The first section, section 7.1, is a discussion regarding mobility of people and technology in the work environments. In section 7.2, the use of communication genres to handle the flow of information is discussed. Genres of multimedia messaging and their potential in the work environments are discussed in section 7.3. Finally, in section 7.4, issues of mobility, genres and MMS are discussed in relation to each other.

7.1   Mobility in the work environments

The descriptions of work praxis in chapter 6 showed that mobility is an important factor in the work environments. The workers need to travel between locations and they wander around while they are visiting a location. The technology, e.g. ICT, they use supports different types of mobility. In order to understand the work praxis and the use of communication genres in the work environments, it is important to investigate the mobility of both people and technology in the work environments.

Work praxis in all the companies that were investigated can with a general term be called service work. The service work requires that the workers travel to the customer's location and perform some service. Using Kristoffersen and Ljungberg's (2000) concepts the workers can be called mobile, because their work tasks require them to move. In addition, three types of mobile modalities are present in the work environments; traveling, visiting and wandering. Because of the mobility of people that is found in the work environments, they fit the description nomadic work environments (Julsrud et al. 2002). In section 7.1.1, the workers' movement between remote locations, traveling, is discussed. The praxis of moving around while visiting at he customer's location, wandering, is discussed in section 7.1.2. The workers also need to use technology in their work praxis, e.g. they register information in Blueapp and they talk to co-workers using their mobile phone. The mobility feature of the technology that is used is discussed in section 7.1.3, using Luff and Heath's (1998) concepts of physical mobility. In section 7.1.4, the different roles that the workers and the technology have in different contexts are discussed as social mobility (Lyytinen and Yoo 2001).

7.1.1 Assignment networks: The cycle of traveling and visiting in the work environments

The workers start their work-days by traveling; they leave their homes and travel to either the office or directly to the customer's location. Where the workers start their work-days is dependant upon the length of the assignments and knowledge about which customers that should be visited that day. The work praxis is different in the various companies. The work-days involve a cycle of traveling and visiting; e.g. first the worker travels to the office which he visits it for a while, then he travels to a customer which he visits for a while etc. Since the workers praxis is centered on assignment, one can say that way the cycle of traveling and visiting form an assignment network. In this network, the locations which are visited are the nodes and the actual traveling is the edges / lines which connect them. The analysis of the work praxis of the nomadic workers shows that there are two distinct types of assignment networks: traveling-based and visiting-based. A traveling-based assignment network is a network with many nodes and connecting edges. The workers in the work environments which have traveling based-assignment networks work on many assignments each day. The assignments usually only require one worker for a limited time, usually 1-2 hours or less, to be completed. Each assignment is for a new customer, which the worker needs to travel to. The assignment networks also vary from day to day since different customers and a different number of customers are visited each day. The workers usually work alone when they are visiting a customer's location; hence the individual work context (Grudin 1994) is the most common. A visiting-based assignment network is a network with few nodes and connecting edges. The workers in work environments which have visiting-based assignment networks work on the same assignment for a long period of time. The assignments usually require several workers for several weeks or months to be completed. The assignment networks are the same each day, since the workers travel to the same customer's location and work there each day. The workers usually work in small groups (ibid.) and this group can be part of a large project (ibid.) at the customer's location, i.e. the assignment is a large construction project where the workers are organized in small groups.

The work praxis at Plumbcomp, Brewcomp, and the work praxis of some of the workers at Elcomp B is traveling-based. The workers at Elcomp A, Constructcomp and the rest of the workers at Elcomp B have work praxis' which is visiting based. Assignment networks have been drawn for the work praxis in each of the nomadic work environments that have been studied; they are presented in figure 7.1 – 7.6 below. The assignment networks are discussed in the subsections below.

7.1.1.1 Traveling-based assignment networks: Stars and circles

The traveling-based assignment networks can be divided into to sub-types; stars-shaped and circular. These sub-types refer to what the pattern of nodes and edges looks like in the figures.

The work praxis at Plumbcomp results in a star-shaped assignment network, illustrated in figure 7.1. The office is the central node, the 'hub', in this network. The plumbers start

their work days at the office. There they are assigned to an assignment and travel to the customer's location using their company car. After the assignment is completed they return to the office, where they are assigned to a new assignment, and so on until the work day is over. The administration at Plumbcomp has deliberately chosen this work praxis for the plumbers. P-chief said that he wants the plumbers to stop by the office between each assignment so that he and the foremen can have an overview over all the assignments. He said that this praxis was possible since Plumbcomp is located in a relatively small city, there are only 10 plumbers, and the number of assignments each day is manageable.
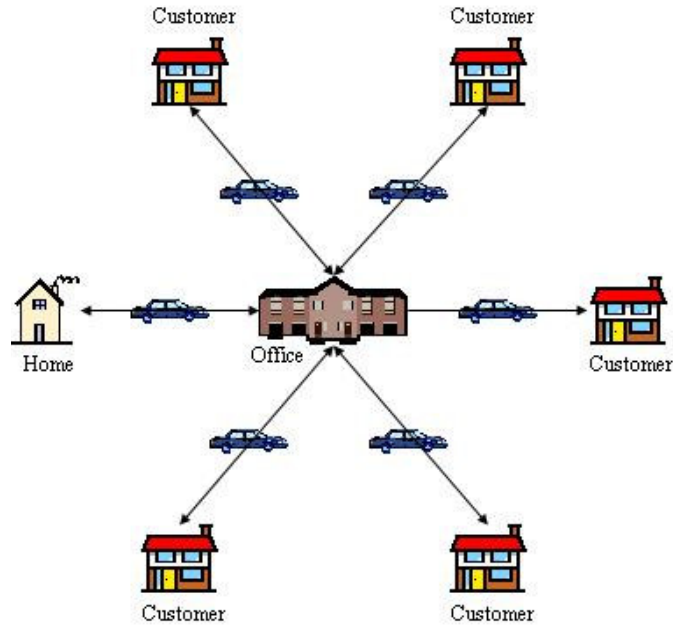
Figure 7.1: Assignment network in the work praxis at Plumbcomp.

The work praxis of the electricians who work on small assignments, visiting several customers each day, at Elcomp B and the soda salesmen at Brewcomp results in a circular assignment network. Both E-B-electrician1 and E-B-electrician2 work like this. The electricians start their days at the office where they synchronize their PDAs and upload all the assignments that they have been assigned to for that day in Blueapp. Then they travel to the first customer on their 'list', i.e. the one that they believe should be visited first. When they have completed their tasks they travel directly to the next customer on the 'list'. When they need parts other than those they have in their company car, they travel to one of the three wholesalers and collect the parts they need. At the end of the day they travel directly from the customer's location to their own home. The assignment network of the electricians is illustrated in figure 7.2. The soda salesmen start their work-days in one of the grocery stores they are assigned to. They decide which one themselves or follow the instruction of the PLAN message that they received the previous afternoon. After they are done with their tasks at one grocery store, they continue to the next store. Occasionally, usually every other week, they travel to the office and attend a meeting with the sales manager, B-chief, the district managers and the other salesmen in their region. All the salesmen have their own company car which they use for traveling between stores. B-salesman1 usually parks his car in a parking garage in the centre of

Oslo in the morning. He then roller-skates when traveling between the stores. At the end of his work-day, he travels to the parking garage, collects his car and travels home. The cycle of traveling and visiting is very similar to that at Elcomp B, illustrated in figure 7.2. The difference is that the salesmen do not start their work-days at the office, and they do not need to visit a wholesaler. The network of assignments resembles a large circle; it is illustrated in figure 7.3. The line that illustrates traveling to the office is dashed since this only occurs occasionally. The assignment network of B-salesman1 is slightly different from the illustration given in figure 7.3; his assignment network is illustrated in figure 7.4.
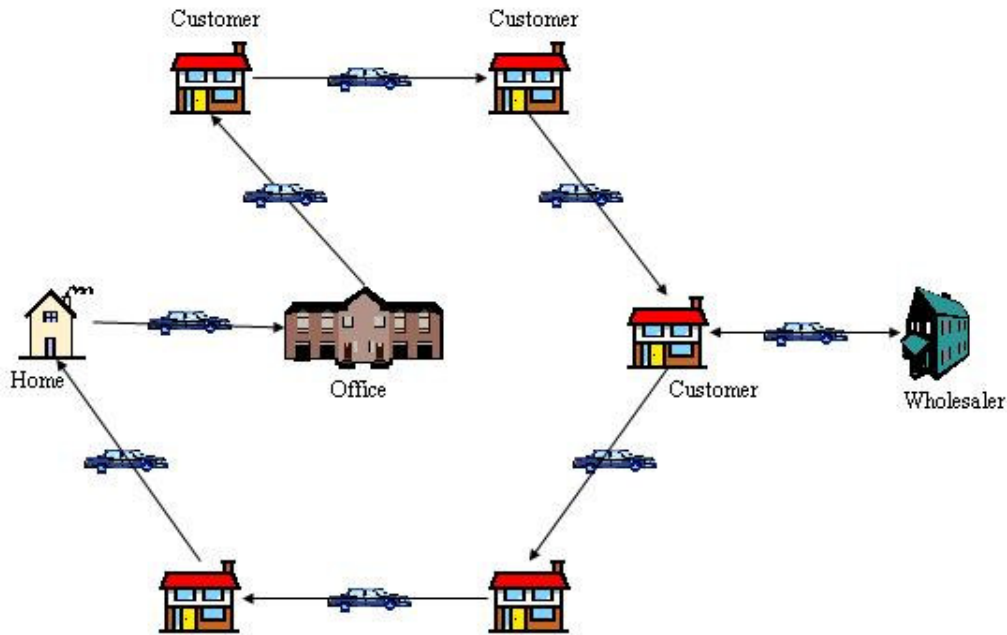
Figure 7.2: Traveling-based assignment network at Elcomp B.
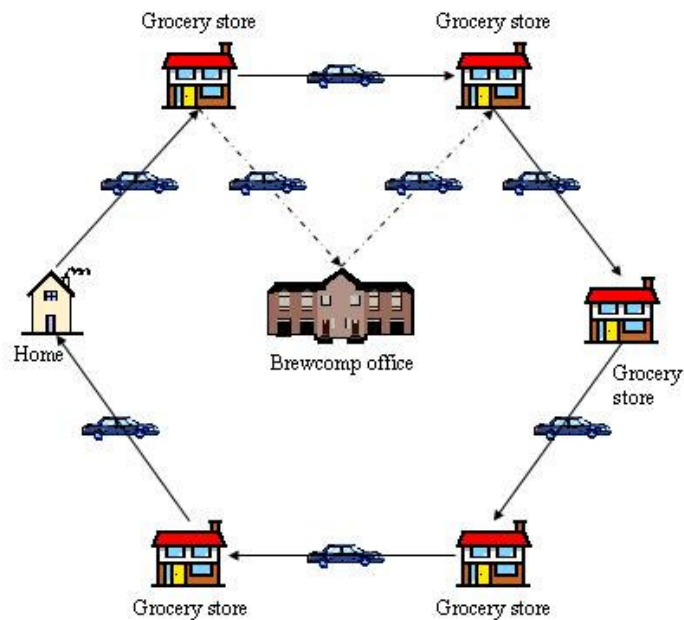
Figure 7.3: Assignment network in the work praxis at Brewcomp: standard.
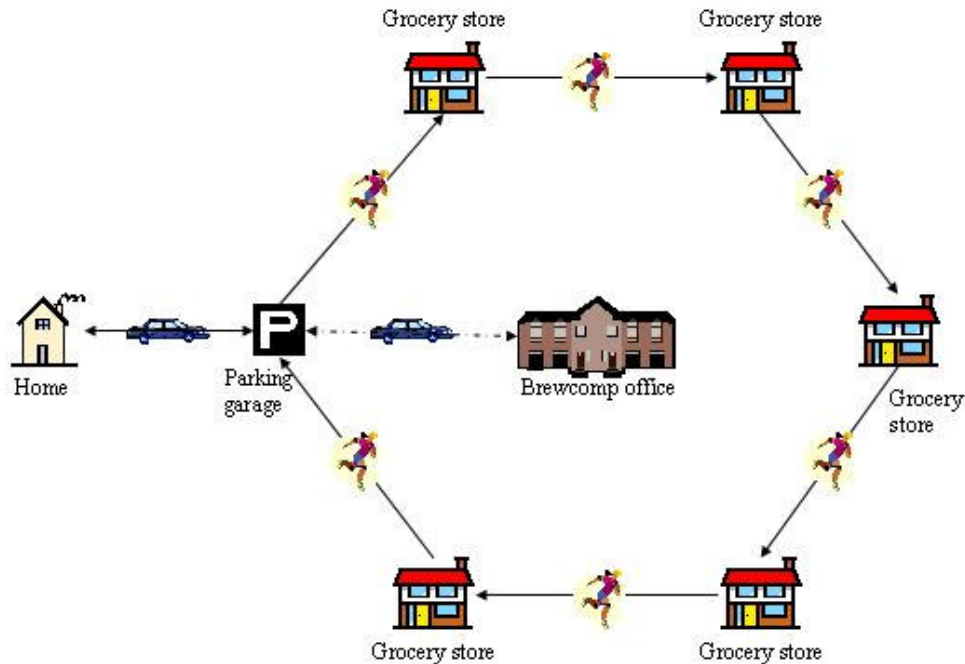
Figure 7.4: Assignment network in the work praxis at Brewcomp: B-salesman1.

7.1.1.2 Visiting-based assignment networks

The visiting-based assignment networks have few nodes and connecting edges. The workers spend most of their time at the customer's location working on tasks, hence, the assignment networks can be said to be centered on the customer's location.
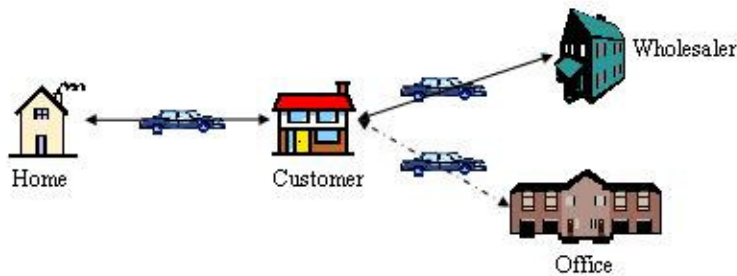
Figure 7.5: Assignment network in the work praxis at Elcomp A and visiting-based assignment network at Elcomp B.

The electricians at Elcomp A and the electricians at Elcomp B who work on large assignments both have visiting-based assignment networks. The electricians at Elcomp A, e.g. E-A-electrician1, travel straight to the customer each morning and spend most of their time there working on assignments. When they need to collect parts for the assignments, the electricians travel to the wholesaler. Most electricians synchronize from the customer's location every other Friday using a GPRS connection. The assignment network at Elcomp A is illustrated in figure 7.5. The dashed line illustrates visits to the office, these are infrequent. Some electricians, e.g. E-A-electrician2, are not able to synchronize using GPRS, they have to visit the office every other Friday in order to

receive their salary. The electricians at Elcomp B who work on large assignments have a cycle of traveling and visiting which is very similar to that at Elcomp A, illustrated in figure 7.5. The difference is that they visit the office every Monday to synchronize their PDAs, so that their salaries can be calculated.

Construction workers working for Constructcomp always start their work-days at the construction site. They travel from their homes with their private cars and stay at the construction site for the duration of the work-day. The construction projects usually last for several months. When the workers' assignments at a construction site are finished they move on to a new construction site. The workers do not need to travel to the central office to deliver their work-hour forms. They deliver them to the construction site chief, C-chief, in his small office at the construction site. The assignment network is illustrated in figure 7.6.
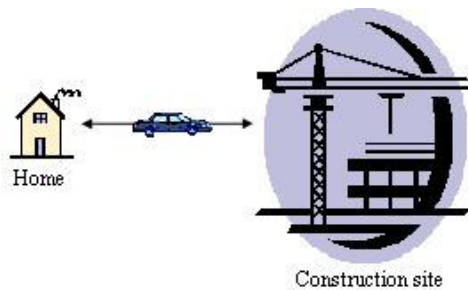
Figure 7.6: Assignment network in the work praxis at Constructcomp.

7.1.1.3 Implications of the difference in assignment networks

The cycle of traveling and visiting in the work environments is so dominant to the work praxis that it can be stated that the work praxis is either traveling-based or visiting-based. The scope of the assignments in the different work environments is the reason why some workers have a work praxis that is traveling-based, while others have a work praxis that is visiting-based. Traveling-based work praxis is due to small assignments which require only one worker for a limited time, while visiting based work praxis is due to large assignments which require several workers for a longer period of time. With the exception of the construction workers, all the workers have company cars which they use to travel between locations. An interesting point is the difference between the star-shaped and the circular traveling-based assignment networks. The circular assignment networks seems much more efficient since the workers spend far less time traveling than star-shaped assignment networks were the workers travel to the office between each visit to a customer. The administration at Plumbcomp are aware of the possibilities that Blueapp hold to coordinate assignments and synchronize using GPRS, however, they want the plumbers to stop by the office between each assignment so that they have complete control over their work praxis.

7.1.2 Wandering around at the customer's location

The actual service work, e.g. when a plumber fixes a faucet at a customer's residence, carried out by the workers usually require that the worker move around the location which he is visiting. This movement is called wandering. Wandering is illustrated in figure 4.3 on page 29.

Wandering is an important part of the work praxis in all the work environments. There are, however, differences between the work environments. The amount of wandering the workers does can be divided into two categories; limited wandering and extensive wandering. These categories can be directly linked to the two types of assignment networks presented above. Workers who work on several small assignments each day, traveling-based work praxis, do not wander much when they visit a location. The workers at Plumbcomp, Brewcomp and the electricians at Elcomp B who work on several assignments each day usually visit customer's locations that are relatively small. The plumbers mostly visit private residences. During the observation of P-observe he traveled to a private residence to fix a leaking faucet. His wandering consisted of movement between the kitchen and his company car parked outside, ca. 10 meters away from the sink in the kitchen. P-observe first walked into he kitchen to fix a faucet, saw what kind of tools he needed (e.g. a wrench), walked out to the car to get these tools, walked back to the kitchen where he used the tools and saw that he needed some parts (e.g. screws, pipes), went to the car to get these parts, walked back to the kitchen and fixed the faucet, and finally walked to his car and drove back to the office. To illustrate this, two pictures taken during the observation are presented below, figure 7.7 and figure 7.8. The electricians at Elcomp B and the salesmen at Brewcomp visit relatively small locations as well and the work tasks are usually performed in one room or 'spot' within that location. Hence, wandering is limited in their work praxis as well.

Figure 7.7: Tools and parts in the company car.

Figure 7.8: P-observe fixes a faucet in the kitchen.

The workers who have visiting-based work praxis usually work at customer's locations that are relatively large in size. E.g. E-A-electrician1 works on an assignment for a company which owns a large compound around the river in the city where Elcomp A is situated, and which governs the harbor in that city. The compound includes many large buildings, e.g. warehouses. Since the compound is rather big he sometimes uses his company car to travel within the compound. Most of the time, however, he walks between buildings and within buildings on the compound. The construction workers at

Constructcomp spend all their work-days at the construction site. The amount of wandering can be relatively large since a construction site usually is a large compound or a large building that is being built or renovated. The workers usually go from working individually or in small groups at one 'spot' to doing the same at another 'spot'.

Similarly to fact that the difference in assignment networks is influenced by the scope of the assignments, it can be stated that the scope of the assignments influence the amount of wandering. In section 7.4, the mobility of people is related to the use of communication genres and the potential use of MMS in the work environments.

7.1.3 Technology on the move

In this section, Luff and Heath's (1998) concepts of physical mobility, micro, local and remote mobility, are used to discuss the interaction between the workers and technology. In the discussion the focus is on the technological devices that are most important in the work environments. The mobility features of the technology that is used by the nomadic workers strongly influences how it is used and for which purposes. Since the form of the genres, the medium, which is used usually requires a technological device, e.g. SMS messages are sent from mobile phone, it is important to investigate the mobility of the technology in order to investigate the use of communication genres in the work environments.

7.1.3.1 Micro mobility vs. local mobility

The majority of the collected data material is from Plumbcomp, Elcomp A and Elcomp B. In all these three work environments, a new information system, Blueapp, has been introduced recently. Blueapp was introduced in order to make the handling of information more efficient. In all the work environments, Blueapp was introduced due to the initiative of the administration. Their primary goal was to make the registration and handling of information related to assignments and the calculation of salaries for the workers more efficient. Prior to the introduction of Blueapp assignment notes were used to assign workers to assignments, several documents were used to record assignment information while it was being worked on, and work-hour forms were used by the workers to register work-hours. The administrations aim of the introduction was to replace most of these documents with a computer-based information system that would make it easier for the administration to coordinate assignments and to handle the assignment information when they were completed, e.g. calculate salaries, generate bills to customers and keep track of the inventory of parts in stock rooms and company cars. The investigation of the work environments, however, show that Blueapp is not used the way it is intended, the mobility features of Blueapp and paper documents is one of the reasons why this is so.

The CEO of Blueapp Corp. said that Blueapp is meant to be used to register information 'in-situ', whenever there is a need to register information. Blueapp Corp. have done research on the work praxis of blue-collars and have found that for this to happen it is important that the registration of information is as easy and fast as possible. The '10-

second rule' has been used to advertise Blueapp, i.e. it should not take more than ten seconds for a worker to turn on his PDA or pocket PC, register information, and put it back in his pocket. In the work environments that have been investigated, however, Blueapp is very seldom used for 'in-situ' registrations.

Even though Blueapp was introduced into the work praxis at Plumbcomp more than 3 years ago, two types of paper documents are still central parts of the work praxis. At Plumbcomp the assignment note (figure 6.2, page 46) plays an important role in the work praxis. The assignment note is present at all stages of the assignment; it is created (i.e. printed from the economy program) when a customer calls the office, it is delegated to a plumber when it is placed on the assignment board or given to him directly, it is used by the plumber to inform himself about the nature and location of the assignment, the plumber register the parts he uses, the time spent and kilometers driven on it, the customer sometimes signs it and the administrative employees use it to double-check the information in the economy program when the assignment is completed. The week summary (figure 6.6, page 47) is the other important document in the work praxis. After a plumber completes an assignment he fills out the hours worked and kilometers driven for this assignment on the week summary. The administrative employees use this document to double check the information in the economy program and the information on the assignment note, and to make sure that the plumber has worked a full week (37.5 hours). The plumbers use the assignment note for 'in-situ' registration of information, Blueapp is updated after the completion of the work tasks, either at the customer's location or when the worker returns to the office. Most of the assignment information is registered three times for each assignment by the plumbers; in Blueapp, on the assignment note and on the week summary. As described in section 6.1.2, this problem could in fact be solved with little effort, and it would improve the effectiveness of the administrative work related to assignments. P-chief said that the main reason for keeping three 'systems' is safety; the plumbers often register invalid information and history has shown that the economy system and Blueapp is prone to malfunction. P-observe and the other plumbers (P-plumbers) believe that things were simpler prior to the introduction of Blueapp and are unsatisfied with having to do 'double work'.

At Elcomp A and Elcomp B the praxis regarding registration of assignment information is very similar. The electricians at Elcomp A use a notebook to register information 'in-situ' and update Blueapp at the end of the day. The notebook was also used to register information prior to the introduction of Blueapp. At Elcomp B, the electricians use the assignment note or other pieces of paper to register information 'in-situ', and update Blueapp after the completion of the assignment or at the end of the day. Pen and paper was used for 'in-situ' registration also before the introduction of Blueapp. The main difference from Plumbcomp is that the electricians register information on paper documents due to their own choice, while the plumbers are required to use both paper documents and Blueapp by the administration. Either way, multiple technologies for registering information are used, resulting in reduced efficiency. In addition, the workers, especially the plumbers, feel that Blueapp in many ways increase their work concerned with handling information.

For Blueapp one can say that the local mobility properties are not used as was intended by the administration and the designers, Blueapp Corp. The workers usually carry the PDA or Pocket PC in their pocket, some leave in their company car. However, when it is used, it is used at one location to update all information that has been registered in a paper document earlier. Paper documents on the other hand are used for registration at different places, e.g. the plumbers register parts on them when they collect them from the company car and when make notes on them while they are inside the customer's residence, hence, the local mobility features are used. Luff and Heath (1998) say that it is important to consider the mobility of artifacts like documents when investigating work environments. In their example about medical consultations, they say that:

> "Despite the introduction of computerized systems, the paper record remains an important resource in professional medical practice. Its portability is a critical part of its success, as it passes between the hands of different professionals, is carried around the practice, and located in different parts of the office and clinic."
>
> Luff and Heath (1998, p. 306)

In the discussion of the use of paper medical records in medical consultations, Luff and Heath (ibid.) stress the importance of the micro mobility features of paper documents. Both Blueapp and paper documents support local mobility, however, the local mobility properties of Blueapp is not utilized. One of the reasons for this is the difference in the micro mobility properties of Blueapp compared to paper documents. The micro mobility of documents refers to the way they can be moved 'at-hand' and manipulated, e.g. write something on them using a pen. The micro mobility of Blueapp refers to how the PDA or pocket PC can be moved 'at-hand' and how information can be registered in them, e.g. using the 'touch-screen pen'. Since paper documents have been used since prior to the introduction of Blueapp, and since paper documents are common in daily life, the workers are well-accustomed to handling them 'at-hand'. Many of the workers are not that familiar with using computer-based systems like PDAs, laptops and PCs. Even though a lot of effort has been invested in enhancing the micro mobility of Blueapp, e.g. the '10-second rule', pen and paper is much faster to use and therefore preferred by the workers.

The construction workers at Constructcomp and the salesmen at Brewcomp do not need to handle as much assignment information as they do in Plumbcomp, Elcomp A and Elcomp B. At Constructcomp the gang leaders and the construction site chiefs handle most of the information that is concerned with the related to the organization of the construction projects. The workers don not need to register the parts they use, and they do not need to fill out work-hour forms since they are paid per month. Therefore there has not been introduced an information for these purposes either. The construction workers do, however, have to document what they have done each day and that they have followed the laws and regulations that apply. They do this by filling out forms, paper documents. These forms are then delivered to C-chief. The documentation takes them about 10-15 minutes and is done at the end of each work day. All the forms are paper documents. They are filled out at one location; therefore local mobility is not required. C-chief thinks that if an ICT was introduced to replace the paper documents used for

documentation this would increase the efficiency in the documentation process considerably. A mobile phone or a PDA with software for this kind of registration could be used. Such an ICT would be used in the same way as the paper documents, e.g. at one location, and would not need to support local mobility. After the registration, however, the information could be transferred to a server. C-chief said that such a system would ease his work load considerable. Today, one of the problems is that the workers often fail to deliver the documents to him. It remains an open question however if this will change with a system where the workers can transfer the information electronically.

At Brewcomp the workers do not need register their work-hours since they are paid per month also. They do not use any parts to complete their tasks either. The main registration task which they perform is to fill out order forms which they use to order soda to the stores. They carry these paper documents with them around the stores and send them to the order department at Brewcomp as faxes from the stores' fax machines. The local mobility of the order forms are utilized, registrations are done at various places within the store, e.g. in the stock room, by the soda 'exhibition' in the store, and they are sent from the fax machine in an office. B-chief said that a new computer-based information system which will be an 'add-on' to the PLAN system is being developed. The intention is that the salesmen will carry with them PDAs which they can use to register soda orders and transfer them using a GPRS connection to the order department.

The workers in all the work environments (this issue was not investigated at Elcomp B) use digital cameras occasionally in their work praxis. Most workers are used to the micro mobility properties of the cameras, since most of them use digital or common cameras in their daily lives as well. The cameras support local mobility, i.e. they can be used to take pictures at various 'spots' at a location.

7.1.32.2 Remote mobility

In general, one can say that the use of and need for technology that supports remote mobility is relatively limited in the work environments. The remote mobility properties of technology are most important in traveling-based work praxis. Mobiles phones is the technology which is most frequently used to interact, i.e. communicate, with someone over a distance. The salesmen use mobile phones the most. Since they seldom visit the office, they use it to communicate with the administration, e.g. the salesmen usually talk to their district manager on the phone once every day. The salesmen also use the mobile phones to communicate with the drivers who deliver the soda to the stores, the managers of the stores, co-workers etc. B-planner sends out PLAN messages (SMS messages) to the workers each afternoon, he also uses an Internet-based SMS service to send out information to the drivers sometimes. Before the introduction of PLAN, paper documents with schedules were used. The remote mobility properties of mobile phones and PLAN make the coordination of workers more dynamic and easier to adjust. Mobile phones are also used frequently by the workers in the other work environments, however, not as much. They usually visit the office more often, and therefore communicate with the administration face-to-face instead. The phone is not usually used to coordinate workers and assignments either; at Constructcomp this is done face-to-face while in the other

work environments assignment notes or Blueapp is used. Phone conversations or SMS messaging is usually used to solve problems or for 'ad-hoc' coordination. In addition to supporting remote mobility, mobile phones support micro and local mobility. The micro mobility of mobile phones is well-known since a vast majority of the population, and all the workers who were interviewed, are mobile phone subscribers and use them frequently in the private life as well. The local mobility of mobile phones is often utilized, e.g. the workers often walk around at a location while talking on the phone.

The remote mobility property of Blueapp is only used in one of the work environments, at Elcomp A. There, the electricians synchronize from the customer's location using a GPRS connection. This saves the electricians from having to travel to the office in order to transfer information regarding assignments and their work-hours. The electricians synchronize every other Friday in order to receive their salary, this often results in a queue on the companies Blueapp server. This reduces the electricians' perceived 'quality' of the remote mobility of Blueapp. Some electricians, e.g. E-A-electrician2, have to visit the office and synchronize using a link cable since they have not been given GPRS-enabled phones which they need to synchronize. At Plumbcomp and Elcomp B the remote mobility properties of Blueapp are not utilized. P-chief said that there is no need at Plumbcomp since the plumbers visit the office between every assignment anyway. However, if assignments were assigned to the workers in Blueapp instead of using the order board, and if the Plumbers could synchronize using a GPRS connection, they would not have to visit the office as often and the work praxis would be more efficient. At Elcomp B assignments are assigned to the electricians in Blueapp, however, they have to visit the office in order to synchronize. E-B-chief said that they plan to start using GPRS for synchronization in the future.

When the workers have taken pictures with digital cameras they have to either visit the office where their manager uploads them to a PC using a link cable or upload the pictures at home and send them in an e-mail to the manager, since the digital cameras do not support remote mobility.

The salesmen use the remote mobility property of the fax machines at the grocery stores to send the orders for soda to the order department at Brewcomp. At the construction sites, walkie-talkies are usually preferred for remote communication, since they make it possible to have an 'open channel' and since it can be used free of charge.

7.1.4 Moving between contexts

So far in this section, the physical movement of workers and technology has been discussed and illustrated with figures. The discussion showed that the nomadic workers move from one social context to another several times each day. In this subsection, these contexts and the transition between them is discussed.

> "As society and organizations becomes more fluid and dynamic, individuals adopt multiple social roles at an increased intensity and need their information services adjusted accordingly. […] In such an environment, individuals need to change

their roles frequently as they move from one social context to another […] Although social mobility can be enabled without physical mobility, these two types of mobility often co-mingle, and increased physical mobility normally precipitates social mobility".

<div align="right">Lyytinen and Yoo (2001, p. 5)</div>

Some of the workers start their work days at the office, while others travel directly to the customer's location. Some of the workers visit the office several times a day, while others visit the office every other week or even more seldom. For all the workers the office, when visited, is a social context which is quite distinct from the others. At the office they meet their co-workers and their superiors. The interaction with co-workers and superiors is usually somewhat different from what it is when they meet at a customer's location. At the office there exists different social contexts as well; an individual worker can do some paperwork (e.g. a plumber can fill out the week summary), a worker can have conversations or meetings with one or several of his co-workers and or superiors, the workers eat lunch together in a lunch room or cantina etc. In some of the work environments that have been investigated the 'lines' between the social contexts are somewhat dim, compared to what might be the case in companies with strict hierarchies (e.g. the military). E.g. Plumbcomp is a relatively small company, 17 employees, where according to the administration they are all 'a big family'. The employees all know each other well. Because of this, the workers interact with others pretty much in the same way when they are at lunch as when they have a meeting. In other companies, like Brewcomp, which has more employees and where the employees do not meet as often, the hierarchical differences are clearer and people interact differently in different contexts.

At the customer's location the workers are in a role where they should act more 'professional' as service providers. In most types of work environments where workers need to interact with customers the workers need to adjust how they communicate and behave; e.g. they do not talk to a customer the same way they talk with their friends. In the work environments that were investigated, however, the workers seem to interact with the customer in a 'loose' manner. Even though there is a distinction between how the workers interact with co-workers and how they interact with the customers, the interaction is not that different. The workers that were observed, P-observe, B-salesman1 and B-salesman2, communicated loosely while they worked. E.g. P-plumber talked with his customer about social matters, and B-salesman1 talked with the customers in the store, saying things like "Good morning" and "How are you today?"

Most of the workers regularly or occasionally work together with co-workers in small groups. Most of the workers have worked together for a long time, and they interact with their co-workers in much the same way that they would with their friends. However, they are in a different social setting, and the focus is on completing the tasks at hand. While working in a small group or on a large project, e.g. a construction project, the workers sometimes work on individual tasks as well. Transition from working in an individual context to working in a small group or a large project requires the workers to coordinate how they work on their tasks with how the others work and the overall goal of their combined work.

The office and the customer's location are the contexts which the workers spend most of their working-hours in. In addition, they sometimes visit the wholesaler, travel by car or communicate with their family. When the workers visit the wholesaler they go into a more 'professional' role, as they do when they visit a customer. However, they often know the people working at the wholesaler rather well and therefore talk 'loosely' with them as well. The workers usually travel by car between locations. This context is either individual or a small group (if they travel with a co-worker). The workers occasionally communicate with family and friends during work-hours. This happens while they are in a specific social context, e.g. working individually, traveling with a co-worker or visiting a customer. They then enter another social context, e.g. a phone conversation.

> "Some claim that the presence of [mobile] devices in the hands, bags and pockets of so many people heralds a new world of work in which people can be reached and information accessed "anywhere, anytime". Whether or not access to information in itself can promote new working practices, individuals whose lives resolve around movement between work sites have been singled out as an obvious market for such portable wireless communication devices. Using these devices such "mobile workers" can be in touch with colleagues, collaborators and clients "24/7", and still sustain non-work social relationships due, apparently, to their constant connectedness whilst mobile."
>
> Churchill and Wakeford (2002, p. 154)

The technology which the workers use follows them as they move between contexts, and has different meanings and is used differently in the various contexts. The three main forms of technology which are used in various contexts are the assignment notes, Blueapp and mobile phones. The use of these technologies is exemplified below.

At Plumbcomp, the assignment note is first read by the plumbers at the office. It is used for reference when the plumber asks the foreman for additional information. The assignment note is used to register the parts used and hours worked at the customer's location. The customer signs his name on it. The registered information is used to register information in Blueapp and on the week summary when the plumbers return to the office. It is used when the order numbers are entered into the economy system on the PC each Friday, and finally the plumbers deliver it to the administrative employees who use it to calculate salaries and generate bills. The assignment notes have been used in this fashion for a long time, and they can be used without problems in the different contexts.

The Blueapp application on the workers' PDAs also follows the workers in their work. At Elcomp B some of the electricians stop by the office each morning to synchronize their PDAs, the electricians synchronize their information individually. At the customer's location Blueapp is used for registration of parts and working-hours after the completion of an assignment, and the customer' signs his name in it. At the wholesaler information about which parts were bough is transmitted to from the wholesalers PC to Blueapp in the electricians' PDA. At Elcomp B Blueapp has just been introduced, hence the electricians are not fully accustomed to using it. However, they have adapted it into the various contexts in the work praxis. As is the case in the other companies who use Blueapp, it is

not used to its full potential; its use has been 'fitted' in to the work praxis instead of the work praxis being changed to better fit this ICT.

Mobile phones are used in most of the social contexts; it is used when a worker is in his car, while he is visiting a customer etc. In some of the contexts, however, mobile phone use is not wanted, e.g. when the workers attend a meeting. Mobile phones are used for communication with customers, co-workers, superiors, family and friends. Almost everybody have a mobile phone with them at any times, so the workers can contact anybody regardless of their own and others' social context.

7.1.5 Mobility issues: A summary

In this section the mobility of people and technology in the nomadic work environments has been discussed. The discussion shows that the work praxis can be said to be either traveling-based or visiting-based based on the assignment network, i.e. the cycle of traveling and visiting. Workers who have traveling-based work praxis work on several assignments each day and spend a considerable amount of time traveling between locations. Traveling-based work praxis can be divided into two sub-types, star-shaped and circular. The plumbers at Plumbcomp have star-shaped assignment networks; they travel to the office between each visit to a customer, therefore the edges (which illustrate traveling) in the assignment network and the nodes (the customers' locations) resemble a star with the office at the center. The salesmen at Brewcomp and the electricians at Elcomp B that work on small assignments have circular assign networks; they travel straight from one customer to another, therefore the edges and the nodes form a circle. Workers with traveling-based work praxis usually work individually. The workers with visiting-based work praxis work at the same locating for a long period of time. The construction workers at Constructcomp, the electricians at Elcomp A and the electricians who work on large assignments at Elcomp B have this kind of work praxis. Their assignment networks consist of few edges and nodes. Because of the scope of the assignments these workers often work in small groups on large project based assignments. The amount of wandering which occurs in the different work environments can be said to be directly related to the type of assignment network that exist in the work environment. The workers who have traveling-based work praxis usually visit relatively small locations for a short time and the amount of wandering is limited. The workers who have visiting-based work praxis usually work for a long period of time at a large compound or in a large building, and the amount of wandering is often extensive.

In general, it can be stated that the local mobility properties of Blueapp are not utilized as was intended when they were introduced into the work environments of Plumbcomp, Elcomp A and Elcomp B. Pen and paper is usually preferred by the nomadic workers for 'in-situ' registration of information, Blueapp is updated at a later time. The micro mobility properties of paper documents is one of the reasons for this, i.e. the workers are well-accustomed to using pen and paper at they find it faster to register information using it than using Blueapp. Luff and Heath (1998) found the same when they investigated the introduction of a new information system at a construction site. The intention was that the foremen should use the new system to register information at various 'spots' around the

compound, i.e. 'in-situ', however, they registered the information in paper documents, as has been the work praxis prior to the introduction of the system, and updated the information system when they returned to the 'hut', i.e. the office, at the end of the work day.

The workers and the technology that is used move between different social contexts and have different roles in these. This social mobility is important in the work environments. The technologies that are most used, assignment notes, Blueapp and mobile phones all support social mobility.

7.2 The use of communication genres in the work environments

In this section, the handling of the flow of information in the work environments is discussed. First the communication genres that have been found in the work environments are described. Then the actual use of these genres in the work environments is discussed. The appropriateness of the communication media, i.e. the form of the genres, for the purposes that they are used for is central to this discussion. In the work environments that were investigated, information needs to be handled in order to be able to delegate workers to assignments, keep track of working-hours and parts spent on assignments, generate invoices and calculate salaries. In addition, information regarding problems with completing tasks, the use of media, and personal issues needs to be handled. Information is handled to reduce uncertainty and equivocality in the communication situation at hand. This is done by using communication media.

In section 7.2.1 the communication genres that have been identified after analyzing the work praxis in the nomadic work environments are presented. The use of communication media and their appropriateness in the communication situations they are used in is discussed in section 7.2.2. In section 7.2.3, additional aspects concerning the technological devices that are used in discussed.

7.2.1 The five communication genres identified in the work environments

In table 4.1 on page 24, four categories of communication were presented; interpersonal communication, group management, task work communication and tool/media communication (Graveline et al. 2000). Further, it was stated that these categories will be used as genres, i.e. typification of communication, in this thesis. These genres have been used to categorize the communication in the work environments. After analyzing the work environments in the case studies, it is evident that an additional genre is needed; documentation. The communication in the documentation genre is meant to reduce uncertainty, i.e. to collect large amounts of data concerning what has been done. The five genres represent different purposes for communication, each of these consist of a several subgenres. E.g. the group management genre includes genres with the purpose of coordinating workers and assignments, and the coordination of meetings. Hence, the group management genre can be thought of as a category of genres. In this thesis, however, the focus is on the main difference in communication situations and the different needs for media richness to handle the flow of information. There is only small

difference regarding the need for media richness between sub-genres, therefore in the discussion the 'genre categories' are considered as the genres and the sub-genres are considered as examples of these genres.

Genres are identified by their purpose and their form. Therefore e.g. group management using face-to-face conversations and SMS are considered as different genres. This way of categorizing genres is somewhat different from how e.g Ling et al. and Julsrud et al. (2004) does it. They categorize genres as e.g. genres of multimedia messaging, and study different purposes for each of this. In this thesis, the genres are categorized based on their purpose to be able to discuss which media (i.e. the form of genres) are used for specific purposes. In section 7.3, where the properties of genres of multimedia messaging are considered, however, the MMS medium is considered as the 'category' with genres identified by their purpose.

Genre	
Purpose	**Form /medium**
Interpersonal communication: - Coordinate non work activities - 'Small talk'	- Face-to-face conversations - Phone conversations - SMS messages
Group management: - Coordination of workers and assignments - Coordination of meetings	- Face-to-face conversations - Phone conversations - SMS messages - Assignment notes - Blueapp - PLAN
Task work communication: - Problem solving, related to work tasks	- Face-to-face conversations - Phone conversations - SMS messages - Digital photographs
Documentation: - Documentation of what has been done during assignments	- Digital photographs - Digital documents - Paper documents
Tool/media communication: - Problem solving, related to use of tool/media	- Face-to-face conversations - Phone conversations - SMS messages

Table 7.1: Purpose and form / medium of the communication genres in the work environments.

The communication genres found in the work environments are presented in table 7.1. The focus of this thesis is on how the nomadic workers, blue-collars and salesmen, handle the flow of information using communication genres. When the work praxis of the nomadic workers was investigated, the purposes presented in the left column were all the general purposes that were found. All these purposes for communicating were found in all the work environments. In the right column all the media that were used in the work environments for each of the purposes are presented. However, not all the media were

used for that specific purpose in all the work environments. Each combination of purpose and medium is one genre; hence there are 19 different genres in the work environments. It is possible that other people in the work environments, e.g. the administration use other genres; however, this is not discussed in this thesis. The communication categories and the genres used in this thesis are not meant to be a strict taxonomy, but are the socially produced typifications of communication which were found in the work environments that were investigated. This method for choosing categories and genres is similar to how Ling et al. (p. 9) selected typifications of SMS messages.

The richness of all the different media has been analyzed using the concepts from media richness theory (Daft and Lengel 1986); the result of this analysis is presented in table 7.2. An overall assessment of the richness of the media is given in the rightmost column. The media are presented with decreasing richness, i.e. the richest medium is presented first.

Form / medium	Feedback capability	Availability of multiple cues	Language variety	Personal focus	Media richness
Face-to-face conversations	Synchronous, support local mobility	Spoken words, gesturing etc.	Spoken language	Personal	High
Phone conversations	Synchronous, support local and remote mobility	Only spoken words	Spoken language	Personal	High
SMS messages	Synchronous and asynchronous	Only writing, on a mobile phone display	Written words and numbers	Semi personal	Medium
PLAN messages	Asynchronous	Only writing, on a mobile phone display	Written words and numbers	Semi Personal	Low
Blueapp	Asynchronous, support local and remote mobility	Graphical user interface, writing, tables	Written words and numbers, editable using 'pen' or keyboard	Impersonal	Low
Digital photographs	Asynchronous (in these cases), support local and remote mobility	Pictures in digital form in the camera and/or in a PC	Pictures	Impersonal	Low
Assignment notes	Asynchronous, support local mobility	Only writing on a paper document	Written words and numbers, editable with pen	Impersonal	Low

Table 7.2: The richness of the media that are used in the work environments.

The media can be related to Daft and Lengel's (ibid., p.560) classification of media types, illustrated in figure 4.1 on page 23. Face-to-face conversations are identical to the medium with highest richness in figure 4.1. Both phone conversations, SMS messages and PLAN messages (which are SMS messages) fit into the telephone medium in figure 4.1. However, the media differ in richness. Phone conversations have high media richness, SMS conversations have medium richness due to them not being 'truly' synchronous and the lack of multiple cues, and PLAN messages have low richness because feedback is not intended. According to Pedersen et al. (2003), SMS messages are "somewhat synchronous". The synchronicity of SMS and MMS is discussed further in section 7.3. SMS messages and PLAN messages can also be said to be semi personal documents, since the messages contains written information and are addressed to a specific receiver. The degree of personalization of the content of a (common) SMS message vary from message to messages, e.g. the same SMS message can be sent to all the salesmen in the Oslo region at Brewcomp to inform them of a meeting or two salesmen can communicate with SMS messaging. Hence, these two media can be related to both personal and impersonal documents. Since the collected data material related to the use of walkie-talkies at Constructcomp is very limited the use of it has not been investigated in detail and is not included in the list of media which are used in the work environments. Walkie-talkie conversations are similar to phone conversations and can be said to have the same media richness.

Blueapp can be related to impersonal documents, since its content is assignment information. Blueapp is also used by the administration to keep track of which plumbers work on which assignments; however, if Blueapp is seen from the workers perspective the form is impersonal. Digital photographs can, in the way they are used in the work environments, be related to impersonal documents. Assignment notes are impersonal documents. As with Blueapp however, the administration use them for coordination (they are placed in 'slots' on the assignment board). The two medias used for the purpose of documentation; digital and paper documents, can be directly related to digital photographs and assignment notes, respectively. The only difference is that the information is textual instead of a picture. The classification of the media richness of the forms is illustrated in figure 7.9.
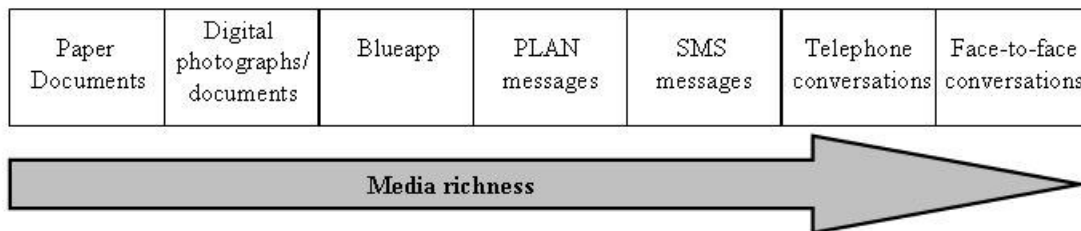

Figure 7.9: Classification of media richness of the media in use in the work environments.

7.2.2 The use of communication media in the work environments

In this section, the use of communication media for the five purposes for communication that have been identified, presented in table 7.1 on page 79, in the work environment is discussed. The appropriateness of the media in the situation is also discussed; this is determined by their media richness, i.e. their ability to reduce equivocality (ambiguity) and uncertainty in the communication situations that they are used in. Each of the purposes for communication is presented in separate subsection below, and for these the usage of all the media which are used are discussed.

7.2.2.1 Interpersonal communication

According to Graveline et al.'s (2000, p. 384), table 4.1 page 24, a rich synchronous, multi-channel medium should be used for interpersonal communication. There are two distinct purposes for interpersonal communication in the work environments; coordination of non work activities and 'small talk'. Communication with these purposes transpires between co-workers and between a worker and his family-members or friends. The use of genres with these two purposes for interpersonal communication are very similar, therefore it is discussed as one phenomenon below.

Face-to-face or telephone conversations should be used for this kind of communication. The amount of personal face-to-face communication between co-workers differs from work environment to work environment. As discussed in section 7.1.1 (page 63), the work praxis in the work environments can be said to be either traveling based or visiting-based. Workers who visit several customers each day usually work alone since the assignments usually require one worker for 1-2 hours. Many of the workers who work the same assignment for weeks or months work together in small groups, because of the large scope of the assignment. These differences naturally influence the amount of interpersonal face-to-face communication which occurs while the workers are working on assignments. Some of the workers stop by the office regularly and talk with co-workers and supervisors, e.g. the plumbers visit the office prior to and after each addition and they all eat lunch together in the lunchrooms, and some of the soda salesmen meet for lunch at cafés. Face-to-face conversations with friends or family members during working-hours are seldom. Personal phone conversations during working-hours are not popular form the administrative employees' point of view, since this reduces the efficiency. However, since the workers often work at locations where supervisors are not present, the workers can have such conversations none the less. This issue was not investigated in detail in the case studies, so the amount of such communication remains unknown.

SMS is not as well-suited for personal communication since it is not necessarily synchronous, the recipient chooses when / if he wants to answer a message, and since they do not allow multiple communication channels. Nonetheless, it is used, however, not as frequent as phone conversations.

7.2.2.2 Group management

The aim of group management communication is to reduce uncertainty; therefore lean, asynchronous, single-channel mediums should be used (Graveline et al. 2000, p. 384). In the work environments the coordination of workers and assignments is the main purpose for such communication. The other purpose is coordination of meetings.

Coordination of workers and assignments

At Plumbcomp, Elcomp A and Elcomp B, Blueapp is used for coordination of workers and assignments. When new assignments, arrive they are registered in the Blueapp administrator program (indirectly; they are registered in the economy, program and are then accessible in the Blueapp administrator program). An administrative employee then assigns workers to assignments using the administrator program. This information is communicated to the worker when he synchronizes his PDA the next time; the assignment information is now available in the workers Blueapp program on his PDA. The worker sends assignment information back to the Blueapp administration program the next time he synchronizes. At Elcomp A this happens every other Friday, at Elcomp B some electricians synchronize every morning while others synchronize every Monday. At Plumbcomp the plumbers are not assigned to assignments in the administrator program. Information is only transmitted from the plumber's pocket PC to the economy program when they synchronize every Friday. The electricians at Elcomp A (most of them) synchronize using a GPRS-connection, and therefore do not have to visit the office to synchronize. At Elcomp B and at Plumbcomp this functionality is not implemented, so the workers have to visit the office in order to synchronize.

Blueapp is a lean asynchronous medium and is therefore well-suited for reducing the uncertainty which is involved in the coordination of orders. The assignment information which is communicated from the administration to the workers, i.e. information about which assignment they shall be working on, and information communicated from the workers to the administration, i.e. information regarding the use of parts, working-hours and the filled out checklists, is usually easy to understand and therefore a medium with low richness is well suited. Sometimes, however, there is need for a richer medium in addition to Blueapp in order to reduce equivocality, e.g. if the worker does not know where the customer is located based on the address he receives in Blueapp he contacts either the administrative employee who registered the assignment, he talks to him face-to-face or phones him, or he phones the customer. If the administrative employee who is calculating the worker's salary does not understand the number of working-hours that has been registered for an assignment (e.g. if the worker has registered a large amount of hours on an assignment which should only require 1 hour, i.e. the worker has probably registered the amount on the wrong assignment), he either talk to the worker face-to-face or phones him to investigate. Phone conversations and face-to-face conversations are in these cases used to reduce equivocality which occurs in the coordination of workers and assignments. This is, however, a very little part of the information which is handled compared to what is communicated using Blueapp.

In two of these work environments assignment notes are still in use. At Elcomp B the workers receive the notes and use them as physical representations of the assignments and register assignment information on them 'in-situ' (instead of using Blueapp). The electricians do not return the assignments notes to the administration. At Plumbcomp the assignment note is the primary coordination medium. The foremen assign assignments to plumbers by placing assignments notes in their 'slots' on the order board. When a plumber visits the office he collects an assignment note from the order board. Sometimes the foremen re-assign assignments, i.e. move them from one 'slot' to another, or assign them ad-hoc, i.e. give them the plumber who is present when the assignment is received from the customer. The plumbers register assignment information on the assignment note when they are in the stock room and when they visit the customer. After the assignment is completed the assignment note is stored in the plumbers' shelves (on the left figure 6.3 on page 46) until they are delivered to the administrative employees the next Friday. The administrative employees use the assignments notes to generate invoices and calculate salaries.

Assignment notes are well-suited for coordination since it is a lean asynchronous medium which is meant to reduce the uncertainty of coordination. As is the case with Blueapp, occasionally richer media are needed if some of the assignment information is unclear. Face-to-face conversations or phone conversations are used for this.

At Brewcomp, PLAN is used to coordinate the work days of the salesmen, i.e. which stores should each of the salesmen visit. B-planner creates plans for each day based on regular 're-fill visits' to grocery stores and the plans for when each store should have soda delivered. Sometimes he also must consider ad-hoc orders, i.e. order for beverages to be delivered on a day when that specific grocery store is not supposed to receive soda (e.g. due to that the all the bottles of Solo are sold out). Based on this information PLAN messages are sent to the mobile phones of each of the salesmen and temps that are filling in for missing salesmen. The communication is only one-way; the salesmen do not answer the SMS message they receive with a new SMS message.

PLAN messages are lean, asynchronous and well-suited for coordination messages. B-chief and B-planner wants that for the PLAN messages to be followed by the salesmen. However, most of the salesmen follow them only loosely or not at all. If the salesmen have questions regarding the PLAN messages they have received, they phone B-planner. E.g. B-salesman1 said that when he receives a PLAN which includes a grocery store which is not one of his regulars he always phones B-planner to investigate. Hence, phone conversations are used in addition to the PLAN messages if there is a need to reduce equivocality.

In some cases, phone conversations are also used to coordinate assignments. These cases mostly involve 'ad-hoc' coordination of assignments. E.g. when E-B-electrician1 receives a new assignment directly from a customer he phones the office. E-B-chief then registers the assignment in the administrator program and gives E-B-electrician1 the assignment number for this new assignment. The electrician can then register a new

assignment with this assignment number in Blueapp on his PDA. In these cases studies, phone conversations are used to reduce equivocality.

The workers also occasionally coordinate directly with co-workers if they need help on assignments. E.g. B-chief said that some of the salesmen worked in close groups of two or three and helped each other out when one of them was running late with his visits. B-salesmen1 said that when he needed to take time off work, e.g. to visit the dentist, he phoned another salesmen and asked if he could visit one or several of his stores. Phone-conversations are used for this. They are well-suited since they can reduce equivocality, e.g. if the salesmen who is to cover for another needs to know additional information about the store, like that one of the refrigerators is out of order.

At Constructcomp the coordination of work tasks is usually communicated by face-to-face conversations from the gang leaders to the workers. The gang leaders are told what to do in the same manner by C-chief. Since the workers usually work in small groups where the group members work in close proximity to each other, face-to-face conversations are used for coordination. Walkie-talkies are preferred for remote communication within the construction site, phone conversations are used less often. A medium which is not as rich, i.e. written work plans could be used instead. However, due to the nature of the work praxis this probably would be well-suited since the administration of such documents would take up more resources.

Coordination of meetings

In all the work environments the workers attends meetings from time to time. In some of the companies meetings are held quite often and on a regular basis, e.g. every other week, while in other companies meetings are held very seldom. Meetings are usually held because the administration believes that the workers should meet to discuss some issues at hand. It is therefore usually the administration which calls for these meetings. The workers are made aware of meetings by being told so in either face-to-face conversation, phone conversations or in SMS messages. In the work environments where there is a small number of employees and the workers stop by the office regularly, e.g. Plumbcomp and Elcomp B meetings are announced through face-to-face conversations. In the work environments were the workers seldom visit the office, e.g. Brewcomp and Elcomp A, the workers receive information about meetings by phone conversations or as SMS messages. E.g. at Brewcomp B-chief have regular meetings with the salesmen every other week. When B-chief decides upon a time for a new meeting he tells this to B-planner who uses an Internet SMS messaging service where he has stored the mobile phone numbers of all the salesmen to send out the same SMS message to all the salesmen. Since this information is meant to reduce uncertainty, a lean medium like SMS is sufficient.

7.2.2.3 Task work communication

According to Graveline et al (2000, p. 384), the aim of task work communication is to reduce equivocality which occurs in relation to work tasks. Rich, synchronous, multi-channel media should be used.

Task work communication is meant to solve problems related to work tasks. The problems which occur are usually that a worker needs help to solve a task at hand. The worker then contacts the administration or his co-workers to get help. Help in this case can either be that he is explained how to complete the task or that another worker travels to the customer's location he is at and helps him complete the task.

Phone conversations are usually used for such communication. The worker phones either his supervisor or a co-worker to get help. Since a phone conversation is a rich medium, it is well-suited for this kind of communication. Some of the workers travel to the office to talk to the administration or co-workers there about the problem. The reason for this is that a face-to-face conversation is the best suited medium to reduce equivocality. In addition, other media can be used at the same time, i.e. while having the conversation, in order to solve the problem. E.g. P-observe at Plumbcomp said that some times when he encounters a problem he can not solve he uses a digital camera to take a photograph of the problem, e.g. a plumbing system, and travel to the office and shows the picture to his foreman. The combination of these to media, face-to-face conversation and digital photography, makes it easier for the plumber and the foreman to reduce the equivocality at hand.

If the problem that is encountered requires a short answer, e.g. "which screw should I use for this situation?" SMS is used. In these situations SMS is suited since the equivocality is relatively low.

7.2.2.4 Documentation

Documentation is performed in the work environments in order to reduce uncertainty; there is a need to have information regarding what the workers have done when they worked on specific assignments. Lean, single-channel media are well-suited for this kind of communication. The are two purposes for documenting the work in the work environments; the administration needs to have this in case there are future enquiries from customers regarding what has been done, and there are governmental rules and laws that demand that certain aspects of the work that is performed is documented. However, in this thesis, only one purpose is considered, documentation of what has been done during assignments, since the communication is not influenced by the differences.

It can be claimed that information about parts used and working-hours related to assignments belong to this category, even though this was mentioned in relation to group management. The reason why this was mentioned in the group management section was that assignment information usually is delivered to the administration after the completion of assignments, and that this marks the end of the assignment for the workers.

The important issue here, however, is that this kind of information is meant to reduce uncertainty and therefore requires a lean, single-channel medium should be used. In the work environments Blueapp and assignment notes are used.

In the Blueapp case, the workers have to fill out a checklist in Blueapp when they have completed the work tasks on the assignment. This checklist includes questions of which tasks have been done and which what laws that apply for the assignment. This information is communicated to the administrator / economy program when the worker synchronizes. The administration stores these checklists as digital documentation together with the other assignment information. The documentation is also printed to paper documents and sent to the customer along with the invoice. Digital (e.g. information in Blueapp on the PDA or on the Blueapp server) and paper documents are well suited for reducing the uncertainty in this communication situation.

At Plumbcomp, the week summary document is used. Although this document contains much of the same information which is registered in Blueapp and on the assignment notes, the week summary has a different purpose; they are meant to reduce equivocality. While the assignment notes and Blueapp are both used in the coordination of workers and assignments, the week summaries are meant to reduce equivocality; they are used to double-check what is registered in the other two 'systems'. This document is only present in one of the work environments and is therefore not included in 7.2 or figure 7.9.

Documentation is especially important for Constructcomp; there are many laws and rules that regulate the construction of buildings. The workers have to fill out paper documents were they document which tasks they have done at the end of every work-day. This usually takes up 10-15 minutes of their time. The documents are delivered to C-chief who systemize them and sends them to the central Constructcomp office and to the government if needed. Paper documents are well-suited for this communication.

At Brewcomp the salesmen are not obliged to document their work. However, occasionally B-chief arranges for contests where the salesman with the best looking soda display in his store wins a prize. The salesmen borrow a digital camera from their district manager or use their own camera to document the work. B-chief also encourages the salesmen to take many pictures of the displays in other ways; at the regular meetings he often shows some of the pictures that he thinks are the best. Some of the salesmen take pictures which they store in their own private 'bragging albums' on their own PC. The pictures are uploaded with a link to either B-chiefs PC directly at the office or the salesmen upload the pictures to their private PC and send the pictures in an e-mail to B-chief.

Digital cameras are used for documentation at Plumbcomp, Elcomp A, Constructcomp and Brewcomp. At Plumbcomp the plumbers take pictures of the plumbing systems when they install large plumbing systems in buildings. They do this because after the floor has been laid they have want proof of how the plumbing system is constructed. According to P-chief they have been in need of this documentation several times, e.g. when the customer has complaints something after the assignment is completed and a concrete

floor has been laid over the plumbing system. The digital photographs are uploaded to the companies PC using a link cable. At Elcomp A digital cameras are used very seldom. E-A-chief said that "it is impossible to take a picture of electricity with a digital camera". The only time they are used is for assignments were situation reports are made. Then they take pictures before and after the problems in the electrical system have been solved. The electricians have to visit E-A-chief who in order to upload the pictures to his PC. He uses a link cable for this, and stores the pictures on his computer in directories corresponding to customers. At the construction sites, the digital cameras are used quite often as well. They are used for documentation. The pictures need to be uploaded to C-chief's PC using a link cable.

7.2.2.5 Tool/media communication

Tool/media communication is either intended to reduce uncertainty or equivocality related to the use of communication media in work environments. A lean, asynchronous, single-channel medium should be chosen for uncertainty reduction, while a rich, synchronous, multi-channel medium should be chosen for equivocality reduction.

The investigation of the work environments showed that communication with this purpose usually was related to the use of Blueapp or the PDAs, e.g. that it 'freezes' the information. When the workers encounter problems with the use of Blueapp they contact either someone in the administration who has good knowledge of Blueapp or a co-worker who they believe can help them. E.g. at Plumbcomp P-chief is usually contacted since he is the one with most knowledge about Blueapp, while at Elcomp A either E-A-chief or E-A-electrician1, who is considered to be a 'power-user', is contacted. The problems usually involve problem solving which demands a rich medium. The workers either visit the office and have a face-to-face conversation with someone in the administration that has good knowledge of Blueapp, or they phone someone they believe can help them. For problems which only require more information to be solved, e.g. "which screen resolution should I use", a lean, asynchronous, single channel medium can be used. SMS is sometimes used in these situations, and is well-suited for this.

7.2.3 Technology use in the work environments

In the previous subsection, the use of communication genres in the work environments and their appropriateness in the communication situations they are used in was discussed. In this subsection, the use of technology, i.e. the technological devices which are used in communication situations, are discussed and related to the discussion in the previous sections.

7.2.3.1 Information and communication technologies

The media which were presented in table 7.2 on page 80, with the exception of face-to-face communication, can all be related to technology, e.g. some type of technological device is used in the communication situation. In section 4.4 (page 32), ICTs were divided into two categories; information technology and communication technology. In

this subsection the ICTs that are used in the work environments are related to these categories. Paper documents can bee seen as a technology. Paper documents can not, however, be called an ICT, they are therefore not related to the discussion of information vs. communication technology.

In the work environments, Blueapp is mostly used as an information technology. Information is communicated from the Blueapp server, to the PDAs or pocket PCs and back to the Blueapp server again, nonetheless it is an information technology. The reason is that when the information is communicated due to synchronization the sender, e.g. E-A-chief at Elcomp A who registers an assignment and assigns it to an electrician, is not expecting the receiver, e.g. E-A-electrician1, to reply. Likewise, when the workers register data in Blueapp and this is communicated due to synchronization to the administration that will generate invoices, they do not expect a reply. The same is the case with the use of the digital cameras; the workers use them to collect data and communicate this data to the administration using a link cable, however they do not expect a reply to this communication.

In the work environments mobile phones are used for three different communication media; conversations, SMS messages and PLAN messages. The PLAN messages are another example of information technology; B-planner sends out PLAN messages, but the salesmen do not reply to them. Phone conversations and SMS messaging are the only two services which are used extensively for communication in the work environments. Phone conversations involve a dialogue between the caller and the person that is called, where information is exchanged. SMS messages are sent for two reasons; to send information without expectation of an answer, e.g. PLAN messages, and to ask a question which one expects to be answered. Phone conversations are synchronous; the receiver gets the information immediately after the sender 'sends' it. SMS messages can be used to communicate in a nearly synchronous manner. Messaging is synchronous in the way that the receiver receives the messages (almost) immediately when the sender initiates the 'send command' on his mobile phone. However, it is up to the receiver to decide if he wants to answer the message immediately or wait until later. The sender does not even have a guarantee that the receiver has read the message.

7.2.3.2 Why do the workers use the ICTs?

An important issue which influences the use of technology in the work environments has not been discussed yet; why do the workers use the technology that they use? In all the work environments that were investigated, the administration has developed rules for how information should be handled in the work environments. However, these rules are not always followed. In the Blueapp case, the workers still use paper and pen for 'in-situ' registration and update Blueapp after the completion of the assignment or at the end of the work day. In fact, at Plumbcomp the administration still demands that the old system, assignment notes, should be used even though a new system, Blueapp, has been implemented several years ago. At Brewcomp the salesmen choose not to follow the PLAN messages, instead they visit the stores in the order that they feel is the best. At Constructcomp the only information the workers have to register is the documentation of

what they have done; still they fail to do this properly. The administration in these companies have spent much money on implementing information handling routines, and use a lot of resources, i.e. manpower/working-hours, to handle this information on a daily basis.

What is the reason for this? As mentioned in chapter 6, the work praxis in the work environments remains the same as prior to the introduction of new information handling routines. The companies might gain from investigating their work praxis closer and try to discover 'what went wrong' during the introduction of the new routines/ICT. Many of the workers that were interviewed in the case studies have e.g. said that they have received only a minimum of information regarding the use of new ICTs. Another reason might be the fact that workers usually use the ICT which is easiest for them to use in the situation that they are in. The use of pen and paper for 'in-situ' registration due to mobile mobility properties was discussed in section 7.1.3.1 (page 70). Another important reason is that the workers in most cases have nothing to gain from following the routines for information handling. In general, the workers feel that their actual work consist of practical tasks, like installing a toilet, repairing a fuse cabinet, erect a wall or display soda in a store. Information handling is seen as extra work which they need to do in order to please the administration. The most evident example of this is at Plumbcomp where the plumbers do not understand why they need to register the same information three times for each assignment. These issues could be discussed in more detail; however, they are not in this thesis. The important issue is, however, that if a new ICT like MMS should be introduced into the work environments, the workers need to see that it would benefit them in their work praxis. In addition, the new ICT should not demand a drastic change in the work praxis, since this is difficult to implement.

7.2.3.3 The influence of the technological drivers

According to Lyytinen and Yoo (2001), mobility, digital convergence and mass scale are technological drivers towards nomadic information environments, see figure 4.4 on page 34. Relating this to the work environments that have been investigated, one can say that these drivers have been influential in changing the work praxis. Until recently blue-collar professions have been considered to be somewhat slower in the adoption of new technology. The exception is the use of mobile phones for voice communication. Usually, new services have been aimed at and adopted by white-collars. One of the reasons for this is perhaps that the work tasks of blue-collars are largely based on practical skills and craftsmanship. E.g. an electrician travels from customer to customer and installs or fixes something at each location using his skills alone. The blue-collars usually have no need for obtaining and handling large quantities of information or communicate with others in order to complete their tasks. White-collars, on the other hand, often need to handle information and communicate with co-workers and customers.

The ICT services that are used are both generic services like mobile phone services, and services that have been designed specially to the work praxis in these environments; Blueapp and PLAN. The ICTs offer services that can be called a digital convergence of the technology and services which were used earlier. E.g. Blueapp organizes the parts

which are used and the working-hours relating to assignments. Because of this it is no longer necessary to record working-hours in a form or record the parts used in a note book or on the assignment note. (However, some of the workers still do both). The paper documents have been digitalized and converged with other technologies, i.e. prior to Blueapp the registration of working-hours and parts were on separate sheets of paper, now both is registered relating to an assignment in Blueapp. In Norway close to everyone have mobile phones. In the work environments everyone carry their phone with them at all times. The mass scale of mobile phones has made them convenient to use for communication in work environments. I.e. a worker knows that everyone he needs to contact has a mobile phone, so he only needs their phone number in order to reach them. Brewcomp and Elcomp A have understood the need for mobile phones in the work praxis and have bought phones for all their employees. Brewcomp even pay for the use of the mobile phones, with a 5000 kroner limit a year, since they know that they are essential to the work praxis of the salesmen. Mobility issues were discussed in section 7.1, the relation between the use of communication genres and the mobility of people and technology is discussed in section 7.4.

The technological drivers have influenced the use of technology in the work environments, making them what they are today. The technological drivers will continue to influence the work environments making them more and more like nomadic information environments (Lyytinen and Yoo 2001), i.e. ICT will become more and more important in the work environments. Smartphones / hybrid technology is perhaps the ICT device which might have the greatest influence on the work environments. The reason for this is not that the workers or administration necessarily will buy such phones because they feel that it might aid them in their work, however, most new mobile phones have hybrid functionality (i.e. functionality from several different 'old' devices) and it is likely that some of the new possibilities these devices bring will be tried out in the work environments. A new service which will become available on some new mobile phones in 2004 is 'push to talk', which in short means that walkie-talkie functionality is available on mobile phones[16]. This service might make it the use of walkie-talkies obsolete at Constructcomp; instead of carrying both mobile phones and walkie-talkies (something which many do), the worker will only need the mobile phone. These matters are not discussed further in this thesis, with one exception; the digital convergence of mobile phones and digital cameras. This is done in section 7.3, in the discussion of MMS.

7.2.4 Communication in the work environments: A summary

In this section the handling of the flow of information in the work environments has been discussed. The investigation of the nomadic work environments has identified five purposes for communication in the work environments; interpersonal communication, group management, task work communication, documentation and tool/media communication. Several different media were used for each of these purposes. All in all there are 19 genres of communication, i.e. combinations of purpose and media. In general, it can be stated that the media are well-suited for the purposes they are used for.

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16 Newspaper articles concerning 'push to talk': http://pub.tv2.no/nettavisen/it/article189320.ece and http://www.dagbladet.no/dinside/2004/02/25/391858.html (both articles in Norwegian)

Rich, synchronous, multi-channel media are used when there is a need to reduce equivocality and lean, asynchronous media are used to reduce uncertainty. Many of the workers in the work environments feel that they do not benefit from using new media which have been introduced into the work environments, and therefore fail to use them as is intended by the administration. Hence, it is important that the workers who use the media have some benefits from using them; if not other media will be preferred. The digital convergence of technology and the mass scale of mobile phones has influenced the work environments making them what they are today. In the future the work environments will continue to evolve, and ICT will become even more important to the work praxis.

7.3   Multimedia messaging in the work environments

In this section, the properties of MMS as a communication medium, and which communication situations it is best suited for is discussed. The aim of this discussion is to uncover the potential of genres of multimedia messaging in the nomadic work environments.

In section 7.3.1, the media richness of MMS is discussed and related to what previous research has found concerning the properties of MMS as a communication medium. The appropriateness of multimedia messaging for the five purposes for communication which were identified in section 7.2.1 is discussed in section 7.3.2. In section 7.3.3, the possible adoption of genres of multimedia messaging in the work environments is discussed. Other issues that are relevant to the discussion of MMS are discussed in section 7.3.4.

7.3.1 The media richness of MMS messages

MMS messages have been analyzed as a communication medium using the same properties that were used to analyze the media richness of the media that are used in the nomadic work environments, table 7.2 on page 80. The result is presented in presented in table 7.3.

Form / medium	Feedback capability	Availability of multiple cues	Language variety	Personal focus	Media richness
MMS messages	Synchronous and asynchronous	Multimedia presentation; picture, text and sound can be displayed simultaneously on a phone display or a PC monitor (if sent to a PC)	Pictures, text, sound clips, video clips	Semi personal	Medium

Table 7.3: The richness of the multimedia messages.

MMS messages can be said to have a medium richness. As is the case for SMS messages they can be either synchronous or asynchronous. If a message is opened immediately after it is received and an answer is created and sent immediately as well, the medium can be called synchronous. It is not as synchronous as e.g. a phone conversation since there is a delay between the moment the sender sends his message and the moment he receives the answer. Still, it is synchronous in the sense that the receiver of the message sends his answer immediately after receiving the message. Depending on the elements that are inserted into the message it can be either faster (i.e. more synchronous) or slower (i.e. less synchronous) to respond than it is with an SMS. If just a picture is inserted and sent as a reply it is faster / as fast as responding with a short text message (SMS), however, if the message is created with several elements it can be slower than responding with an SMS (depending on the length of the SMS message). If the receiver of the message does not read the message instantaneously or waits before he responds, the communication is asynchronous. Pedersen et al. (2003, p. 6) say that MMS is asynchronous, while SMS is somewhat synchronous (see table 2.3, section 2.5). They do not describe why they have this view however. In the MEMO project (Julsrud et al. 2004, Ling et al. and Ling and Julsrud) messaging services are understood as "asynchronous peer-to-peer communication either by text, pictures, sound video or animations" (Julsrud et al. 2004, p. 3). In Ling et al., however, it is stated that SMS is more conversational-like than e.g. e-mail, and they reference one of their interviewees:

> "Per(24): For me it is like when I send an SMS that I expect to get an answer immediately. If you write e-mail then you think that it can go a whole day, not all the time but you think that you will get an answer during the day. E-mail is often about things that you do not need immediate answer to."

Based on the discussion above, however, there is no real reason why MMS in general should be considered as an asynchronous medium. The users determine the level of synchronicity. In addition to the synchronicity decided by the users, synchronicity is also affected by the communication network. The technology tests have shown that there is not yet a guarantee that an MMS will arrive at the receivers end immediately after it is sent. Many of the initial problems when the service was first introduced have been fixed but problems still occur. E.g. the author of this thesis received an MMS on March 30. that was sent on March 12. However, in general, one can say that the network will ensure synchronous delivery of MMS messages.

Ling et al.'s article does not discuss how conversational-like MMS messaging is. Based on the technology test of MMS messaging, however, it can be claimed that SMS and MMS are similar at this point as well. When the receiver receives an MMS he is notified in the same way as with an SMS, with a audible tune and / or vibration. Based on experience, it can be claimed that MMS messages are read instantaneously, just as SMS are. Concerning answering the message, they are also answered in the same fashion as SMS'. The difference is that while an SMS usually is answered by an SMS, an MMS message is often answered by an SMS message. This phenomenon has not been investigated in detail, however, it is an interesting phenomenon. One of the reasons for answering using a different medium can be that while the initial message is meant to

reduce equivocality, i.e. the sender is uncertain of how to solve a problem, the answer is meant to reduce uncertainty, i.e. the (initial) sender only needs a textual description to solve the problem. This change of media also occur when other media are used, if a richer medium is needed; e.g. in the case studies B-salesman1 said that if he receives a PLAN message that contains a grocery store that is not one of his regular stores he always phones B-planner. However, for MMS it seems that the answer usually does not need to contain more than text. In some cases, however, an MMS is answered with a richer medium, e.g. a phone conversation, if this is necessary in order to reduce the equivocality.

MMS messages can include multiple cues, since they can present several elements at the same time; e.g. a message shows a picture with a short caption underneath it while a sound clip explains what is depicted in the picture. The 'language' used to construct MMS messages includes picture, sound clips, text and video clips. In addition, these elements can be structured on 'pages' in the message and can be put together to form a multimedia presentation. This presentation can be structured by setting the start and stop time and duration of each element. MMS messages are semi-personal. A message can be sent to one or several respondents and be tailored in various ways to that / those respondents.

MMS messages are semi personal, like SMS messages are. However, they offer additional cues which can be used to personalize the messages even more than SMS can. I.e. personal pictures can be inserted along with text and recorded sound clips, while SMS only offers text to be included. MMS messages can be sent to one respondent or be more generic and sent to many respondents.

All in all, it can be concluded that MMS messages have medium richness. In figure 6.12 they are illustrated as having a higher media richness of SMS which also has medium richness. The reason for this the availability of multiple cues and the language variety which MMS offers. MMS can be used to reduce both uncertainty and equivocality; MMS messages can include large textual descriptions which can help solve uncertainty and they can include pictures which can help explain ambiguity.
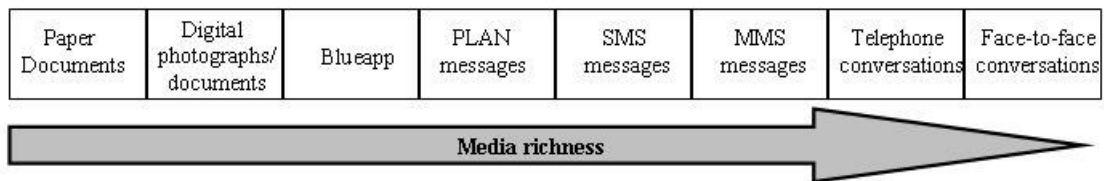

Figure 7.10: Classification of media richness of media used in the work environments and MMS messages.

7.3.2 The appropriateness of multimedia messaging in different communication situations

In section 7.2.1, five purposes for communication, i.e. communication situations, were discussed in relation to the use of media in the work environments. In this section, the possible use of multimedia messaging for each of these five purposes will be described. First, however, the genres of messaging found in the MEMO project will be discussed and related to these genres. Ling et al. (p. 9, table 1) found 18 genres of SMS messaging in their "analysis of 865 messages gathered from a random sample of Norwegians (all age groups) in 2002". Julsrud et al. (2004) relate these to the genres which they have found in their case study of blue-collar workers, soda salesmen and real-estate brokers. Most of the genres of SMS can be said to fit into the 'interpersonal communication' genre used in this thesis. The 'middle future coordination' and 'near future coordination' genres can be related to the 'task work communication genre' used in this thesis. The 'questions,' 'commands/requests' and 'information' genres can be related to the 'task work communication' and 'tool/media communication' genres used in this thesis. Of the SMS genres found by Ling et al., the majority of the SMS messages, 23 percent, belonged to the 'middle future coordination' genre. Julsrud et al. (2002) and Ling and Julsrud found 5 genres of MMS communication when they analyzed the qualitative data collected from their case study; 'visual documentation,' 'explanations and illustrations,' 'snapshots,' 'chain messages' and 'vacation pictures and greetings'. The 'snapshots,' 'chain messages' and 'vacation pictures and greetings' genres can all be said to be examples of interpersonal communication. The 'visual documentation' genre can be related to the 'documentation' genre used in this thesis. 'Explanations and illustrations' are examples of task work communication. Their results are based on the feedback they got from the workers after they had tried out MMS in their work praxis for several months, they were all given MMS-enabled phones (Nokia 7650). The results show that the soda salesmen were the ones that used MMS the most, it was used mostly for documentation and interpersonal communication. The blue-collars also used MMS quite much, most of the messages were interpersonal communication, however, task work communication was also starting to become popular. The real-estate brokers did not use MMS that much, and they only used it for interpersonal communication. The five genres presented in section 7.2.1 are used in this thesis since by using them is easier to compare the possibilities genres of multimedia messaging with the genres of communication already in use in the work environments studied in the case studies.

7.3.2.1 Interpersonal communication

MMS can be said to be more suited for interpersonal communication than SMS, since it is somewhat richer as a medium. However, it lacks the high level of synchronicity of phone conversations and face-to-face conversations, and therefore is not as suited as these media. The question, however, is how can they be used for interpersonal communication among the workers in the work environments and between the workers and their family and friends? The amount of interpersonal communication between co-workers who are not co-located was limited in the work environments. Phones or SMS messages were used for this purpose. It therefore seems unlikely that the possibility to

send personal messages with pictures in them would change this. The plumbers, P-plumbers, did, however, say in a humorous tone that they could use MMS messages to send pornographic images to one-another. Even though pornography has been predicted to be one of the prime uses for MMS messaging, it is unlikely that MMS will be used for this on a large scale in the work environments. It is likely, however, that the workers will receive MMS-messages from family members or friends, containing pictures. I.e. a worker can receive messages which include pictures of his child from his wife. This use is unlikely to have an impact on the work praxis since it would only substitute current SMS or phone communications.

The MEMO project (Julsrud et al. 2004) found that there was an extensive use of MMS for interpersonal communication between the workers. Chain messages and Snapshots were most common. A reason for this is that the workers in their case studies worked close in teams and therefore had a strong internal social structure. It is uncertain, however, if this is representative for how MMS will be used in such work environments since the workers had been given free phones by the researcher, they were urged to try out this new service, and since MMS was offered free of charge by the network operators (Telenor and NetCom) at the time of the case study.

7.3.2.2 Group management

MMS messages are likely to be used in situations were SMS messages do not suffice in richness for the communication situation at hand. MMS messaging will probably not have an influence on the group management since textual information usually is enough to coordinate work activities. In some cases where there is a need to reduce equivocality in relation to coordination, MMS might be helpful. E.g. in the Brewcomp case the salesmen could receive a MMS if they are assigned to a grocery store that is not one of their regular ones. This MMS could contain a longer textual explanation for this (longer than SMS, which only can contain 160 characters), and / or a sound clip where B-planner explains the reason, and a map which shows the location of the grocery store. If such a PLAN is used, the salesmen might not need to phone B-planner for additional information.

7.3.2.3 Task work communication

In situations where there is a need to reduce equivocality, MMS messages containing pictures can be used. Some of the workers say that MMS communication might aid them in their work praxis. E.g. P-observe said that currently he sometimes use his digital camera to take a picture of a problem and travels to the office to show it to P-chief. If he could send a picture of the problem as an MMS message instead, he would not have to visit the office. One of the key issues with MMS' suitability for task work communication is the quality of the pictures. If the pictures are sent to a mobile phone, the display of the phone limits the quality. So if the worker needs help from a co-worker who only carries a mobile phone, the picture needs to be easy-understandable in order to be of any use. This means that pictures with many details are unlikely to be of any use. The displays of mobiles phones are constantly being improved, i.e. the Sony Ericsson

S700 has a large display with 262k color-depth, which will improve the usability. Today's mobile phone displays, however, are not well-suited for this use. If the picture is sent to a PC, something which is likely in e.g. the example of P-observe, the quality is limited by the resolution of the picture. Most of the phones available offer a resolution of ca. 0.3 mega pixels (640 x 480 pixels). These pictures are not well suited for illustrating details. Most of the mobile phone manufacturers have announced the production of camera phones with much higher resolution capabilities, e.g. S700 with 1.3 mega pixels. This will strongly improve the usability of MMS messages for task work communication, but still the pictures are not as good as the pictures taken with digital cameras. In the future it is likely that the difference between the quality of pictures taken with a mobile phone and a common digital camera will be far less / insignificant. The lighting in the place a picture is taken is also important to the quality of the picture. The place needs to be well-lit if the picture is to be of any use. Future phone models that have been announced will have integrated flash functionality. This will probably improve the usability of MMS messaging.

Ling et al. (p. 18) refer to a situation where MMS can be used for task work communication in order to reduce equivocality, and say that "a picture, at least in this case, is worth a thousand words". They say that sometimes it is much simpler to describe a situation with a picture than with text; it often difficult to describe something precisely with text alone. And in addition, the sender does not always have the correct vocabulary to describe the situation. In the work environments this is the purpose that MMS is best suited for. Julsrud et al. (2004) also say that this use of multimedia messaging seems to be very promising.

7.3.2.4 Documentation

In all the work environments digital cameras are sometimes used to document the work that needs to be done or that has been completed. These pictures are usually uploaded to a PC at the office. If these pictures could be sent as MMS messages to the company's PC instead, this would eliminate the need to travel to the office in order to deliver the pictures. The quality of the pictures that are to be used for documentation is even more important than it is for task work communication. The pictures need to show a detailed image of the work that has been completed, if not they are not usable for documentation. Therefore, the pictures which can be taken with today camera phones can be said, in general, not to suffice for this purpose. Future phones will have to be tested for this purpose to see if the pictures have the demanded quality. In some cases where the need for quality is not as high, the picture quality is good enough. This is generally the case for the pictures which the soda salesmen take of the soda-displays that they have created in their stores.

Julsrud et al. (2004) say that the quality of the pictures was sufficient for internal use in the work environments, i.e. for task work communication between workers and documentation that was meant for use in the organization only. The workers they interviewed said that the demands for picture quality were higher for external use, i.e. when they need to send pictures to a customer. Julsrud et al. say that increased quality of

the pictures will have probably have a huge impact on the future use of genres of MMS communication in work environments. Ling et al. say that:

> "[An] emerging MMS genre is documentation. The soft-drink sales people discussed this […] In their work, they are extremely concerned with the placement of their products in the various stores. The competition between the different brands for optimal placement means that the territory within the store is carefully monitored. […] The soft drink sales people found MMS useful in documenting, in real time, the placement of the product inside the store. The photos were taken, transmitted to their boss and interpreted vis-à-vis the agreements as to the contractual placement of the products."
>
> (Ling et al., pp. 16-17)

Ling et al. also describe how carpenters use MMS messages to document what they have built and send the pictures to the architect of the construction for approval. The carpenters themselves say that the pictures are saved for documentation, even though the quality of the pictures are not as good as they should be. The results found in this thesis agree with the findings of the MEMO project; documentation using MMS is likely to be one of the most important purposes for using this genre.

7.3.2.5 Tool/media communication

It is unlikely that MMS will be used on a large scale for this kind of communication. The problems which the workers need to communicate usually require rich media in order to reduce equivocality. In such situations the workers often need to interact with the medium which they have problems with while they are communicating with someone. A rich medium, synchronous is best suited for this. E.g. if when an electrician experiences that Blueapp 'freezes' on his PDA, he has a phone conversation or a face-to-face conversation with someone who can help him. A synchronous conversation lets the worker try to fix the problem while communicating; i.e. he can interact with Blueapp while talking on the phone.

7.3.3 The adoption of genres of multimedia messaging

In the previous subsection the appropriateness of genres of multimedia messaging in the work environments was discussed. In this subsection some of the factors that will influence the possible adoption of these genres to handle the flow of information in the work environments are discussed.

In section 4.5, table 4.3 on page 36, Pedersen et al.'s (2003) characteristics of SMS and MMS were presented. According to Pedersen et al., the main difference between SMS and MMS is channel capacity. While SMS offers only text, MMS allows text, pictures, sound, video and animations which are presented using multiple cues. This has already influenced the adoption of MMS. Marketing campaigns on TV in newspapers etc. have focused on the possibility of sending pictures. The novelty of picture messages has

probably been influential for the early adopters; innovators have wanted to investigate this new medium.

Regarding the adoption of MMS, one of the key findings of Pedersen et al. (ibid., p. 56) is that "expressiveness and enjoyment are the main motivations for using, whereas usefulness and attitudes are not". As discussed in section 4.5., their result may be due to the nature of the study they conducted. The results from this thesis show that many of the workers see situations in their work praxis where MMS might ease the handling of the flow of information. E.g. the P-observe who uses a regular digital camera for task work communication and who has to travel to the office to get help from P-chief.

Julsrud et al. (2004) describe four factors which influence the evolution and establishing of genres of multimedia messaging in work environments; existing genres, job-related motivation, group structure and comparative advantages. Since MMS is a new medium in work environments, its possibilities is dependant upon the genres which currently are used for communication. In the work environments that have been studied, the use of mobile phones is well-adopted. This is influential, since the workers already are familiar with the device they need to use the medium, i.e. send MMS messages. Several genres of SMS messages are well adopted in the work environments, e.g. the use of PLAN messages for group management. The introduction of MMS might be easier due to the fact that the workers already are familiar with messaging as a way of communicating. In order for genres of MMS messages to establish themselves in the work environments it is important that the users of the genres have something to gain from this. As discussed earlier the common workers did not see in what way the PLAN system or Blueapp would benefit them, their only seemed to be real advantages for the administration, therefore the workers continued working as they were used to, i.e. they do not work according to the PLAN and they use pen and paper for 'in-situ' registrations of information instead of Blueapp. It seems that the workers also will benefit if they start using MMS, e.g. for task work communication; P-observe certainly believed this. The salesmen would also benefit from this, since they all would have their own cameras and would not have to upload the pictures to a PC using a link cable when they take pictures to document their 'exhibitions'. Julsrud et al. (2004) found this among the soda salesmen which were part of their case study also. Unlike what was the case in the work environments studied by the MEMO project, the work environments studied in this thesis did not seem to involve much group activities. This result might be erroneous, however, since the workers at Constructcomp and the workers at Elcomp A and B which worked in small groups were not interviewed about this or observed while they work. The hierarchical structure might, however, influence the adoption of MMS. In both the Blueapp case and the Brewcomp case it was the administration which governed the introduction of new media, and hence influenced the adoption of communication genres. E.g. at Brewcomp, B-chief arranges contest where the salesmen are asked to take pictures of their 'exhibitions', the best pictures are rewarded with money bonuses. If such incentives are used for MMS as well this will influence the adoption. However, it is also likely that the adoption of MMS will be influenced by private use in the same way that SMS was; SMS was adopted as a communication service in everyday live and 'moved into' the work environments. The comparative advantages of MMS, e.g. that it is possible to take pictures with the mobile

phone instead of having to carry two devices (mobile phone and (digital) camera) will also influence the adoption of MMS genres. MMM adoption will, in addition, be influenced by the quality of the pictures and the mobile phone displays, and user friendliness of the mobile phones and there software.

7.3.4 Other issues

MMS messages are usually sent using mobile phones. As mentioned before, this limits the usability of the medium to the properties of the mobile phone. The size and color-depth of the display limits the quality of the pictures. In addition, the data input devices limit the usability of the medium. As is the case with SMS messages, the input of text has to be done with the keypad. Some people write messages very quickly because they are familiar with the location of the characters and the usage of 'dictionaries' like 'T9'. Others think it is troublesome to write this way, and prefer to send very short message, i.e. containing only one word or phrase like "OK" or "Will do". Taking pictures and inserting these into an MMS message is also influenced by the way this is done. Most of the new phones have very small keys, this makes it difficult for those who have large fingers to operate the keys in an effective manner. C-chief said that it is very important that ICT solutions are as easy to use as possible for the workers and that inputting data requires very little effort. At Plumbcomp the plumbers opposed that PDAs should be replace the pocket PCs. The reason for this is that the PDAs have keyboards which make it easier to write text. All these issues are issues which reflect the micro mobility issues of the devices. In order for the MMS message to be of any use in the work environments it is important that the micro mobility properties of the mobile phones makes is as easy as possible to send pictures. QuickShare is an example of how the mobile manufactures try to facilitate the sending of multimedia messages.

In this thesis, the investigation of actual use of MMS is limited to technology testing. There has been no observation or interviews which can shed light on actual usage of such messages. Such an investigation could have given additional information concerning the potential of MMS in work environments. This would make it possible to better understand what influence multimedia messaging will have on the handling of information in nomadic work environments.

Both Koskinen et al. (2002) and Ling et al point out that messages which contain pictures can be interpreted in several ways:

> "[T]here is, it seems, a much broader potential for mismatch between intention an interpretation with MMS and photographic communications than with text. […] Where the text of an SMS will, in all likelihood, be interpretable in 100 years, or by those outside the immediate interaction, an MMS message that bases itself on a photograph may only be understood in the immediate context."
>
> (Ling et al., p. 20)

> "[I]mage-based interaction is situated: the result of sending a visual message is dependent on how the recipients interpret it and how they express their interpretation."
>
> (Koskinen et al. 2002, p. 33)

Koskinen et al. point out that it in order to reduce the chance of misinterpretations, it is important to add textual descriptions to the pictures. If MMS is to be used as a communicational tool in the work environments the use of textual descriptions / captions to pictures would improve the probability that the person who reads the message will understand the intent of the sender. For messages which are meant to reduce equivocality related to tasks such captions are very important to give the recipient a context in which to interpret the pictures. Pictures which are meant to be documentation need to be captioned as well; either with a subject which explains the content of the MMS message, with a caption in the message or with a descriptive file name for the picture. MMS also allows for sound clips to be included, this can be used to describe pictures as well.

Is MMS messaging an information- or communication technology? The two other mobile phone services which have been discussed in this thesis, phone conversations and SMS messaging, are both communication services. When someone (sender) calls or sends an SMS to someone else (receiver) it is with the intent that they want an answer. In some cases, the intent is just to distribute information. PLAN messages are an example of this. However, generally, an answer is expected. As mentioned, actual use of MMS messaging has not been investigated in detail. It is therefore difficult to claim that MMS messages usually results in an answer. The technology test, however, show that sending an MMS message often result in an SMS message as a reply. I.e. a message containing i.e. a photograph is sent and a textual answer is returned. If this can be said to be how MMS communication generally transpires, it can be called an information technology. Most mobile phone manufacturer seem to have noticed this and have changed their MMS-software to make it possible to answer an MMS with an SMS. In older phones you could only choose to answer an MMS with another MMS, if you wanted to send an SMS you would have to exit the MMS message, and go to the SMS creation program. Newer phones let you choose which medium you want to use to answer. Even though there is a change of media, this makes the service better suited as a communication service.

Multimedia messaging can be said to be the result of digital convergence between many media; the mobile phone, (digital) pictures, written messages etc. The convergence of all these media into a mobile phone capable of taking pictures and communicating them to others has resulted in that fewer technological artifacts / devices will be needed in the work environments. E.g. if the pictures taken with a mobile phone have satisfactory quality, the common digital cameras are no longer needed. Blueapp Corp. aims at including picture handling in the next Blueapp version. This is also a form of digital convergence. This will perhaps be a competing medium to MMS in some of the work environments. The administration will perhaps prefer the use of Blueapp for taking and communicating pictures since the pictures then will be linked to a customer and an assignment directly. E-A-chief said that if this service will function as Blueapp Corp. has announced, it will ease his work load. In the new version of Blueapp, pictures will be

saved in directories corresponding to customers, and can be retrieved in the Blueapp administrator program by searching for assignment number, date etc. The way E-A-chief does it now is that he needs to upload the pictures from the digital cameras using a link cable and put them in the right directories manually. The workers on the other hand might prefer to use MMS since they probably will be more familiar with this service. Most new phones have MMS functionality, and it is therefore likely that the workers will familiarize themselves with how this service works. This is only hypothetical thinking, off course, since neither the actual use of MMS by the workers nor the Blueapp functionality with pictures has been investigated in actual use.

Julsrud et al. (2004, p. 35) say that the cost of MMS messages is important for private users. This is unlikely, however, to influence the adoption of the service in the work environments to a large degree. The reason for this is that if genres of MMS messages are introduced in the work environments and regularly used for work related communication, it is likely that the administration will pay for this communication. In Brewcomp the salesmen each receive 5000 kr each year to cover the use of their mobile phones. The others companies are likely to do this as well if MMS becomes an important part of the handling of the flow of information.

7.3.2 Multimedia messaging in the work environments: A summary

In this section the media richness of MMS messages and the appropriateness of genres of multimedia messaging for different purposes in the work environments has been discussed. The discussion shows that MMS has medium media richness. This is mainly due to it not being 'truly' synchronous, and that it offers multiple cues for communication. The ability to include large textual descriptions makes it well-suited for reducing uncertainty and the ability to send pictures makes it well suited for reducing equivocality as well. Five genres of multimedia communication have been discussed in relation to the work environments. Task work communication and documentation are the purposes which MMS is best suited for. The ability for nomadic workers to send pictures to a PC at the office or to the mobile phone of a co-worker, using their mobile phone is well suited for reducing the equivocality in task work communication. The ability to take pictures with camera phones to document work related information and send it to the administration is also a communication genre that is well suited in the work environments. These results are equal to what was discovered by the MEMO project (Julsrud et al. 2004).

The adoption of multimedia messaging in the work environments is likely to be easier than the adoption of other media, e.g. PLAN and Blueapp. The reason for this is that the nomadic workers see that they benefit from using this technology. In addition, the fact that MMS is available on mobile phones and that it resembles SMS which is well-adopted in the population will probable make it easier for genres of multimedia communication to be adopted in the nomadic work environments.

7.4   Mobility, genres and MMS in the work environments

Three issues have been the prime focus of this discussion chapter; the mobility of workers and technology, the workers' use of communication genres and the potential of genres of multimedia messaging in the work environments. The two last issues have been related two each other in section 7.3; the media richness of MMS has been related to the media richness of the other media that are used in the work environments, figure 7.10 on page 94, and the appropriateness of multimedia messaging for the five purposes for communication has been discussed. In this section, mobility issues are related to the use of communication genres and the potential of MMS.

The work praxis in the work environments is either traveling-based or visiting-based (discussed in section 7.1.1), what does this have to say for the use of communication genres? The nomadic workers have traveling-based work praxis usually work in an individual context. The amount of face-to-face interpersonal communication is therefore limited to when they talk with the customer or wholesaler and to the meetings they have with co-workers and the administration. The plumbers, who have star-shaped assignment networks, have regular face-to-face conversations with co-workers and the administration, since they visit the office so often. The electricians and salesmen who have circular assignment networks on the other hand, have face-to-face conversations less frequently. The electricians and construction workers who have visiting-based work praxis usually work in small groups and have frequent face-to-face conversations with co-workers. In both kinds of work praxis, interpersonal communication using phone conversations or SMS messages is limited. The need to communicate using mobile phones is, however, more frequent for traveling-based work praxis, since workers with visiting-based work praxis usually are co-located with their co-workers. It is likely that MMS messaging will be more used in traveling-based work praxis, since the workers then have the ability to send pictures to someone who is not co-located with them.

The use of genres of group management is quite different in the two types of work praxis. The plumbers, electricians and salesmen who work on several assignments each day communicate much more information regarding the coordination of assignments than the electricians and construction workers who work for the same customer for a long duration of time. In addition, the use of communication media for this purpose differs; workers with visiting-based work praxis usually coordinate work tasks by face-to-face conversations, while workers with traveling-based work praxis use mobile phone services (phone conversations, SMS and PLAN messaging), Blueapp and assignment notes to coordinate several different assignments each day. If MMS is to be used for this kind of communication, it is has potential for workers with traveling-based work praxis, and it could be used similarly to how SMS and PLAN messaging is used today.

Face-to-face conversations are frequently used for task work communication in both types of work praxis. Worker who have traveling-based work praxis often have phone conversations with co-workers or the administration when they need help solving a problem, SMS messaging and digital photographs are also occasionally used for this

purpose. For workers with traveling based work praxis MMS seems to have a large potential. This was also the result of the MEMO project (Julsrud et al. 2004).

Documentation seems to be important in both types of work environments. However, the assignments which last for weeks or months usually require more documentation due to all the regulations and laws that apply. MMS seems to have a large potential in both traveling-based and visiting-based work praxis. This viewpoint is shared by Julsrud et al. (ibid.).

Tool/media communication is rather limited in the work environments. For visiting-based work praxis face-to-face conversations is preferred for this kind of communication. Face-to-face conversations are also frequently used in traveling-based work praxis, so is phone conversations. SMS messaging is also used occasionally. The potential of MMS for this kind of communication seems limited; however, it has greater potential for traveling-based work praxis because the person with the problem usually is not co-located with the one he contacts to get help.

As was discussed in section 7.1.2, traveling-based work praxis involves limited wandering, while visiting based work praxis involves extensive wandering. Since all the media, with the exception of face-to-face conversations, are related to technology, one can say that the mobility properties of the technology determine how they can be used while wandering. The physical mobility (Luff and Heath 1998) of the technology was discussed in section 7.1.3. All the technologies support local mobility, and can be called mobile technologies, see table 4.2 on page 30, therefore they can be used while the workers are wandering. Technology that supports remote mobility, e.g. mobile phones and Blueapp, is best suited for traveling-based work praxis. All the technological devices that are used in the work environments support social mobility, social mobility was discussed in section 7.1.4.

Chapter 8

Conclusion

In this thesis, the handling of the flow of information in nomadic work environments has been discussed. The work praxis of nomadic workers, blue-collars and soda salesmen, and their use of communication genres has been investigated and discussed. The aim of the thesis has been to investigate the potential of genres of multimedia messaging in these work environments. In section 8.1 and 8.2, some conclusions that can be drawn from this investigation are presented. In section 8.3 implications and further research is discussed.

8.1.1 How are communication genres used to handle the flow of in nomadic work environments?

In this thesis, five nomadic work environments have been studied in five case studies. The work environments are all examples of typical service professions where the work praxis is centered on assignments from customers which require that the nomadic workers travel to the customer's location to perform some tasks. The focus of this thesis has been on the work praxis of the nomadic workers, blue-collars and salesmen. The work praxis has been divided into two types, traveling-based and visiting-based, based on the assignment networks, i.e. the cycle of visiting customers and traveling between locations. The difference in assignment networks was identified using theory of mobile work (Kristoffersen and Ljungberg 2000) and has been illustrated with figures.

In the nomadic work environments that have investigated, five general communication genres have been identified; interpersonal communication, group management, task work communication, documentation and tool/media communication. These genres represent the five general purposes for communication in the work environments. Different media are used for these purposes and the choice of media is different in the various work environments. Workers who have visiting-based work praxis usually work in small groups and therefore communicate by face-to-face conversations more often than workers with traveling-based work praxis who usually work individually. Workers with traveling-based work praxis work on assignments that are small in scope and visit several customers each day, while workers with visiting-based work praxis work on the same assignment for several weeks or months. The need for group management, i.e. coordination of assignments, is therefore greater for traveling-based work praxis. In three of the work environments, a new information system, Blueapp, has been introduced to make the communication of assignment-related information more effective. Blueapp is used for group management in two of these work environments, while in the third, paper documents are still used for this purpose. Task work communication and tool/media communication is somewhat different in the two types of work praxis; workers who work individually need to use mobile phones to have conversations or send SMS messages to the administration or co-workers to solve problems, while workers who work in small groups have face-to-face conversations with people who are co-located with them. I.e.

traveling-based work praxis requires that media which support remote mobility are used. In both types of work praxis, paper documents and digital cameras are used for documentation purposes. Interpersonal communication between co-workers usually occurs when the workers meet face-to-face, the amount of interpersonal communication using other communication media is limited.

The media richness of the communication media that are used in the work environments has been discussed. Generally, it can be stated that the communication media that are used are well-suited for the communication situations that that they are used in; rich, synchronous multi-channel media, e.g. phone conversations and face-to-face conversations, are used to reduce equivocality, and lean, asynchronous media are, e.g. paper documents and Blueapp, is used to reduce uncertainty. The nomadic workers tend to use the communication media they feel is best-suited for the communication situation at hand, even though the administration wants them to use other media. All the communication media, except face-to-face communication, is related to some type of technology. In general, it can be stated that the local mobility properties of the technological devices that are used are not used as intended by the administration. The workers tend to use pen and paper for 'in-situ' registration of information and update the information system they are supposed to use, i.e. Blueapp, after the completion of the assignment or at the end of the work-day. One of the reasons for this is that the micro mobility properties of pen and paper is better known to the workers and offers faster and more dependable registration of information. This result is similar to what Luff and Heath (1998) found when they investigated the introduction of a computer-based information system at a construction site; the local mobility features of the new system wasn't used and the user preferred to use pen and paper for 'in-situ' registration of information.

8.1.2 How can genres of multimedia messaging be used to handle the flow of information in nomadic work environments?

The media richness of multimedia messages influences which purposes it is suited for, since. According to Graveline et al. (1999) and Daft and Lengel (1986), rich media are suited for reducing equivocality while lean media are suited for reducing uncertainty. The media richness of multimedia messages has been analyzed and it has been determined as medium in this thesis. In addition, MMS messages are considered to be richer as a medium than SMS messages. The main reason for this is the that MMS offers multiple cues and has a more varied language, i.e. MMS offers the ability to send both pictures, sound clips, video clips, animation and text, while SMS is pure textual. MMS messages can contain large textual descriptions which can be used to reduce uncertainty and they can contain pictures which can be used to reduce equivocality.

The possibilities of multimedia messaging for the five purposes for communication that were identified in the work environments have been discussed. MMS messaging is best-suited for task work communication and documentation. This result is the same as was found by the MEMO project (Julsrud et al. 2004). The ability to send pictures to get help in solving difficult tasks, i.e. reduce uncertainty, seems promising. Digital cameras are currently used for documentation in the work environments. The ability to take pictures

with a mobile phone and send them instantaneously in MMS messages can help make the handling of information in the work environments more efficient. MMS seems to be best suited for traveling-based work praxis. Nomadic workers who are working individually will benefit from the possibility of sending picture messages to others. The physical mobility of MMS messages is tied to mobile phones. The remote and local mobility of mobile phones makes it possible to send picture messages to people at a distant location while wandering. The micro mobility properties, i.e. user interface, of MMS are similar to SMS and digital cameras. Most nomadic workers are well-accustomed to using these technologies and this will ease the adoption of multimedia messaging in work environments.

Genres of multimedia messaging seem to have a large potential in nomadic work environments. The main reason for this is that it offers a way of communicating that is new compared to other media and that it benefits the nomadic workers. Many of the nomadic workers feel that that the use of specific communication media, i.e. Blueapp, results in additional work for them and while the administration benefits from the use. This hostility has resulted in that e.g. Blueapp is not used as intended by the administration. MMS, however, seems to be a service which is will be a positive addition for nomadic workers, which will aid them in the handling of information.

8.3   Implications and further research

This thesis offers a detailed description of the work praxis of blue-collars and salesmen. The findings show that the workers use various communication media to communicate, and they use the media that they believe is best suited in the communication situation that they are in. The administration in nomadic work environments should consider and pay attention to how the workers use communication genres to handle the flow of information in their work praxis. By doing this they will gain better knowledge of which routines regarding communication they should have in their organization and how these should be implemented so that the communication media that are used are well-suited for the communication situations they are used in.

For researchers, this thesis shows that it is important to consider how workers use communication media and how the mobility of the workers and the technology they use affects their work praxis. The aim of this thesis has not been to generalize the findings to all kinds of work environments. The focus has been on some specific nomadic work environments. When other work environments are studied, the specific work praxis can differ from those that have been studied in relation to this thesis. The aim of this thesis is that by using the findings of this thesis researchers will be better 'equipped' when investigating how people carry out their daily work.

The theoretical framework used in this thesis, presented in figure 2.5 in section 2.7, has proven useful in the analysis of the work environments. It has made it possible to investigate how the flow of information is handled by workers in some nomadic work environments. The use of case studies to collect rich data material regarding how people work has been well-suited for the purpose of this thesis. Interviews with workers and

observations of how they work have given a detailed insight into many aspects of the work praxis nomadic work environments.

Since MMS is a relatively new communication medium / service the amount of research regarding actual use is very limited. Koskinen et al. (2003) and the MEMO project (Julsrud et al. 2004, Ling and Julsrud, and Ling et al.) have studied the use by early adopters, and Pedersen et al. (2003) have studied the factors which influence the adoption of MMS. Actual use of MMS in work environments is very limited, and should be investigated much more in order to gain an understanding of the potential to support work praxis. Observation of work praxis and in-depth interviews with workers prior to and after the adoption of the service should be used for this.

"The mobile phone is already changing from being a tool for voice communication into being a more general communication device. Whatever these devices will look like in the future, the mobile phone in some form is here to stay" Weilenmann and Larsson (2002, p. 93). MMS-enabled phones and the software used to send MMS messages are still evolving, and the introduction of the 3G (the third generation mobile phone network) phones and services will probably have a huge impact on how MMS is used. The properties of the mobile phones, e.g. picture resolution, display quality, ease of use etc., should be investigated related to the use of these phones to understand how they influence the way MMS is used, and how the service might need to be adjusted to the needs of the users. The mobile phone manufacturers and the network operators should also be consulted to learn of their thoughts of the service and the use of it.

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Appendices

A   Newspaper articles

Several newspaper articles are referenced in footnotes in this thesis. All the newspaper articles originate from Norwegian newspapers and are therefore in Norwegian.

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www.nettavisen.no (04.03.2004): "Nei til kameramobiler på jobb," *Nettavisen*, link: http://pub.tv2.no/nettavisen/it/article194789.ece

B   Links

Several Internet pages were referenced in footnotes in this thesis. Some of the Internet pages are in Norwegian, some are in English.

Danish centre for pervasive computing: http://www.pervasive.dk/

Garner research agency: http://www.gartner.com

MobileMMS' MMS FAQ: http://www.mobilemms.com/downloads/MMS_FAQ_v2.PDF

MOWAHS homepage: http://www.mowahs.com/

NetCom's MMS pages: http://mms.netcom.no/05.html

Nokia 7650 mobile phone: http://www.nokia.co.uk/nokia/0,,137,00.html

Nokia Observation Camera: http://www.nokia.co.uk/nokia/0,,18286,00.html

Pervasive computing, second international conference (2004): http://www.pervasive2004.org/

Sony Ericsson' mobile phones: T68i: http://www.sonyericsson.com/t68i/, T610: http://www.sonyericsson.com/t610/, S700: http://www.sonyericsson.com/s700/

Statistisk Sentralbyrå http://www.ssb.no/

Telenor's MMS pages: http://telenormobil.no/priser/tjenester/mms/

Thumbnail gallery containing pictures from Plumbcomp (taken during observation, using an Ericsson T68i and a click-on MCA-20 camera): http://folk.uio.no/aresolbe/Plumbcomp_pictures/

Ubiquitous computing page: http://www.ubiq.com/hypertext/weiser/UbiHome.html