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Networking

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Doctoral Dissertation

Abstract

The thesis is a collection of five papers that approach networking from the perspective of "the New Informatics." Networking is a kind of working practice that typically is concerned with knowledge or service work, carried out by empowered employees who are engaged in highly co-operative efforts, and who rely extensively on the use of information technology (IT). "The New Informatics" is an artificial science that explores the possibilities for inventing new ways of using IT with the objective to produce elaborated ideas that seem likely to be applicable in several situations. The overall research question asked in the thesis is: *What are the possibilities to improve existing and invent new ideas of CSCW technology use in networking?* The research question is approached from an individual and a group perspective. These perspectives are investigated in two empirical studies exploring the work in a dispersed and mobile IT support group and a clinical trial management group. The field studies involved approximately 400 hours of ethnography and 20 qualitative interviews.

One overall result is the empirically based analysis and confirmation of networking as an emerging kind of work. Exploring the research question from a group perspective revealed three overall results. First, networking individuals involved in close and continuous interaction with their personal networks and customers, experience difficulties in sharing experiences and co-ordinating work with the group they formally belong to. A second result is the design, implementation, evaluation, and detailed discussion of the potential use of the DARWIN application to resolve the conflict between networking and group work. The third result is MOSCOW, a development framework that in taking a unified approach to CSCW technology use seeks to reflect the condition of group work in networking. Investigating the research question from the perspective of the individual revealed two overall results. First, the study of the

use of IT as an integrated part of clinical trial work shed light on novel problems. A second result is the exploration and development of the Collaboration Interface prototype, which is an attempt to unify the experiences from the fieldwork with theoretical claims in CSCW, to approach one of the obstacles explored in the field study: how to launch CSCW sessions appropriately.

Preface

The thesis is a collection of papers comprising research efforts that were initiated in July 1994, when the *Co-operative Technology project* was launched at the Department of Informatics, Göteborg University. The work has primarily been funded by the Swedish National Board for Industrial and Technical Development (NUTEK), through supporting the Co-operative Technology project. Financial support has also been received from the Swedish Transport and Communications Research Board (KFB), the sponsor of *the Internet project*, and the newly established *Viktoria research institute* in Göteborg.

The overall theme of the thesis is *networking* which is approached from the perspective of what Dahlbom recently has called "the New Informatics" (Dahlbom 1996b). Networking is understood as a type of working practice that typically is concerned with knowledge or service work, carried out by empowered employees who are engaged in highly co-operative efforts, and who rely extensively on the use of IT. The new informatics is "…a *theory* and *design*-oriented study of *information technology use*, an artificial science with the intertwined complex of people and information technology as its subject matter" (Dahlbom 1996b, p. 29). The overall research question of the thesis is: *What are the possibilities to improve existing and invent new ideas of CSCW technology use in networking?*

The thesis contains five individual papers and an introduction. In the introduction I seek to provide an empirical and theoretical background for the individual papers, outline the research approach adopted and present the main results. The empirical background contains a description of the research context of the thesis and a discussion of networking. The theoretical background reviews Computer Supported Co-operative Work (CSCW), which is the particular field in which the thesis aims to make a contribution.

After describing the research approach I recapitulate the five individual papers and the overall results of the thesis. The five individual papers are listed below.

1. Kristoffersen, S., and F. Ljungberg (1996) "Supporting mobility, co-ordination and sharing in dispersed, networking groups," In *Proceedings of the Fifth International Conference on Information Systems Development*, edited by S. Wrycza and J. Zupancic, pp. 339-354, Gdansk, Poland: University of Gdansk, Department of Information Systems.

2. Ljungberg, F., and S. Kristoffersen (1997) "DARWIN: Message pad support for networked, dispersed groups," To appear in *Scandinavian Journal of Information Systems*.

3. Ljungberg, F., and S. Kristoffersen (1997) "MOSCOW: Unified support for mobile networking," To appear in *Proceedings of the International Workshop on CSCW in Design*, Bangkok: International Academic Publishers.

4. Ljungberg, F. (1997) "Communicating @ work: Problems in making IT work," in *Systems Development Methods for the Next Century*, edited by G. Wojtkowski *et al.*, pp. 441 - 461, New York: Plenum Press.

5. Ljungberg, F. (1997) "A "Collaboration Interface" to CSCW," *Studies in the Use of Information Technology*, No. 19., Department of Informatics, Göteborg University, Sweden. Submitted for publication in *Scandinavian Journal of Information Systems*.

For a complete list of the research which I have been involved in during the Ph.D. studies, please see Appendix A.

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Contents

Introduction

Networking

Introduction

Conradson (Conradson 1988) outlines a picture of the work in an insurance company in the 1940s, where jobs were designed to require a minimum of co-operation and communication. Few employees had the use of communication technologies such as telephones, and one main rule was that work should proceed "as silently as possible" not to cause any unnecessary interruptions. Tasks were passed between employees in the organisation, but the ambition was to minimise interaction. Work was to a great extent synonymous with individual work, not to be disturbed by communication. Informal co-operation took place, e.g., people sending notes to each others, but it had to be done secretly not to be noticed by management. In fact, department managers' main tasks were to control that employees were not late for work and that they did not take any prohibited breaks; those who did were put on a list, "the list of shame," which was placed on public view. The department manager was assisted in this work by spies among the employees, but it was also common that people reported inappropriate behaviour "spontaneously."

Much has changed in society since the time of Conradson's description, at least this is what a considerable amount of contemporary literature seeks to convince us about. One overall change, purported by many authors, is that service and knowledge work gradually have replaced industrial production as the main

business sector (Drucker 1993, Ingelstam 1995, Dahlbom 1997). The transition, which started already in the beginning of the 1960s (Ingelstam 1995, p. 139), has amongst others been called the "post-industrial revolution," as it is supposed to *radically* transform the society created by the industrial revolution into a new, "post-industrial" era (Bell 1973). Some authors, such as Toffler (see, Toffler 1970) have described this change in a more popular way, while others, like Ingelstam (see, Ingelstam 1995, especially pp. 129 - 187) have focused on "hard facts," such as labour statistics.[1]

It is often argued that technological development is the main cause of this change. Flexible manufacturing systems, for example, are claimed to enable companies to increasingly automate the production without losing flexibility (Boer 1994). This is supposed to reduce the need for blue-collar workers, but also increase the knowledge demand of those workers left: tasks which are easy to define, simple, and repeated, are automated, leaving the more complex and sophisticated jobs left to a declining number of workers (Hage and Powers 1992).[2] Zuboff's (Zuboff 1988) well-known study seems to lend some empirical credibility to this trend.

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[1]The industrial revolution started in England in the mid 18th century (Drucker 1993), but did not reach Sweden until the last decades of the 19th century (Dahlbom 1997). Then things started to change rapidly. Within 50 years industrial production had become the dominating business sector in the country, employing about 40% of the population (Ingelstam 1995). Farming was declining rapidly, from employing about 80% of the Swedes in 1880 to less than 40% in 1930 (Ingelstam 1995). This trend — more workers and less farmers — was intact until the beginning of the 1960s, when industrial production started to employ less people, and service, which had been increasing since the 1940s, started to gain ground seriously (Ingelstam 1995). About 50% of the population was employed in industrial production in the beginning of the 1960s, today's figure is 22% and, official predictions say, will fall to 10% in 2010 (Dahlbom 1997). Service has, since the mid 1970s, been the main business in Sweden (Ingelstam 1995).

[2]This has fostered a paradox: On one hand, there is a high amount of unemployed workers looking for a job, and on the other, companies claiming they cannot find workers for their openings, the reason being that the unemployed people do not meet the qualification criteria. The news report of the Swedish public service broadcasting ("Dagens Eko") on June 22 1997 at 16.45 p.m., is one example: "The Swedish industry has, despite the current mass

If such radical changes actually have taken place in society, then it seems likely that the daily work in organisations also have been subjected to change. This would mean that the work practices in the insurance company described above, probably have been evolving rather significantly. This is also what Conradson's ethnological study of the insurance company implies. From the 40s, work is described as increasingly more informal, comprising more aspects of co-operation. Communication was, for example, more and more accepted, coffee breaks became more common, and the doors to the offices were opened (they were always closed previously). The work situation in the mid 80s, where Conradson's study ends, differs quite significantly from the state of affairs 40 years earlier.

Networking

New terms are being coined to describe the emergence of new types of work. One such type of work, which has been increasingly debated in the literature on new and emerging work forms, is *networking*. Literature on networking typically describes a work situation that is characterised by knowledge or service work as opposed to

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unemployment, a shortage of labour. And according to Torbjörn Israelsson, investigator at the Swedish Labour Market Board, and the author of the report "Where are the job opportunities?" that will be presented this week, the industry does not lack technicians and engineers only. "There's a lack of, amongst others, welders and mechanics…" Several recent trend outlooks say that industrial companies produce increasingly more goods, and slowly but surely it becomes evident that there is a shortage of labour, *despite* the high amount of unemployment. And the problem is education, or rather the *lack* of education. There are, for instance, unemployed welders but, according to Torbjörn Israelsson, many of these people do not meet the demands of the employers. This "competence problem" gives rise to an increased amount of so called "bottle necks" in the industrial production. And the problem of lack of manpower is being diffused in the country. "What we've seen so far is what has been experienced in many administrative provinces in the south and middle of Sweden, which have a large industrial sector. […] …but along with the strengthening of the market, the demands will increase in most parts of the country." […] …Israelsson stresses the importance of education, and that rapid actions have to be taken in many of the cases…"

manufacturing (Svensson and Orban 1995b); employees are assumed to be empowered as opposed to controlled (Tapscott and Caston 1993); co-operative work is assumed to be the main form of work as opposed to individual work (Katzenbach and Smith 1993), and IT plays a very important role (Keen 1991). These aspects, and sometimes others, are assumed to capture the main characteristics of this new kind of work, but also articulate how it differs from other forms of work.

Networking is a problematic term in many ways. It has not only been used to denote different aspects of work, ranging from the use of personal contacts (Liebeskind *et al.* 1996) to different co-operative forms of work (Wagner 1994), but also to describe overall trends in the society (Dahlbom 1996a) as well as technical devices in computer networks (Smythe 1995). Authors have also used other terms to denote seemingly similar or at least overlapping phenomena. Informal collaboration (Kraut *et al.* 1990), weak ties (Constant *et al*. 1996), and connections (Sproull and Kiesler 1993), are some examples. Networking, and similar terms, are also problematic in the sense that they have a strong symbolic value (Alvesson 1992) — is there any company that does not want to be networked? The empirical evidence of new kinds of work and organisations has, furthermore, been questioned (Clement 1994, Klein and Kraft 1994). At the same time, social scientists (Callon and Latour 1992), sociologists (Hage and Powers 1992, Svensson and Orban 1995b) and organisational theorists (Daft and Lewin 1993, Liebeskind *et al*. 1996) have recently argued against the conservative attitude within their disciplines, suggesting the need for new perspectives and theories that actually reflect the world of today.

Not only does this messy situation constitute a viable *rationale* for further exploration of networking, but it also gives some implications to be considered in such an effort. First, one has to articulate what overall meaning of networking to explore, e.g., a work situation or technical devices. This should not usually be very problematic. Research efforts, like the thesis, do not seldom start out from an interest in a phenomenon, in my case networking as a kind of work practice, rather than a term as such. Second, since networking has been used to denote several aspects of the same phenomenon, one has to decide what aspect to explore further, e.g.,

the role of personal contacts in work (Sproull and Kiesler 1993), co-operative forms of work (Wagner 1994), or the overall work situation (Kreiner and Schultz 1993). Third, when the phenomenon of study is chosen, one has to consider from what perspective the phenomenon should be approached, e.g., a management perspective, and make a selection, i.e., decide what aspects in the world to emphasise, e.g., IT use.

Networking is here viewed as a *type of work practice*, i.e., networking is a term that seeks to capture important aspects of the actions people perform to do their work. Work practice is viewed from the perspective of *the persons doing the work* (similar to Button and Harper 1995/1996), opposed to, for example, a management perspective (e.g., Heydebrand 1989). In taking such a standpoint, I particularly focus on *the use of IT and co-operation*.

Objectives

The objective of the thesis is to based on the field of informatics add to our understanding of networking. This means, simply put, that I seek to investigate and analyse networking empirically with the ambition to explore new ways of using IT in such settings. The research approach used in the thesis, viewing informatics as an artificial science aiming to produce ideas for the use of IT, is detailed in section 5.

The introduction serves three purposes. First, I wish to provide a rich description of the working practices on which the individual papers of the thesis are based, in order to outline the empirical background of the research. A second aim is to try to add to our understanding of networking as such, by providing a rich and critical analysis of the notion based on the two field studies on which the individual papers of the thesis are based. The analysis is based on four key words that often are found in literature on this kind of work: service and knowledge work, empowerment, co-operation and IT use. A third objective of this chapter is to outline the five individual papers of the thesis and summarise the main results.

Structure of the chapter

This chapter is divided into four main sections. In the first part of the chapter I describe the research context and analyse the working practices investigated in the field studies from the perspective of networking. The empirical background is followed by the theoretical background, in which I review the particular research field in which the thesis seeks to make a contribution, i.e., Computer Supported Co-operative Work (CSCW). Subsequently, the third part of the chapter directs the attention towards the research approach that has been applied. Based on the understanding of networking and the research approach applied, the final part of the chapter formulates the overall research question and recapitulates the overall results.

Research context

In this section I provide a brief description of the context surrounding the empirical research, i.e., the pharmaceutical research company, and in particular, the two groups which havze bee the subjects of empirical studies: the Dyspepsia group, concerned with clinical trial management, and CIDES, a dispersed and mobile IT support group.

The pharmaceutical research company

The empirical research presented was carried out at a pharmaceutical research company outside Göteborg in Sweden. The company moved from Helsingborg, in the south of Sweden, to Göteborg in the mid 1950s, and started an intensive collaboration with the Faculty of Medicine established at Göteborg University. Collaboration with academic institutions is still a very important part of the research process of the company.

The majority of staff is highly educated. Approximately 600 of the 1200 employees have a college degree, and about 270 of them hold

doctorates.[3] The company's greatest commercial success to date has been *Losec*. This was the best-selling pharmaceutical in the world in 1996 with about 200 million treatments prescribed. The drug was launched in 1988 after 22 years of research at the company.

Organisationally, the research company is divided into three divisions: the pre-clinical division, the clinical division and the pharmaceutical division. My empirical work has been carried out in the clinical division, investigating the work of a research group in one of the departments concerned with clinical research management, and the work of an IT support group at the clinical division's local IT department. The following sections describe these two research contexts in more detail.

Clinical trial projects

The clinical division employs about 350 people. Approximately 50 staff work at the third Clinical Research Management department (CRM III). The researchers at CRM III evaluate drugs that have passed through pre-clinical research. Evaluation involves investigation on human beings. Since the authorities certify drugs for specific indications, not the pharmaceutical as such, a main part of the clinical research is concerned with exploring new indications for already approved drugs.

CRM III is organised into project groups served by administrative staff and the Data Management group. The project groups are put together on a three to six years basis, to manage a set of clinical trials investigating a series of related hypotheses. The project groups involve group managers, clinical trial managers and secretaries. The group managers are responsible for the overall work in the groups, while the clinical trial managers are responsible for individual projects each. The group manager and the trial managers are assisted by secretaries, who do much of the administrative work, such as ordering and distributing equipment for the trials. In

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[3]The number of employees were approximately 1000 when the empirical research presented in the thesis was carried out.

carrying out the trials, the project groups are engaged in close co-operation with nurses, doctors, administrative staff, etc., all over the world.

My fieldwork primarily investigated the Dyspepsia group at CRM III. The group employed six people: one group manager, three clinical trial managers, and two secretaries. The term Dyspepsia is used to describe symptoms where people have serious stomach-ache without any symptoms of a gastric ulcer: "…an asynchronous or recurrent abdominal pain or discomfort centered in the upper abdomen" (Talley *et al.* 1991). The hypothesis researched by the Dyspepsia group was that the stomach ache was caused by acid and could be cured by Losec.

Clinical trial projects involve the preparation and realisation of a hypothetical-deductive study. The point of departure is one or several hypotheses about how well a drug recovers a certain indication, and what the authorities demand to certify that relationship. Hypotheses are suggested by many different actors, such as the pre-clinical researchers and the marketing staff. These hypotheses and demands from the authorities guide the design of the trial, e.g., sample size and number of treatments.

IT support work

The clinical division has a local IT department called "Clinical IT and Data Management." The local IT department offers the clinical division various services, including what they call "proactive IT support." The latter is provided by "Clinical Information and Data management, Education and Support" (CIDES), the local IT support group. CIDES is the second research context of the thesis.

The CIDES group has 9 members; six of them are engaged in regular support work, one serves as system administrator, one is a secretary, and one group manager. In contradiction to traditional helpdesk services, provided by the IS department of most companies including the one investigated, the CIDES group are dispersed among the users. The six group members who are directly engaged in the support work, have been assigned responsibility for one or several

departments of the clinical division. Their job is, basically, to promote effective IT use within these departments. This includes suggesting and assisting employees in the adoption of new IT, as well as helping them to resolve IT related problems. The basic assumption is that in order to offer such services, referred to by the group as "proactive support," the support staff have to assure close and continuous interaction with the users.

In the following section I use the empirical experiences from the studies of the CIDES and Dyspepsia groups, to analyse and explore networking.

Networking

Networking has been used to describe various aspects of work, ranging from different forms of co-operation (Wagner 1994) to the overall work situation (Kreiner and Schultz 1993). This makes the term ambiguous and thus it is not obvious what empirical phenomena it seeks to comprise. It is therefore appropriate to develop an understanding of what the term may encapsulate, i.e., what phenomena that are likely to be present in this particular kind of work. This can be approached typically by introducing other terms.

The terms that I have chosen to characterise networking are knowledge or service work, empowerment, co-operation, and IT use. This selection is based on three observations. First, these terms are used frequently in literature on networking, i.e., many authors have used them, more or less explicitly, in their analyses of networking practices (see, Heydebrand 1989, Kreiner and Schultz 1993, Nohria and Berkley 1994). Secondly, besides the term "IT use," these terms are often considered to be different to other kinds of work. Typically, these terms refute "how it used to be." Such oppositions are often useful in this kind of analyses, amongst others, because they facilitate the formation of an identity of the phenomenon of study and distinguish it from other phenomena. The contradictions claimed are:

- Knowledge and service work as opposed to manufacturing (Svensson and Orban 1995b),
- employees are assumed to be empowered as opposed to controlled (Tapscott and Caston 1993),
- co-operative work is assumed to be the main form of work as opposed to individual work (Katzenbach and Smith 1993),

Because these terms are considered to be in opposition to a previous state of affairs, they are also supposed to reflect more or less general changes in work, which is a third reason for selecting them.

Based on these four terms, networking is understood here as a kind of working practice that typically is concerned with knowledge or service work, carried out by empowered employees who are engaged in highly co-operative efforts, and who rely extensively on the use of IT. The remainder of this section provides a critical discussion and analysis of networking based on the empirical work carried out at the pharmaceutical company.

Service and knowledge works

The increased demands of knowledge on a declining blue-collar work force, appears to come along with the emergent importance of service and knowledge work (see, Bell 1973, Drucker 1993). These terms are often used at an overall, intuitive level. R & D work, for example, is often described as knowledge work, while cleaning is an intuitive example of a service (see, Drucker 1993). This clear and unambiguous picture often seems to become much more blurred however, when taking a closer look at a real work situation, for example when analysing what actions people actually take in order to get their job done. For example, Bowers *et al*. (Bowers *et al*. 1995) found that the work in a print industry shopfloor relied on the employees' willingness to provide each other with continuous support. That is to say, offer each others ongoing *service*. In other words, although the shopfloor personnel were mainly doing industrial work, they were also engaged in service oriented activities. Another

example is the empirical work conducted by Muller *et al.* (Muller *et al.* 1995), which suggested that telephone operators, a seemingly pure service profession, actually spend much of their working day performing *knowledge work*.

These empirical accounts imply that work practices should not necessarily be thought of as pure instances of service, knowledge, or industrial work, but rather as a mix of these forms of work, of which one, typically, often seems to dominate. In other words, even though nursing, for instance, might include aspects of both knowledge and production work, it is *primarily* a service occupation. Similarly, workers on the assembly line are mainly concerned with industrial work, while researchers at the university mainly are engaged in knowledge work.

Let us now consider service and knowledge work in more detail.

Service work

There seems to be some confusion among social scientists concerning the use of the term service (see, Furåker 1995). The term is often used loosely to denote operations that do not mainly concern the production of goods (see, Norman 1983). Services are therefore often said to be intangible (Bruzelius and Skärvad 1989). At the same time, services are often provided along with products, and vice versa (Furåker 1995). For example, restaurants do not only provide their guests with services but they also "produce" meals. Software engineering companies do not only produce applications but they also usually offer their clients services, for example user training and installation assistance. The picture becomes even more blurred when traditional service providers direct their efforts towards production rather than service, e.g., restaurants applying strict self service.

The view of service provided by Marx is broad, to say the least, denoting all activities that people carry out on behalf of others (Furåker 1995, p. 27). This is arguably too broad a definition, as it for example, implies that all employees, independent of their work, essentially are providing services — to their employers. Gershuny (Gershuny 1978, p. 56) offers a more narrow view of service, saying

that it typically is intangible (see also, Sayer and Walker 1992), produced by people to be consumed by other people (see also, Bruzelius and Skärvad 1989), and provided and consumed simultaneously (see also, Parsons and Smesler 1956). This perspective is also problematic.

Clearly, services do not primarily concern the construction of new products and could therefore be considered intangible. However, artefacts play important roles in many services. The service worker often uses artefacts in providing the service, the service is not rarely directed towards clients' artefacts, and many services are provided along with the delivery of products. Car mechanics, for instance, use tools (artefacts) to repair clients' cars (not the clients *per se*), and in doing so, they often replace or add parts (i.e., service aligned with new products). As noted by Furåker (Furåker 1995), it is not incorrect to say that services are provided by people for others, but is not that the overall aim with industrial production too? Having stated this, it is evident that the distance between the producer and the consumer often is closer in services compared to industrial production (Svensson and Orban 1995a). What is clearly debatable, however, is that all services are provided and consumed simultaneously. Do cleaners, for instance, actually deliver their services while cleaning a house? Do the house owners actually consume the service during the period of time the cleaner spends in their house?

The above discussion implies that it is very difficult to describe the typical qualities of a service. Service seems to be one of those terms ("group" and "communication" are other examples) that is virtually impossible to define practically. That is, define it in a way that actually reveals important aspects of the phenomena it seeks to capture without failing to include obvious examples. One common way to overcome this problem is to shift perspective, from attempting to define a concept to providing examples of the phenomenon (Dahlbom and Mathiassen 1993, p. 34-37). The empirical investigations that I have conducted, exploring both what people say (interviews) and do (ethnography), provide a good point of departure for that. Without offering detailed empirical descriptions at this point, the brief discussion below concludes that the work practices in

the support group mainly consists of service work, while the clinical trial only partly do that.

The overall objective of clinical trials is to scientifically prepare empirical data confirming drugs' effectiveness to specific indications, which could be sent to the authorities along with an application to register a new drug. The output of the clinical trial is thus, ultimately, a document, i.e., a product. The support group, on the other hand, has as its primary task, to provide users with continuos, proactive IT support. Co-locating the group members with their users was an attempt to establish this. The support members are mainly engaged in activities such as: walking rounds to see how things are going; providing users assistance in using vertical applications; anticipating problems and resolving them in advance, e.g., ensuring that the LAN (Local Area Network) is not shut down for maintenance work the weekend before an important project deadline; suggesting to employees new ways of using IT that deemed particularly suitable for their work situation, etc. In other words, the "output" of this type of support work is not primarily a physical product, but close and continuous support to assure that users benefit from IT use in their work. Opposed to the trial projects, support work does not really have an "end," but is an ongoing activity (see the description of a service provided by Gershuny 1978, p. 56).

The day to day work of clinical trial managers partly involves activities that could be labelled service work. The trial managers spend much of their time assisting project members in taking appropriate actions in unexpected situations. The high economic incentives to meet the project deadlines make this work very important. This indicates that the trial managers, at least partly, do this work because they are responsible for the project, i.e., as a part of their management function. It is not clear whether management ever could be conceived as a service function for subordinates. According to Furåker (Furåker 1995, e.g., p. 28) and Eliasson *et al.* (Eliasson *et al.* 1986, p. 218) that would be possible. The critical tradition of Scandinavian informatics research, would not, at least historically, agree with this, claiming that the contradiction between labour and capital is fundamental (see, Nygaard 1991).

To conclude the above discussion it appears that IT support, but not clinical trial work, could be considered to consist of service work.

Knowledge work

Drucker (Drucker 1993) claims to have defined the term knowledge work, using it to describe an overall trend: the increased importance of knowledge in the emerging post-industrial business environment. This is, however, only one of several ways the term has been used.[4] Another perspective that I find more useful for my purpose here, i.e., to analyse networking, is offered by Alvesson (Alvesson 1992). For Alvesson, knowledge work is one kind of work practice that typically is present in knowledge intensive firms, such as R & D companies.

Knowledge work has a strong symbolic value. People sometimes use the term because "it sounds good" rather than because it reveals important aspects of work. Is there any company that does not want to be engaged in knowledge work? Another problem is that the term, at least implicitly, assumes that some work constitutes "non-knowledge work." Is there any work that does not include knowledge? At the same time, the research staff at the pharmaceutical research company, and other R & D firms, apply scientific methods to elaborate on what usually is termed knowledge. Against this background one could argue that such companies essentially are concerned with the production of knowledge, and that their employees accordingly are engaged in knowledge work (see, Alvesson 1992).

Below I recapitulate the most salient feature of knowledge work, as described by Alvesson (Alvesson 1992), along with brief analyses of their applicability to clinical trials and IT support.

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[4]Knowledge and learning have become fashionable in the area of organisation and IT the last couple of years, and many concepts and approaches that touch upon the notion of knowledge work have been suggested. Some well-known examples are the "learning organisation" (e.g., Senge and Sterman 1992), the "knowledge-creating company" (e.g., Nonaka and Takeuchi 1995), and "organisational memory" (e.g., Conklin 1993).

- *Work is to a considerable part concerned with problem solving and most work processes are non-standardised.*

This seems to be a good description of the clinical trial work. For example, the trials usually differ in the way they are organised, how project members are picked, etc., and the way the operative day to day operations investigated did not adopt many standard procedures, but were mainly concerned with problem solving and negotiation. Trial personnel maintained that their work mainly concerned assisting peers in resolving unexpected events.

IT support work seemed to include more structured elements than the work in the trial projects. Although many of the daily operations of resolving users' emergent IT problems were quite unstructured, support work also comprised relatively structured tasks, such as upgrading and installation of software.

- *Knowledge working companies are very dependent on the employees and their ability to take actions.*

Due to the unstructured nature of the trial process, many clinical trial managers had decided to "…not put so much efforts on trying to anticipate all possible situations in advance, but deal with problems when they occur." This strategy partly explains why the trial projects usually become very dependent on their personnel. Project members, especially the managers, are involved in continuous interaction and negotiation, and the projects soon become dependent on a vast amount of agreements. These agreements are only partly formalised and thus not always accountable beyond interpersonal relations. They are also often difficult to recapitulate and mediate to others. The importance of having experienced the history of a project for taking adequate actions, was also maintained by trial staff: "It explains so much… Why things are in a certain way." It seems quite obvious that the trial work fulfils the above requirement of knowledge work.

IT support work is not the main business of the pharmaceutical firm. However importantly, IT is increasingly becoming a prerequisite and an infrastructure for most work: "When

the computer network goes down, 99% of the work goes down…," as an interviewee put it. From this, it follows that the IT support staff plays an important role in assuring that the pharmaceutical personnel have access to appropriate IT. Even though this service cannot be fully provided without, amongst others, having established the right personal contacts, it seems likely that a new support worker more or less immediately could assist users in resolving their operational problems. This implies that the pharmaceutical company might not be equally dependent on the IT support staff as compared to the clinical trial personnel.

- *The employees are often highly educated.*

This criterion is fulfilled by the trial projects. For example, all trial personnel involved in the empirical investigations had a university degree. Compared to the trial personnel, the members of the IT support group are less educated. Three of the nine members had a university degree, which is lower than the average of the company (50 %).

- *The intellectual assets of the employees and their networks are more important for the company than substantial assets like machinery.*

It is obvious that both the work practices explored meet this requirement.

- *The company is strongly dependent on key personnel and their loyalty.*

The term "key personnel" indicates that there are a relatively *small number* of very important employees who are *significantly* more important to the company than others. This is not the case of trial work, simply because the company is dependent on most of the personnel. In other words, "key personnel," as interpreted here, does not seem to be an appropriate term to describe the relationship between the company and the employees concerned with trial projects.

The company is to some extent dependent on the IT support group, but they are not, strictly business speaking, as essential as the trial workers. The notion of "key personnel" does not apply based on my research experiences at the pharmaceutical company.

- *Employees, and their environment, are characterised by creativity.*

According to Webster's dictionary one meaning of "creative" is the ability some people have to get around legal or conventional limits. This applies quite well with the contingent activities that the trial staff perform in their day to day work. At the same time, the two other meanings of creative as defined in Webster's, deal with artistic skills that seem far removed from the work in the trial projects. Creative does not seem to be a salient aspect of clinical trial work. Creativity is not a central aspect of IT support work either.

To conclude, in developing a comparison between the research contexts of the thesis and the aspects of knowledge work that Alvesson offers, it would appear that clinical trial work fulfils many of the criteria of knowledge work, while support work only meet some of them.

Complex work and the ability to take action

It is often stated in the literature that knowledge and service work typically are complex activities. The term "complex" is then often used to emphasise that such activities are unpredictable rather than predictable, requiring participants' ability to take action in new situations rather than following instructions (see, Drucker 1993). In this section I analyse this phenomenon based on the empirical work at the pharmaceutical company.

Many services are complex in the sense that they are difficult to pre-define. For example, when the members of the IT support staff investigated are requested to resolve problems, their actions are dependent on, amongst others, the users' understanding of the problems they experience, their competence in articulating problems,

their ideas of the potential solutions, together with issues such as others interfering with the customer interaction, users' past experiences of IT use and IT support, the dependence of users on using the computer, etc. Hence, this type of encounter between support workers and users is dependent on a vast amount of factors of which the majority seem difficult to grasp and consider in advance (see, Hage and Powers 1992, p. 11 - 12). This makes IT support work difficult to pre-define (see, Heydebrand 1989), because what will be considered as appropriate actions partly originate from the unique circumstances of the situation, e.g., how the interaction with the user develops. Therefore, the quality of IT support largely depends on the service provider's ability to take actions that sit well with the circumstances "here and now" (see, Bruzelius and Skärvad 1989).

Providing applications with help features could be seen as an attempt to encapsulate the support service into a product. The assumption is, that users in general experience a set of problems that can be resolved appropriately by applying certain methods. The literature reports that users are likely to benefit from help features when they, for instance, work overtime and therefore cannot get assistance by others (see, Ackerman and McDonald 1996). This is probably a valid assumption. However, help features usually suffer from some problems as they, essentially, do not only remove the complexity of the support service, but also some of its usefulness. For example, and perhaps needless to say, the dialectics of the interaction between users and support staff do not only add complexity but also quality to the service. By removing the interaction between the IT support provider and the user, one delegates the task of diagnosing the problem to the users themselves, i.e., to those who experience the problem. One consequence of doing that could be that users spend too much time trying to find their current situation in the help system, rather than being provided with rapid help to resolve a practical problem (see, Hughes *et al*. 1996).

Pharmaceutical research is also a complex process that relies heavily on the employees' ability to act appropriately in new situations. For example, whether the data of a particular patient is valid for the scientific study depends on a vast amount of factors, such as what other illnesses the particular patient has, other

medications, etc. Because patients are typically examined several times, often during a period of several years, the possible combinations of factors that have to be considered, are huge. Putting efforts into the detailing of rules that regulate such situations, therefore becomes meaningful only to a limited amount:

> "We could impossibly cover all possible exceptions: 'If a patient three months before the third examination had three such pills, took a quick ride at his bike and had bananas for breakfast, then do this and that.' Trying to anticipate all possible situations would be meaningless. […] I prefer to deal with the problems when they occur…" (Clinical Trial Manager)

Not only is it important to deal with such situations properly to fulfil the scientific requirements and the rules set up by the authorities, but also to meet the deadlines of the trial projects. The economical incentives for the latter are strong, and data cannot therefore be rejected automatically if it has attributes that were not considered in advance. In such situations, the trial personnel have to take on actions to investigate whether the data is valid or not. If there are any doubts at all, then the data is removed from the study.

Trial work is also complex because of the large number of participants and countries involved. The projects are dispersed in time and space, there are language problems, there are cultural differences, mistakes are made that have to be discussed and resolved, and so on. The trial manager, the person mainly responsible for assuring that the projects are carried out appropriately in time, therefore have a quite complex job that requires ability to improvise and act in new situations, to be done properly.

To conclude, the service and knowledge work that I have investigated are both quite complex, most notably in terms of unpredictability, and for that reason, they rely significantly on people's ability to take action in new, unexpected situations to be carried out properly.

Empowerment

When people are given the authority to make decisions in their daily work, using their own judgement to take apt actions in new situations rather than consulting management, they are often said to be "empowered" (see, Tapscott and Caston 1993, p. 209). Much contemporary management literature claims that organisations have to empower their employees to stay viable, most predominantly due to the global and continuously changing business environment (see, Scott Morton 1991, Hammer and Champy 1993, Imparato and Harari 1994).

This view has been criticised by researchers within the Scandinavian School of informatics, especially promoters of the Collective Resource Approach (see, Bjerknes *et al*. 1987, Ehn 1988, Nygaard 1991). Clement (Clement 1994), for instance, argues that such "functional empowerment" typically is an obligation that workers receive from management. The alternative offered by Clement, called "democratic empowerment," argues workers' rights to control and improve the working conditions. This includes employees' rights to have their voice heard in decisions that directly affect their work, e.g., new technology, and employees' rights to suggest and implement changes in their work, typically operations to improve the working conditions.

Issues could be raised against both functional and democratic empowerment. Functional empowerment has been criticised for intensifying rather than loosening management's control of employees, not necessarily by means of direct supervision but also by what has been called social or normative control, i.e., by "…bind[ing] the employees' hearts and minds to the corporate interest" (Kunda 1992, p. 218). Social control was, in fact, a main message in the "corporate-cultural boom" (Alvesson 1993) some years ago (see, Peters and Waterman 1982), which claimed the efficiency of making employees adopting norms and beliefs "…useful to the achievement of corporate goals defined by management" (Alvesson 1993, p. 28). The desirability of making employees perform right actions unconsciously is a serious concern that has been contested and questioned (see, Kunda 1992, p. 226-227).

The empirical work of Klein and Kraft (Klein and Kraft 1994) points out the related problem of responsibility and rights being separated. The participants they investigated were indeed empowered to suggest changes in their work processes, but *not* to implement them. It is however not obvious that employees are satisfied with being assigned greater responsibilities. Zuboff (Zuboff 1988), for example, describes how people felt uncomfortable because they did not know anymore exactly what they were supposed to accomplish. This had previously been much more clearly stipulated by management.

Advocates of democratic empowerment have been criticised for overlooking crucial issues for companies in capitalistic societies, such as shareholders and competitors, in their analyses. Critique could also be directed towards authors claiming that improved performance can not be aligned with improved working conditions. In fact, this is what the Scandinavian countries, at least historically, has managed to accomplish, providing appropriate conditions for highly competitive *and* social responsible companies (see, Ehn 1988, pp. 254). The long-term studies at Volvo, conducted by Jönsson and associates (Jönsson 1992), provide some empirical evidence for that claim. This ambition was adopted in the famous Utopia project, which opposed to earlier projects in the "critical tradition" of Scandinavian informatics research (Bansler 1990), did not merely concern industrial democracy but also took the challenge of unify such an endeavour with making "good-quality products and services" serious (Ehn 1992, p. 112).

The two perspectives of empowerment, functional and democratic, claim employees' obligations and rights exclusively, and in doing so, they restrict the meaning of the phenomenon in a way that neither fits previous attempts in the Scandinavian setting (see, e.g., the Utopia project, Ehn 1988), nor my observations at the pharmaceutical company. Participants in the work situations I investigated were empowered both in the sense that they had considerable options to design and negotiate their work operations locally. Laws on democratisation (Ehn 1988, pp. 254) furthermore protected these people from, for example, being set aside or disregarded by management in change projects affecting their work. The empirical investigations thus advocate a pragmatic view of

empowerment, comprising — to different degrees — aspects of both "obligations" and "rights," and the hypothesis that these two issues cannot be reconciled was accordingly not confirmed.

So, let us now analyse in more detail exactly what would be the reasons to believe that trial and support workers were empowered.

The rules regulating the trial work were few, and it was very much up to the trial manager to — in collaboration with others — take the initiative to organise and carry out the projects. Not only were the accounting systems few but they also played an insignificant role in the daily work operations. This disqualified trial personnel from being controlled, but also fostered a situations where they could not expect others from discovering and resolve problems in the trials. Failures would not be apparent for others until afterwards, when the trial managers mainly would be the ones made accountable. Empowerment did not only concern obligations however, but also many local options in the organisation of work. Different groups organised their projects differently. For example, some trial managers preferred to provide the testers with detailed instructions about the trials, while others applied the "less is more" approach, detailing only the most obvious and important rules in before hand.

IT support work also subscribed to many empowerment qualities. The obligations of the support staff were however fewer than in the case of the trial workers, at least in the sense that less people would be likely to notice whether they did a good job or not. Support work was, furthermore, even less visible than trial work, and did not apply any other accounting systems than spontaneous communication and a weekly meeting. Support staff were free to organise the work according to their preferences, and their network of contacts, assisting them in resolving different problems, differed considerably. Invisible work and poor accounting systems made the company very dependent on the support staff's commitment to do a good job.

Based on these observations it is here claimed that the work practices investigated in the thesis, comprise an important aspect of empowerment. It should be noticed that empowerment, as described here, could have important implications, as it does not agree with the

traditional, cybernetic system of management control. The above discussion outline a situation where the work operations and their organisation, and, in the case of the support group, even the very output of work[5], to a considerable extent are without sight for management — few and unimportant accounting systems and little normative control — and mainly dealt with locally. The traditional "head and hand split" (Greenbaum 1995, e.g., p. 63 - 64) seems thereby less present, and the accounting systems appear likely to have problems to comprise the actual work and its contribution to the company. Jönsson (Jönsson 1992, p. 100), in commenting on this phenomenon, claims: "Accounting (and rationality) becomes a financial abstraction that is disconnected from the doing of work. Its adequacy in describing the activities of the organisation and their contribution to its objective is diminished." Empowerment might thus question traditional management control in organisations.

Co-operation

From the perspective that organisations, fundamentally, are designed to enable co-operative efforts (Drucker 1993), the recent interest in co-operation shown in the business literature (Ciborra 1993, Katzenbach and Smith 1993), might seem odd, not to say trivial. Is not co-operation what organisations always has been concerned with? Why organise otherwise? Similar concerns would perhaps also be raised by some social scientists, claiming that work, as all human action, essentially is social (Button *et al.* 1995), and that work thus always has been co-operative in its nature; how could it not be?

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[5]The support group was established to provide employees with proactive support in their use and adoption of IT. What such work concerns was — and is — not established, and how it could be controlled is far from obvious. During the empirical study, the manager of the support group discussed with us how one could investigate whether the group actually did a good job. Questionnaires sent to the users was his main idea at that time. As far as I am concerned, this came to nothing.

Although these two claims are true in many ways, there are reasons to believe that co-operation in many workplaces has not only changed during the last couple of years but also become increasingly important. This is not to say that co-operation did not occur in organisations previously, nor that human action has not always been social, but that co-operation has evolved over the years and that the conditions for many people to co-operate have increased. Let us consider some examples.

First, today organisations are often said to be designed to enable and encourage co-operation (see, Mohrman *et al*. 1995), and the potential value of spontaneous and serendipitous encounters is often claimed (see, Kraut *et al.* 1990, Isaacs *et al.* 1996). The traditional bureaucracy, on the other hand, is essentially designed to avoid human interaction, especially ad hoc communication (Mintzberg 1983).

Second, empowerment seems likely to give rise to co-operative efforts in organisations. Empowered employees, in trying to resolve complex tasks, would contact others for assistance. The person to contact, however, is not necessary the person above on the organisational chart. This would have been much more likely, and most often even a necessity, in traditional organisations: "…to jump a level in the hierarchy was conceived as a deadly sin," as Conradson (Conradson 1988, p. 102) puts it in characterising the work in "divined hierarchy" of the 1940s.

Third, the current adoption of networking technologies in organisations gives participants easy access to a vast amount of other people with whom they could interact, set up forums, and so on (see, Perin 1991). Previously, without such technologies, interaction was much more restricted by time and place (Sproull and Kiesler 1993, especially chapter 1 - 2).

Functional co-operation

One reason why employees at the pharmaceutical company joined together in co-operation was that they experienced tasks that they for different reasons believed could benefit from co-operative efforts. This kind of co-operation could be termed functional, as it explains co-

operative efforts as a functional requirement to complete a given task. Functional co-operation is the point of departure for Schmidt (Schmidt 1994c, p. 108), who argues that co-operation emerges in response to tasks that are either impossible or not feasible to complete individually. Schmidt articulates four functions of co-operation, or rather four reasons why tasks need co-operative efforts. These four functions, and their application in trial and support work, are discussed below (see, Schmidt 1994c).

- *"Augmentation of capacity," i.e., the mental or physical capabilities of any people to accomplish a task co-operatively.*

Although this kind of co-operation does not seem to be very common in trial work, it sometimes takes place, especially close to project deadlines. Particularly during the last week before project deadlines, it is common that local project members join together in one single room, where they co-operatively assure to meet the deadline. By then they often appear to benefit from what Schmidt call "augmentation of capacity," because remaining tasks, as all emerging, that do not require any competence that goes beyond what everybody knows in the group, are assigned to virtually anyone.

"Augmentation of capacity" is also involved in the actions IT support employees perform to do their work, especially when participants assist each others in doing repetitive work, such as software upgradings and installations, i.e., tasks that can be done by anybody in the group.

- *"Differentiation and combination of specialities," i.e., some persons with dedicated and different specialities accomplish tasks that neither could have been done individually or by any persons.*

This type of co-operation seems to be the starting point for most organisations, assigning people with appropriate background to predefined roles that are responsible for a set of activities. This is also true for both trial and support work. The formal organisation of the trial project comprises roles like trial managers and secretaries, which only could be assigned to persons with appropriate

qualifications. As noted above, if this kind of division of labour is considered to be co-operation, then most organisations, including trial and support work, comprise important aspects of co-operative work. However, it is not obvious that co-operation is a good term for this kind of division of labour ("work groups" in terms of Wagner 1994).

If "differentiation and combination of specialities" includes situations where someone to complete a task needs to perform operations to which she lacks the authority, and therefore has to contact others who has the authority required, then this kind of co-operation was common in the pharmaceutical company, especially in support work. Support workers did not have the authority to, amongst others, correct errors in all databases, change access rights in all systems, or order any computer equipment. Dedicated roles also had to approach certain tasks in the trials, e.g., certain medical issues were associated with certain roles.

- *"Mutual critical assessment," i.e., several persons who have the same exclusive qualification, examining the same problem. They do so in order to enable a comparison of the conclusions at which the different persons, and in particular, different "problem-solving strategies and heuristics" arrive. This aims at minimising bias in decision making.*

One reason why this kind of co-operation seems important in trial work is that decisions to be made often are important, and that participants therefore want to assure that they do not arrive at inappropriate conclusions. One example is when a trial manager receives a call from a tester who does not know if a particular patient should be included in the trial. If the trial staff reach a wrong conclusion, e.g., include a patient who should have been excluded, and the authorities, in checking the raw data upon which the application for a new drug is based, discovers the error, then the incorrect decision could be a disaster for the company. For example, a new drug that would bring a vast amount of money that is not approved. It is very important that trial personnel establish personal networks of peers whom they can consult when necessary. This was mentioned frequently during the study.

Although "mutual critical assessment" also was comprised by support work, e.g., someone requesting a second opinion from a colleague, asking others how they would act in a certain situation does not seem to be very common in support work.

- *"Confrontation and combination of perspectives," i.e., persons with different backgrounds examining the same problem in order to confront different perspectives on the same phenomena with each others.*

This kind of co-operation is also common in trial work, as staff do not only consult persons with the same background as themselves for a second opinion, but also people with other specialities. This is common when people have to make complex decisions, such as deciding whether to include a particular patient in the study. Because such decisions involve a vast number of factors, discussions with experts in several different areas are often needed to arrive at an appropriate conclusion. Personal networks played a very important role in this work.

This kind of co-operative effort does not seem to play a major role in IT support work.

To summaries, functional co-operation was thus present in both trial and support work:

- "Augmentation of capacity" takes place in both trial and support work, but it does not seem to play any major role in neither of these work practices.
- "Differentiation and combination of specialities" is important in both trial and support work.
- "Mutual critical assessment" takes place in both trial and support work, but it is more common in the former.
- "Confrontation and combination of perspectives" seems thus to be common in trial work, but seldom occurs in support work.

Beyond the functional perspective

The empirical work, and the literature on CSCW, both suggest co-operative efforts that do not easily classify within the functional perspective suggested by Schmidt. Let us consider three examples from the fieldwork.

The very notion of IT support work, that is a *service*, does not really agree with the tacit assumption made by Schmidt, namely that work becomes co-operative only when it has exceeded a certain level of complexity. Support work is an ongoing collaborative effort that cannot be done without a service provider and a customer, i.e., an activity that *cannot be done individually* (see, Svensson and Orban 1995a). For example, support workers walk rounds regularly where they try to be visible to their customers and check how things are going. Accordingly, co-operative work as a special instance of work, occurring when tasks are too complex, does not make sense in the case of service work.[6]

Another example of co-operative work that does not fit with Schmidt's framework took place in the trial projects. Many trial managers did not put much effort in detailing rules and policies for the projects in advance. Instead, they chose to deal with questions and problems when they occurred, and inform the project members continuously. This approach fosters much communication that does not originate from a functional need to resolve a task. For example, the trial managers have regular contact with the testers to check how things are going, they regularly send information to these people about newly established policies and rules, and so on. This kind of interaction, also described by Dahlbom (see also Dahlbom 1997), does not seem to fit Schmidt's framework of co-operation.

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[6]One could argue that the service provider, in this case the support person, and the customer, i.e., the user, join together because the task, i.e., support work, requires what Schmidt calls "differentiation and combination of specialities" to be accomplished. This only makes sense, however, if IT support work is seen as being provided for the company as such, i.e., that the users and the support persons combine their specialities to complete the task: "Making pharmaceutical research more effective by the use of IT." This interpretation is not obvious, but seems a bit far-fetched.

A third example of co-operation that goes beyond Schmidt's framework originates from the importance of taking part of the ongoing conversations that take place at the department during coffee breaks, and so on, to stay aware of others work, rumours, and so on.[7] The importance of awareness in work has been discussed frequently in CSCW (see, Dourish and Bly 1992, Heath and Luff 1992).

Personal networks

Another aspect of co-operation that is being discussed in literature on networking is so called personal or social networks (Kreiner and Schultz 1993, Fulk and DeSanctis 1995, Liebeskind *et al*. 1996). The use of personal networks is, in fact, often used synonymously with networking.[8]

As discussed in the individual papers of the thesis, personal networks played a very important role in both trial and IT support work. This is not a novel finding, but has been documented in many empirical studies (see, Kreiner and Schultz 1993, Fulk and DeSanctis 1995, Liebeskind *et al.* 1996). Both trial and support personnel seemed to use their personal networks for the purpose of getting advice, such as asking others for second opinions. The support staff also appeared to assign tasks to their personal contacts, i.e., asking others to do something individually (or co-operatively with others). Such tasks were often very brief and most often caused by either lack of competence, e.g., a support worker who does not know how to resolve a particular hard disk problem, or lack of authority, e.g., a support person who does not have the authority to fix a problem that requires root access in a company wide system.

The personal networks seemed mainly to comprise previous collaborators, e.g., peers from earlier projects. The trial personnel seemed to have more global networks than the IT support staff,

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[7]Schmidt has elsewhere discussed the importance of similar issues (e.g., Schmidt 1994b, p. 59).

[8]Some of the individual papers of the thesis use such an understanding of the term.

whose contacts mainly were inside the organisational boundaries. The value of social networks was stressed by both trial and support workers. In fact, participants from both these groups maintained that it was difficult to do a good job before one had managed to establish "good contacts." Another general claim was that the networks were indeed personal, and for that reasons, they could not be assigned or given. Especially the support group had noticed that it took some time to establish personal networks.

IT use

It seems to be increasingly assumed that IT use has become an integrated and intertwined part of most human activities, including work such as networking. In this section I discuss this idea relating it to the empirical accounts from the pharmaceutical company.

The integration of IT and work

Extensive adoption of IT in organisations the last couple of years, has affected and enabled a vast amount of activities. This often becomes painfully apparent when, for instance, the computer network fails, when a hard drive crashes, when a cellular phone runs out of power, and so on. From this it follows, some authors claim (Hanseth and Monteiro 1997), that IT is becoming an increasingly incorporated but also complexly intertwined part of many human activities. This, in turn, is claimed to have disqualified the classical distinction made in social sciences, between "the social" and "the technical" (Dahlbom and Janlert 1997), the reason being that neither of these parts are possible, or at least not fruitful, to study in isolation.

Within the social sciences, this trend has received considerable attention, perhaps especially in the field of "Science, technology, and society" (Law 1991), where "actor-network theory" is being developed. Actor-network theory stresses, amongst others, the power and importance of artefacts in today's society (Latour 1992, Law and Bijker 1992, p. 306) and that all relations should be seen as *both* social and technical:

> "Purely social relations are found only in the imaginations of sociologist, among baboons, or possibly, just possibly, on nudist beaches; and purely technical relations are found only in the wilder reaches of science fiction" (Law and Bijker 1992, p. 290).

Such claims have made other sociologists quite upset, amongst others, because the social and the technical are being viewed and analysed equally, and even given the same terms (Callon and Latour 1992).[9] Collins and Yearly (Collins and Yearley 1992), for example, in commenting on this, argues that it clearly is a step back to a natural science view of human action, placing the actor-network paradigm on "the nature" pole on an axis which other extreme is "the social." Callon and Latour (Callon and Latour 1992) reply that this yardstick, with social and natural on each extreme, is no inherent truth, maintaining that their interest is in *explaining the society*, which today, they observe, comprise important aspects of artefacts, and *not* providing social explanations of anything. Two other well-known perspectives on the role of technology in society are "technological determinism," which argues that technology by itself changes the society, and what has been called "the social construction of technology," saying that technology essentially is what people construct it to be socially (Dahlbom and Mathiassen 1993, pp. 196)

The integration of artefacts and human practices has also been highlighted in informatics. Hanseth and Monteiro (Hanseth and Monteiro 1997), for instance, have recently argued that practice, which they note often is very difficult to change by means of IT, should be viewed as institutionalised networks of social and technical actors, which in most cases only can be changed incrementally.[10]

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[9]"Actant," for example, could refer to either a human actor or a technological actor in an actor-network.

[10]"Cultivation" has been used as a metaphor for such change efforts, to denote the dialectical relation between on one hand the capabilities and efforts of the change agent, and on the other, that the phenomena that is concerned evolves and, in a sense, lives its own life (see, Dahlbom and Mathiassen 1993, Dahlbom and Janlert 1997). Successful change efforts would thus be characterised by continuous but incremental intervention of a "natural" process.

Kling also emphasises the integration of IT and working practices (Kling 1996). He claims that IT design should be thought of as the design of the work situation of which the technology becomes an intertwined part (Kling 1996, e.g., pp. 294). Similar suggestions are being made by Dahlbom and Janlert (Dahlbom and Janlert 1997), who claim that artefacts are enrolled and play important roles in virtually all activities in today's society. Empirical confirmations of the integration of computing and (routine) work are provide by, amongst others, Gasser (Gasser 1986).

IT use in trial and support work

IT use is without any doubt a very important but also intertwined part of both work practices investigated at the pharmaceutical company. Let use consider some examples.

The clinical trial personnel stored and processed virtually everything about their trials on computers, e.g., documents, trial data, analyses, plans, etc. Most individual efforts in the trial projects concerned manipulating such information in different way. The co-operative efforts in the trials were also to a large part carried out using IT. The main reason was that the trial personnel co-operated with people in other countries. Most project members were dispersed all over the world and could only be communicated with electronically. Participants in the personal networks were also usually dispersed, or not easy to access physically. Vertical communication at the company, such as information from management, was also distributed electronically. The work in the support group was equally dependent on IT, and mainly for the same reasons: most individual work concerned IT use, e.g., programming, and so did also many co-operative efforts. Most interaction with the clients took however place face to face.

Because work in the pharmaceutical company is so dependent on IT, it was vulnerable to technological failure. When the network fails, most information about the trials become inaccessible, as does a considerable part of staff's work. Not only does this imply the importance and integration of IT in work, but also that work is artificial in many ways (see, Zuboff 1988). Information displayed on

the computer screen is in fact the closest most staff come to the real trials.[11]

This implies that IT use plays an important role in the three previously discussed aspects of networking, i.e., service and knowledge work, empowerment and co-operation. IT use should therefore be seen as an overall aspect of networking, integrated and important in virtually all activities participants engage in.

Summing up

Starting out from an understanding of networking as a type of working practice in which knowledge or service work, empowerment, co-operation, and IT use, typically play the most important roles, this section has aimed at providing a critical discussion and analysis of networking based on a large body of empirical work. This in turn has intended to provide a description of the working practices that the thesis explores, but also add to our understanding of networking as such.

The four bullets below summarise the discussion of networking.

- *Knowledge and service work*: Clinical trial work seems to be mainly knowledge work, while IT support work most appropriately can be viewed as a service.
- *Empowerment*: Both clinical trial and IT support personnel seem reasonably empowered. They do not only have obligations but also rights, there are few and seemingly unimportant accounting systems, and there are few traces of normative control.

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[11]This implies that IT use plays an important role in the three previously discussed aspects of networking, i.e., service and knowledge work, empowerment and co-operation. IT use should therefore be seen as an overall aspect of networking, integrated and important in virtually all activities participants do.

- *Co-operation*: Clinical trials and IT support appeared to rely significantly on co-operation. Functional co-operation seemed important in both IT support and clinical trial works, but other types of co-operation were also identified. The value of personal network was also stressed.

- *IT use*: IT use played an essential, integrated and complex role in both IT support work and the clinical trials; virtually all individual and most co-operative efforts concerned IT use.

The overall conclusion to be drawn from the discussion above is that both clinical trial and IT support work meet many of the qualities of networking. Furthermore, these qualities are not only possible to trace, they also seem to play significant roles in these work practices. This implies that clinical trials and IT support work actually is oriented towards knowledge and service works rather than manufacturing, participants appear to be empowered rather than controlled, most work seems to rely on co-operative rather than individual efforts, and IT use appears to be very important.

These conclusions are based on three main assumptions. First, one has to adopt the understanding of networking used here, i.e., that networking is best understood in terms of knowledge or service work, empowerment, co-operation, and IT use. Second, one has to agree on how these four terms have been understood, which due to their ambiguous nature would not be obvious. Third, one has to agree with my interpretations of the empirical accounts.

After having outlined the empirical background of the thesis, I wish to direct the attention towards the field of Computer Supported Co-operative Work (CSCW), which is the theoretical background of the research.

CSCW

The areas in which IT is being applied have increased immensely the last couple of years. The number of scientific fields and communities dedicated towards particular aspects of IT have grown accordingly. Some of these fields could be seen as sub-disciplines of informatics, while others are more inter-disciplinary. The field of CSCW is an example of the latter, as it attracts researchers from many different disciplines. In this section CSCW is reviewed in order to provide a theoretical background for the individual papers of the thesis.

CSCW emerged as a field during the late 1980s (Bannon 1993). Because CSCW is interdisciplinary (Grudin 1994a), the field cannot be characterised by a uniform research agenda (Bannon and Schmidt 1991). CSCW research is concerned with many different issues, ranging from highly technical aspects of groupware technologies to sociological interpretations of work. CSCW is, therefore, in many ways an umbrella term (Kling 1991), comprising different perspectives of IT use and co-operation, as well as the design and construction of such IT (Bannon 1993). Schmidt and Bannon (Schmidt and Bannon 1992) argue for a more precise view, claiming that CSCW essentially is a design-oriented research area focusing on co-operative work.

In reviewing CSCW I first outline the theoretical perspectives that have been most frequently applied in the field. Then I outline some well-known groupware taxonomies, before reviewing the technologies that so far have been most important.

Theoretical perspectives

In this section I outline the four theoretical perspectives that I believe have played the most important role in CSCW research so far.

Language-Action theory

Winograd and Flores (Winograd and Flores 1986), in their widely cited book *Understanding computers and cognition*, suggested the

language-action perspective as a new foundation for IT design. The perspective is based on speech act theory, a linguistic theory developed by Austin, and later by Searle. Austin questioned the idea that people use their language to describe things only, arguing that there are certain kinds of utterances, which are used to make things happen. The utterance "I pronounce you man and wife," for instance, when being uttered by the official at a wedding, does not really describe the world, but it changes it. Such utterances Austin called speech acts. Searle formalised these ideas and identified five so called illocutionary points. Directives, for example, which is one of these illocutionary points, denotes speech acts which "…attempt to get the hearer to do something" (Winograd and Flores 1986, p. 58), e.g., a customer requesting a service.

Winograd and Flores assumed that certain speech acts create recurrent structures when they are related to each others in conversations. When people are requested to do something (a directive), for example, shop personnel being requested services by customers, they only have three options: accept the request, give a counter offer, or reject the request. Besides there is always the risk of misunderstandings, which could require additional interaction, and any of the parties could for various reasons interrupt the interaction at any point in time.

The speech acts starting out from this type of situation, i.e., where a customer requests something from a performer, or a performer offers a customer something, form a recurrent structure called a "conversation for action." This structure is shown in figure 1.

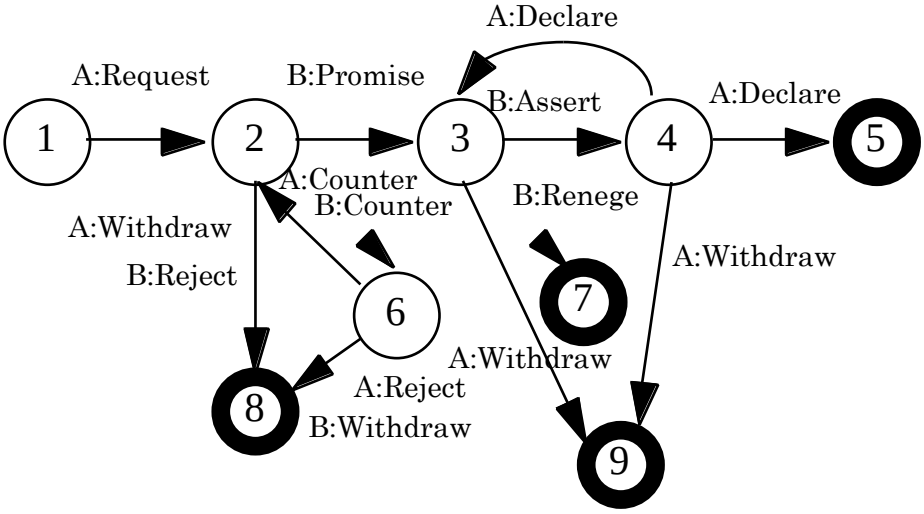

Figure 1. Conversation for action (Winograd and Flores 1986, p. 65). The circles are states in the conversation, the bold circles are completion of the conversation, and the lines are speech acts.

Interaction according to the conversation for action scheme thus starts out from one person, A, requesting something from another person, B. Then B has three options: first, reject the request (2 → 8), second, give a counter offer (2 → 6), which very well might give rise to negotiations, i.e., subsequent counter offers from A, or, third, accept the request (2 → 3). Counter offers, in turn, could be rejected by A (6 → 8), but A could chose to withdraw, not only after counter offer negotiation but also directly after the request (2 → 8). The ideal situation is if the conversation ends in circle number 5, i.e., that A declares that she is satisfied with the task that B has completed for here.

According to Winograd and Flores, people in organisations are continuously engaged in various conversations for actions. These conversations are assumed to cause commitments, which in turn, are assumed to be one main reason why people work. Supporting these processes by means of IT seems therefore likely to improve the performance of the organisation. This was one main idea behind the Coordinator (Flores *et al*. 1988), an application that enabled people to manage and negotiate commitments with each others electronically. These ideas were later elaborated into the "action workflow approach"

(Medina-Mora *et al.* 1992), an approach for designing and implementing workflow management systems in organisations.

The language-action perspective has been highly influential in CSCW. It has been applied as the theoretical foundation by several researchers (see, Bowers and Churcher 1988, De Michelis and Grasso 1994, Holm and Ljungberg 1996). Its usefulness in practice has been investigated in empirical studies (see, Schäl and Zeller 1993, Agostini *et al*. 1994), and it has caused controversies (see, Suchman 1994, Winograd 1994).

Co-ordination theory

Various theoretical perspectives focusing on co-ordination in co-operative work have been applied in CSCW.[12] Authors such as Strauss (Strauss 1985), and Gerson and Leigh Star (Gerson and Star 1986), have used the notion of co-ordination to understand and describe work, while others, such as Malone and Crowston (Malone and Crowston 1992) and Schmidt and Simone (Schmidt and Simone 1996), have been more interested in establishing a foundation for CSCW design.[13]

Most perspectives on co-ordination start out from the problem of how to cope with *interdependency*. Co-operative work, it is argued, makes people interdependent on each others, and for that reason, they have to co-ordinate their individual efforts. What essentially distinguishes co-operative work from individual work is accordingly *the need for co-ordination* (Carstensen 1996). This implies, Carstensen (Carstensen 1996) claims, that we can make an analytical distinction between two kinds of activities in co-operation, namely tangible work and co-ordination work (see also, Schmidt and Simone 1996). This distinction is analytical, Carstensen stresses,

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[12]Many early perspectives of CSCW, such as "the shared material" metaphor, invented by Sørgaard (Sørgaard 1987, Sørgaard 1988) takes a co-ordination perspective of CSCW.

[13]Some authors have used the term articulation instead of co-ordination. The terms seem however quite similar, and I will not elaborate on the distinction here.

which seems to be equal to say that it does not really exist in practice, where co-ordination and other work activities usually are intertwined with each others in complex ways. Nevertheless, this distinction is the basis for Carstensen, Schmidt, and associates.[14]

Within management literature, workflow systems are often suggested as an approach to improve the co-ordination of work (see, Abbott and Sarin 1994). Workflow systems aim to automate tasks in work processes, most notably the co-ordination of activities among participants, so as, for example, tasks when completed are automatically routed to the next person in the work process (Ljungberg 1996b). Co-ordination is also an important topic in organisational theory, especially in literature on organisational design (see, Mintzberg 1983).

Various approaches to the co-ordination of co-operative work have been suggested in the CSCW literature. Some examples are: *Displans*, an approach and programming language for the implementation of co-ordination mechanisms (Holt 1988); *Oval*, a development environment of computer-supported co-ordination based on the idea of radical tailorability, i.e., that the users themselves should be able to design and re-design their applications (Malone *et al.* 1995); and, *Ariadne*, a general notation for the development of co-ordination mechanism based on the theory developed by Schmidt, Carstensen, and colleagues (Schmidt and Simone 1996).

Activity theory

Activity theory seems to be increasingly applied by CSCW researchers as a theoretical foundation for their work. The theory has several historical sources, ranging from classical German philosophy to the writings of Marx, as well as the work of Vygotski, Leontev and Luria in the Soviet Union in the beginning of this century (Kuutti 1994, pp. 51). During the last couple of years the

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[14]The theoretical foundations of this approach was developed in the COMIC project. People involved in the work were, besides Schmidt and Carstensen, also Carla Simone, Carsten Sørensen, Tuomo Tuikka, Monica Divitini, and Hans Andersen.

theory has been developed further by, amongst others, Yrjö Engeström.

Activity theory, as described by Kuutti (Kuutti 1994), is primarily concerned with human activities, such as work. An *activity* is an action directed towards an *object,* which is transformed by a *subject*, i.e., a human actor, using one or several *tools*, into an *outcome*. This is assumed to take place in a *community*, i.e., among subjects sharing the same object. The three parts of an activity, i.e., subject, object and community, which together produce the outcome, are related to each others through so called *mediators* (Kuutti and Arvonen 1992, pp. 235 - 236):

- The relationships between the *subject* and the *object* is mediated by the *tool*. For example, the relationship between the crafts person and the artifact she creates is mediated by the hammer.

- The relationships between the *subject* and the *community* is mediated by *rules*. For example, the relationship between the individual's efforts in an organisation is regulated by institutionalised practice, culture, formal routines, law, and so on.

- The relationships between the *object* and the *community* is mediated by the *division of labour*. For example, the relationship between the car produced at Volvo and the work force is mediated by the division of labour, e.g., work groups, roles, and shifts.

The above items, when put together, form "the basic structure of an activity" (Kuutti 1994, p. 54). This is visualised in figure 2.

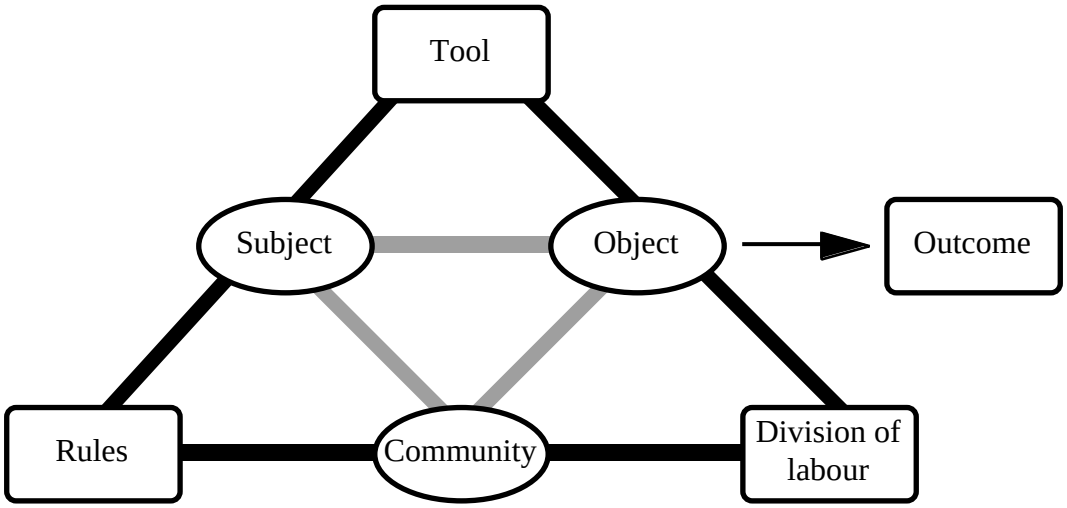

Figure 2. The basic structure of an activity (Kuutti 1994, p. 54), showing the parts of an activity (ovals) and their mediators (squares). The grey lines symbolise the relationships between the parts, the black lines how these relationships are mediated.

In CSCW, and related fields such as HCI, activity theory has been used for making sense of work practices (see, Nardi 1996, especially Ch. 7), as a theoretical foundation for design (Raeeithel 1992), and as a design paradigm used to analyse real work settings (Kuutti and Arvonen 1992).

Plans and situated action

Suchman's book *Plans and situated action* (Suchman 1987) has played a major role in CSCW research. The book argues that the cognitive science approach to human action, which then dominated computing research, is problematic, at least when it comes to the design of interactive systems. Suchman is particularly concerned with systems that interact with people based on some notion of intelligence, e.g., trying to understand what the user wants to accomplish, and based on that, taking purposeful actions. Albeit not always made consciously, the design of such systems always makes assumptions about human behaviour. The cognitive science perspective of human behaviour relies on a planning model, suggesting that human action always derive from predefined plans. Interactive systems, relying on such a perspective, are therefore

designed to recognise the user's current plan, and based on that, take appropriate actions. Suchman's study of an expert help system based on a cognitive approach, implies that problems could occur when the users' actions do not proceed according to the plan implemented in the system, simply because the system, when this happens, stops responding appropriately (Suchman 1987, p. 121 - 170).

The alternative suggested by Suchman is the ethnomethodological perspective. Etnomethodology was mainly developed by Garfinkel in the 60s (Garfinkel 1967). It is concerned with explaining the ordinary and obvious day to day actions on a very detailed level of analysis. The point of departure is that people, by using certain methods, make sense of their everyday life. These methods are used both for the purpose of interpretation and production of everyday experiences. People use methods to make their actions intelligible to others, who reproduce their social reality by using methods to recognise what is trying to be made intelligibly. These methods are ubiquitous, thus they are also used to cope with "breakdowns" such as misunderstandings. Because participants perform actions to make their interpretation of a situation intelligible to others, they are engaged in a process of reducing the potential views of the situation to a description that reflects their view of what is going on. All situations, even seemingly well-known and recurrent, have therefore to be produced by participants. This makes all situations unique (Cuff *et al*. 1979).

This implies that ethnomethodology, in advocating situated action guided by participants' methods, differs significantly from the cognitive science perspective, suggesting goal-oriented action guided by plans. Suchman, in taking an ethnomethodological perspective, is therefore quite critical to the cognitive science perspective. The problem for designers of interactive systems, Suchman claims, is that "plans are inherently vague" (p. 185), and for that reason, they should be viewed as "resources for action rather than […] controlling structures" (p. 186). Suchman does not detail her suggestion concerning how to use the perspective she suggests in the design of interactive system. This was perhaps not her ambition. Despite of that, Suchman's book clearly fulfilled a purpose in providing an *alternative* perspective that differed significantly from the

perspectives used within artificial intelligence, and related fields, which were very popular in the mid 1980s, when Suchman conducted her research.

Ethnomethodological perspectives have been applied in various ways in CSCW. One important area of application has been to describe work practices (see, Heath and Luff 1992, Bowers *et al*. 1995, Rouncefield *et al*. 1995). The perspective has also been used by social scientists in exploring work for the purpose of informing design (see, Bentley *et al*. 1992, Hughes *et al*. 1993, Hughes *et al*. 1994).

Groupware taxonomies

The term groupware has increasingly become synonymous with applications explicitly designed to support co-operative work (Ellis *et al.* 1991, p. 40). Groupware systems are often differentiated using the 2-by-2 matrix suggested by Johansen (Johansen 1988). The matrix has the dimensions time and space, which are distinguished in the categorises same and different respectively. This makes in total four scenarios of groupware usage. These are shown in figure 3 along with examples.

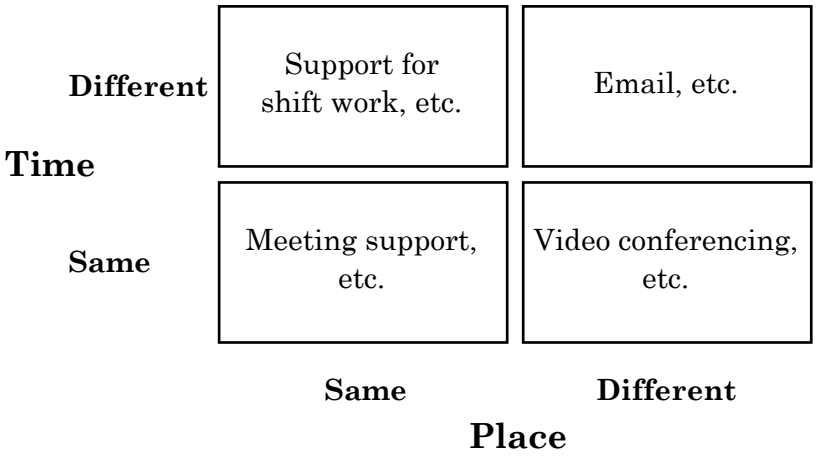

Figure 3. Four scenarios of groupware use (Johansen 1988).

According to the above figure groupware technologies can assist four kinds of collaboration situations:

- Same time, same place: Co-located people who have joined together physically, to, e.g., carry out a meeting, which could be facilitated by a so called meeting support system, i.e., IT explicitly developed to assist people in the process of running meetings effectively (see, e.g., Nunamaker *et al*. 1991).

- Same time, different place: Distributed participants co-operating synchronously, assisted by, e.g., a media space, i.e., a system that seeks to decrease the physical constraints experienced by distributed participants by enabling close and continuous audio and video interaction (see, e.g., Bly *et al.* 1993).

- Different time, different place: Distributed participants working at different times, supported by, e.g., an email application, which enable them to exchange messages with each others asynchronously (see, e.g., Mackay 1989).

- Different time, same place: Co-located participants working at different times, assisted by, e.g., a system supporting shift work (see, e.g., Johansen 1991).

Johansen's 2-by-2 matrix suffers from the problem that it only states four potential kinds of collaborative situations, but nothing about *how* participants in these situations could be supported by IT. This is not so much a problem in the so called "functional classification scheme for groupware" presented by Sauter *et al.* (Sauter *et al*. 1995). This typology is basically a map formed as a triangle with the three corners communication, co-ordination and co-operation, along which all groupware technologies could be placed according to their support. One problem with this classification is that communication, co-ordination and co-operation are difficult to define and distinguish from each other.

Groupware technologies

CSCW research has, thus, chosen many different approaches, focusing on various issues within the overall area of IT and co-operation. The theoretical perspectives outlined above have played important roles, both in descriptive and design oriented research, but there are also many research efforts that have been carried out without any theoretical perspective stated explicitly. Because much CSCW research is design oriented, quite a few projects have been concerned with exploring and elaborating on different kinds of groupware technologies and their use. This section aims to give a brief overview of the technologies that so far have been most important.

Email systems

Many early research efforts in CSCW were directed towards message systems and how they could be extended. The well-known information lens project (Malone *et al*. 1987a, Malone *et al*. 1987b, Mackay 1988, Mackay 1989, Mackay *et al*. 1989) was concerned with how to design information-sharing systems that would reduce the so called information sharing problem, "...which has to do with disseminating information so that it reaches those people to whom it is valuable without interfering with those to whom it is not" (Malone *et al.* 1987b, p. 390). This problem was approached by, amongst others, the idea of "semi-structured messages," which made it much more easy for people to filter incoming messages. Email is the most successful groupware so far (Baecker *et al*. 1995, p. 743), and it has been developed further in various ways, e.g., incorporating multimedia features (Borenstein and Thyberg 1991) and new ways of viewing the exchange process (Goldberg *et al*. 1992b). Early research attempts were, besides email, also concerned with computer conferencing and bulletin board systems (see, e.g., Hiltz and Turoff 1993).

Organisational memory systems

Organisational memory systems seek to capture experiences that people make in organisations and make these accessible (Ackerman 1994). The gIBIS system (graphical Issue-Based Information Systems), for instance, is concerned with making decision processes explicit by capturing the argumentation (Conklin and Begeman 1988a, Yakemovic and Conklin 1990), while Answer Garden, amongst others, aims to help organisations to capture experiences made by their employees (Ackerman 1994, Ackerman and McDonald 1996). The idea of an organisational memory has been criticised by Bannon and Kuutti (Bannon and Kuutti 1996), Hughes *et al.* (Hughes *et al.* 1996), and others, who have claimed that the metaphor does not sit well with the process of remembering as it actually takes place in organisations.

Video-supporting systems

Video has been used as an enabling technology in many CSCW efforts, ranging from simpler "video phones," designed for ad hoc communication between dispersed actors, to more advanced media space systems, aiming to enable close collaboration across physical distance (Bly *et al*. 1993). Several media space projects have been carried out so far (e.g., Bellotti and Sellen 1993, Bly *et al.* 1993, Heath and Luff 1994, Heath *et al.* 1995), starting with the SCL (System Concept Laboratory) media space at Xerox in the mid 80s, which began as an attempt to enable a design team to work close together despite being dispersed in two places (Bly *et al.* 1993). Closely related are the many efforts spent on providing support for serendipitous and informal interaction by means of video, such as Cruiser (Root 1988) and Rave (Gaver *et al*. 1992), and in recent years, Montage (Tang and Rua 1994) and Piazza (Isaacs *et al.* 1996). Advanced collaboration enabled by video technologies have also been explored by Ishii and associates, in their efforts to design support for seamless co-operation, which aim at enabling people to switch easily between individual and collaborative work, and use the tool they prefer, computer-based or not, in collaboration independent on others' preferences (Ishii and Miyake 1991, Ishii *et al*. 1994).

Recommender systems

Recommender systems seek to decrease the problem of information overload emerging from large information spaces, such as the WWW, by taking advantage of the fact that many people who interact with the information have common interests, and therefore, can provide each others with valuable recommendations (Goldberg *et al*. 1992a, Maltz and Ehrlich 1995, Resnick and Varian 1997). To capture information to be used for generating recommendations, people either have to vote explicitly (Resnick *et al*. 1994, Konstan *et al*. 1997), or let the system monitor their behaviour (Hill and Terveen 1996, Rucker and Polanko 1997). The first recommender system, called Tapestry, was presented only five years ago, but the research community did not actually direct much attention towards the topic before the Internet boom in the mid 90s.[15] Collaborative filtering was originally used to denote this type of technology (see, Resnick *et al*. 1994).

Collaborative virtual environments

Collaborative virtual environments, such as Massive (Greenhalgh and Benford 1995a), FreeWalk (Nakanishi *et al.* 1996), and DIVE (Fahlén *et al*. 1993), enable interaction among embodied participants in virtual worlds (Bowers *et al*. 1996). Such systems differ from other CSCW technologies in that they embody their users, assigning them to characters that interact in often game-like artificial worlds. Research efforts on collaborative virtual environments have mainly concerned application design (see, Greenhalgh and Benford 1995a, Nakanishi *et al.* 1996), the development of underlying models for virtual worlds (see, Benford and Fahlén 1993, Rodden 1996), and recently, even some investigations into experiences of these systems in use (see, Greenhalgh and Benford 1995a, Bowers *et al*. 1996).

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[15]The papers on Tapestry were first published in 1992 (Goldberg *et al*. 1992a, Terry 1993). Papers on the topic became more frequent at conferences around 1995 (see, Resnick *et al*. 1994, Maltz and Ehrlich 1995, Shardanand and Maes 1995).

Workflow and scheduling systems

Workflow management systems aim to execute, manage, and automate business processes (Abbott and Sarin 1994). One important issue in such systems is to support co-ordination of tasks, which sometimes is implemented based on one of the theories available (see, Medina-Mora *et al.* 1992). Another kind of system supporting co-ordination in organisations is scheduling applications, which are intended to facilitate the process of booking a meeting.

Collaborative writing and drawing

Quite a few authors have analysed collaborative writing and drawing, e.g., how people actually write together (Posner and Baecker 1993). These processes have been supported when taking place synchronously, e.g., on-line collaborative editors like Grove (Ellis *et al*. 1991), but also when being done asynchronously, e.g., mechanisms that acknowledge past activities in co-operative environment, such as, who has updated what in a document (Fuchs *et al*. 1995).

Meeting support systems

Meeting support systems, also called electronic meeting systems (Nunamaker *et al*. 1991), seek to support the actions taken by people who have joined together in a meeting. Group decision support systems, which were one of the most early groupware systems available, are developed to support collaborative decision making, most often, among co-located people in a so called electronic meeting room (Turban 1990, pp. 136). Two examples are Capture Lab, investigated by Mantei (Mantei 1993), and GroupSystem, described by Nunamaker *et al*. (Nunamaker *et al*. 1991). Support for meetings are also provided by so called Liveboards (Elrod *et al*. 1992, Mark *et al.* 1995).

Mobile computing systems

In recent years increased attention has been directed towards the use of mobile computing devices, such as PDAs (Personal Digital Assistants) and wireless networks, and their application in organisations. There are however still very few contributions on this topic within CSCW. Some exceptions are Kristoffersen and Rodden (Kristoffersen and Rodden 1996) and Bellotti and Bly (Bellotti and Bly 1996), as well as three of the papers in the thesis (paper 1, 2 and 3). So far, research on mobile computing has mainly concentrated on highly technical issues (e.g., Comparetto and Ramirez 1997).

Other research strands

There are some research strands within CSCW that were not mentioned in the above discussion. Efforts have, for example, been directed towards developing toolkits for groupware design, e.g., GroupKit (Roseman and Greenberg 1996a), COLA (Trevor *et al.* 1993), and Mediate (Kristoffersen 1997). Yet another strand has been concerned with developing new techniques and methods for design, e.g., co-operative design (Kyng 1991, Kyng 1994), and multidisciplinary design (Bentley *et al*. 1992, Baecker 1993, p. 187, Hughes *et al*. 1994). Researchers have also focused on the adoption and diffusion of groupware systems in organisations (see, Grudin 1994b, Ciborra 1996). The effects of groupware on organisations (see, Pinsonneault and Kraemer 1993) and human beings (see, Olson *et al*. 1995, McGrath and Arrow 1995/1996) have also been investigated.

After having outlined the empirical and theoretical backgrounds of the thesis, I now direct attention towards the research approach adopted in the thesis.

Research approach

The approach adopted in this research has very much in common with what Dahlbom calls "the New Informatics," defined as "…a *theory* and *design*-oriented study of *information technology use*, an artificial science with the intertwined complex of people and information technology as its subject matter" (Dahlbom 1996b, p. 29). Together with Steinar Kristoffersen, I have previously elaborated on the practical implications of such a perspective (Kristoffersen and Ljungberg 1996a). In this section I want to recapitulate these ideas.

Perspective

Our point of departure is that informatics is an artificial science concerned with *the use of IT*. The knowledge interest of artificial sciences, such as informatics, is to improve and invent the use of artefacts (Simon 1981, e.g., p. 7). Such a knowledge interest goes beyond the classical distinction between the social and the natural sciences, with their ambition to interpret and explain respectively (Dahlbom and Janlert 1990). The notion of "IT use" seeks to capture the use of all kinds of IT from the perspective of the people affected. We do not see IT as a "dead object," but rather as a powerful and complex artifact that more and more seems to be integrated in human practices, enabling but also dictating the conditions, and not seldom acting in seemingly uncontrollable ways (Dahlbom 1996b, Ciborra 1997). The perspective is not restricted to a particular domain of IT use, such as the office.

The focus on IT use with the ambition to improve and invent such practices, makes the suggested approach closely associated with design. It should be noticed, however, that design as understood here does not only concern IT as such, but also the new practices of which the new or improved artefacts would be an integrated part (see, Kling 1996, p. 295).

The standpoint in exploring new and improved use of IT is the practice in which such an intervention would take place, as seen and understood by those people who act in this domain. When exploring

the current practice empirically, the researcher is supposed to intertwine knowledge of IT use, such as previous work on the topic explored, with an understanding of the current practice, in order to imagine new or improved kinds of IT use, i.e., new practices. Analysing practice and empirical accounts is, therefore, similar to imagining different kinds of IT use. This implies that the empirical work should be done by people trained in IT use. The research methods involved in empirical work would typically be participant observations using ethnographic techniques, and qualitative interviews. The overall objective of this kind of informatics research is to discern new ideas of IT use that are likely to be appropriate in several situations. This is not to say that the aim is to discover "the grand theory of IT use."

The evaluation of informatics research, as understood here, would primarily focus on how the research contributes to improve the use of IT. To be able to produce such research empirical work seems likely to be necessary. It could also be a good idea to discuss the research with potential users and colleges, design prototypes, perform usability tests, and so on. However, detailed descriptions of work, statistically proved relationships, carefully engineered software, etc., would not qualify in their own rights.

Research process

The research process of the suggested approach involves two steps. The first step is to *investigate practice with a purpose*, i.e., selecting certain aspects of IT use and current work practices according to the overall purpose, which initially might not be very specific. The idea of this step is to develop overall, brief ideas of future IT use in the particular situation.

In the second step of the research process, we seek to detail, explore and, ideally, generalise the ideas of IT use, designing and elaborating on different options with serious attention to the empirical experiences. This typically involves design efforts, producing IT artifacts, but also the views of others, including research associates and the participants explored. Ideally, the output

of step two is ideas of improved or new IT use that seem likely to be more or less generally applicable.

Methods

There are in particular two scientific methods that this perspective of informatics research advocates: ethnography and qualitative interviews. Ethnography is concerned with describing a certain domain, such as a working day, as seen from the people involved (Hughes *et al.* 1993). This is done by direct involvement of the researcher, typically but not necessarily (see, e.g., "quick and dirty ethnography," Hughes *et al*. 1994, pp. 432) during an extended period of time (Hammersley and Atkinson 1993). While doing the empirical work, the researcher seeks to collect whatever data available that shed light on the focus of the research efforts (Hammersley and Atkinson 1993). The analysis of the empirical accounts is an important part of ethnography, which formally starts when the data is collected (Hammersley and Atkinson 1993). Ethnography is being used in many different ways and for many different purposes, ranging from long-term anthropological studies of cultural phenomena (Alvesson and Sköldberg 1994, pp. 109) to snapshots of work for the purpose of systems design (see, Kristoffersen and Rodden 1995).

Qualitative interviews are characterised by openness and flexibility (Mason 1989). The researcher only sets the overall agenda and then let the person interviewed be the one in charge (Holme and Solvang 1986). Ideally the interview takes place within a context with which the interviewee is familiar (Holme and Solvang 1986). Qualitative interviewing thus favours richness of worldly realism, rather than tightness of control (Mason 1989).

Summing up

The perspective of informatics research outlined above is summarised in table 1.

Aspects of the perspective	
Subject matter	IT use
Knowledge interest	Improve and invent IT use
Objective	Produce elaborate ideas of IT use which are more or less applicable in many situations.
Standpoint	The practice considered as seen and understood by those people who act in this domain.
Steps of the research process	
1 Investigate practice with a purpose	
· Process	Combining knowledge of IT use with an understanding of the current practice, to imagine improved or new kinds of IT use.
· Method	Typically participant observation using ethnographic techniques, and qualitative interviews.
· Product	Overall, brief ideas of improved or new IT use in the particular domain.
2 Explore and elaborate on ideas of IT use	
· Process	Explore and elaborate on overall ideas of IT.
· Method	Typically designing IT artifacts and discuss their use with research associates and potential users.
· Product	Ideas for IT use that are likely to be fruitful in many situations.

Table 1. A summary of the perspective of informatics research used in the thesis.

Networking meets "the New Informatics"

After having described the focus of the thesis, i.e., networking, as well as the research approach advocated, I now outline the characterising aspects of the five individual papers of the thesis. The papers approach networking from the perspective of "the New Informatics" outlined previously, using the two-step research process introduced.

The scope of the research has been delimited to *co-operation* in networking, and accordingly, *the use of CSCW technologies* in such working practices. The individual papers, in adopting this approach, address the following research question:

> *What are the possibilities to improve existing and invent new ideas of CSCW technology use in networking?*

The overall research question has been approached from two perspectives: the individual and the group. The first perspective (paper 4 and 5) focuses on the individual participant's use of CSCW technologies in networking, while the second perspective (paper 1, 2 and 3) is concerned with the use of CSCW technologies in networking groups.

The research on networking groups deals with the problem of group work in networking practices. The empirical research carried out on this topic explores the networking actors in the dispersed and mobile IT support group described previously. The networking support group members are co-located with their customers. This enables the group members to offer intimate and proactive support, but it also results in problems. Through empirical work, we found that the group experience problems related to the co-ordination of work and the sharing of experiences. We, therefore, wanted to explore the possibilities for the networking actors in such a dispersed and mobile group, to use CSCW technologies to co-ordinate their work and share their experiences more effectively, given the networking practice and without impairing the close, personal and proactive

support services. The first paper of the thesis explores the work in the IT support group with such a purpose. The second paper details these ideas, which subsequently, in the third paper, are elaborated into a general development framework for these kinds of applications.

The second perspective of the thesis approaches the research question from the perspective of the networking person, focusing on CSCW technology use as an integrated and important part of the working practices of the individual worker. The empirical research on this topic explored the work in clinical trial projects. A preliminary exploration of the topic implied that the CSCW technologies used by the pharmaceutical staff did not provide appropriate support for the range of situations in which they were being employed (Ljungberg 1996a, Ljungberg and Sørensen 1996). To analyse these problems in more detail, exploring how they could be decreased by means of new or improved technology, I decided to set up a second, more extensive empirical study. In the fourth paper of the thesis I analyse and explore the problems found in the second study, and make some brief suggestions for design. The fifth paper, finally, elaborates further on one of these suggestions.

The papers, in approaching the overall research question from these two perspectives, apply the two-step model of informatics research described previously. According to this model, informatics research basically comprises two steps: first, investigate empirically the possibilities of new or improved use of IT, and second, explore and elaborate further on these ideas with the ambition to generalise. The papers of the thesis apply this two-step model to approach the overall research question from two perspectives: the individual and the group. This is illustrated in figure 4. Below I briefly recapitulate the five individual papers.

The networking group

The research on CSCW technology use in networking groups was launched in January 1996. Ethnographical observations and qualitative interviews were used as the main mode of inquiry. A group evaluation session in which we presented our overall ideas,

was also set up. During the process of elaborating on the overall ideas, and

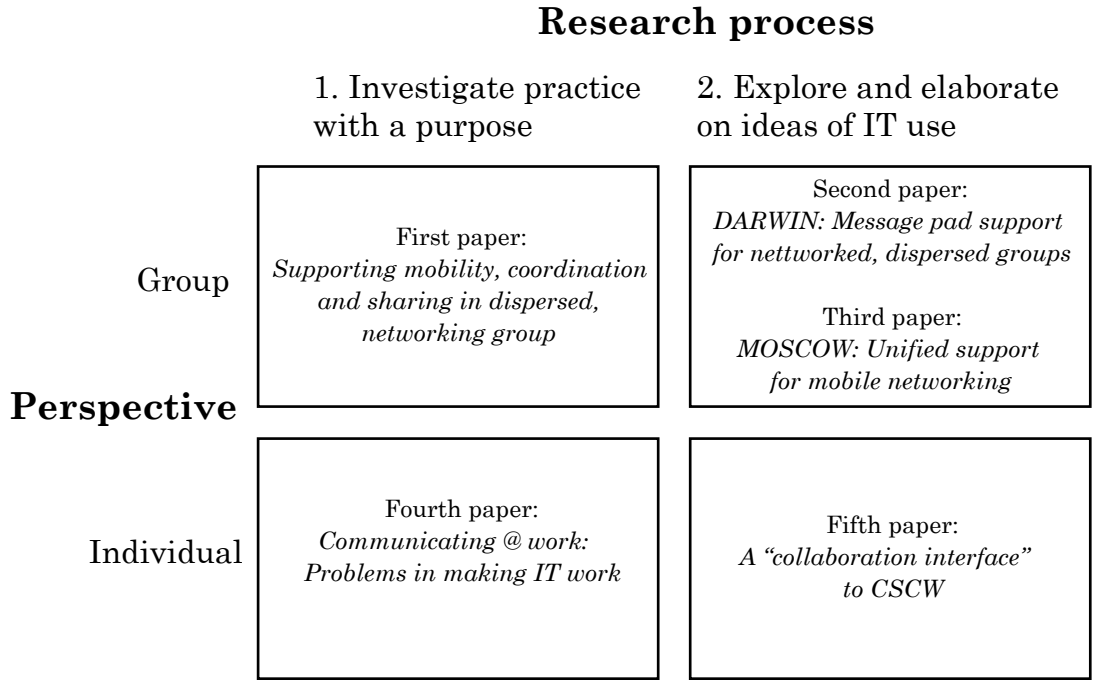

Figure 4. The overall research question of the thesis is: *What are the possibilities to improve existing and invent new ideas of CSCW technology use in networking?* The individual papers approach this question from two perspectives, the person and the group, using the two-step research model advocated in section 5.

making more precise suggestions for new and improved use of CSCW technologies in the group, we met the group occasionally. The idea was to get valuable feedback to improve the ideas. Below I briefly recapitulate the three papers that approach research question of the thesis from the perspective of the networking group. For a summary of the entire project, see Kristoffersen and Ljungberg (Kristoffersen and Ljungberg 1997).

First paper: "Supporting mobility, co-ordination and sharing in dispersed, networking groups"

In this paper we explore the work practices in the dispersed and mobile IT support group of networking actors. We analyse the problems experienced in the group, maintaining that they must not be resolved at the sacrifice of the close, personal, and continuous support services currently provided by the group members. Given these conditions, this paper explores the possibilities of using CSCW technologies to resolve the problems experienced. The paper suggests that these problems are likely to be reduced if staff are provided with mobile support for co-ordination and sharing.

Second paper: "DARWIN: Message pad support for networked, dispersed groups"

In this paper we elaborates further on the ideas of how the networking group of dispersed and mobile support persons could use CSCW technologies to collaborate more effectively. We do so by suggesting DARWIN, a CSCW application designed to assist the networking and mobile group in co-ordinating work and sharing experiences. DARWIN comprises two common information spaces which communicate asynchronously with mobile computing devices. The common task space aims to assist the co-ordination of work in the group, while the common experience space seeks to facilitate staff in sharing experiences. The support staff access these common information spaces through mobile computing devices. The paper details the design of DARWIN and reports from a group session in which the application was evaluated by the support staff.

Third paper: "MOSCOW: Unified support for mobile networking"

In this paper we detail and elaborate on the underlying mechanism of DARWIN, suggesting the MOSCOW development framework. MOSCOW is basically a client-server architecture and message passing protocol that address the conditions and constraints of the networking, dispersed and mobile group. The paper describes the

architecture and protocol of MOSCOW, showing how it could be used in design.

The networking person

A brief interview study exploring how nine pharmaceutical researchers used CSCW technologies as an integrated part of their everyday work, was carried out during the spring of 1995 (Ljungberg 1996a, Ljungberg and Sørensen 1996). The result implied that the technologies used did not offer appropriate support for the plethora of situations in which they were being employed. To explore these problems and how they could be resolved, more extensive empirical work was required. Against this background the Dyspepsia group described previously in this chapter was contacted. The clinical trial group was explored during three months, starting in November 1995. The empirical efforts comprised about 320 man-hours of ethnographical observations and 12 qualitative interviews. The objective was to explore possibilities to improve and invent new mechanisms to improve the use of CSCW technologies from the perspective of the networking participant. Below I summaries the two papers that approach the research question of the thesis from the perspective of the networking person.

Fourth paper: "Communicating @ work: Problems in making IT work"

In this paper I investigate the use of CSCW technologies in the everyday practices of clinical trial personnel. The paper analyses in what ways the networking actor has problems to effectively align the use of CSCW technologies with other work activities, and in doing so, it seeks to elicit brief implications for design. This paper suggests that the networking actor experiences problems related to, first, tracking and resuming not completed activities, second, modes of communication, third, the initiation of conversations, fourth, notification of incoming messages, fifth, information overload, and sixth, "junk mails."

Fifth paper: "A "collaboration interface" to CSCW"

This paper approaches one of the problem areas explored in the fourth paper, namely the set of obstacles related to the process of setting up CSCW sessions. In the first part of the paper I analyse the general problem with the purpose to elicit implications for the design of new CSCW technology use. This analysis serves as the rationale and background for the Collaboration Interface prototype system suggested in the latter part of the paper. The Collaboration Interface aims to facilitate the process of setting up CSCW sessions by providing two mechanisms applicable to all CSCW systems that do not launch sessions automatically. The accessibility mechanism makes it possible for users to implement plans for who they want to be accessible for using what CSCW system, while the awareness mechanism assists participants in making their actions visible for each others in the actual process of setting up CSCW sessions.

Results

In this section I describe the overall results of the thesis, synthesising the main points of the introductory chapter and the five individual papers. The overall results are:

- …the empirically based analysis and confirmation of *networking* as an emerging kind of work. It was concluded in section 3 in this introductory chapter that the working practices explored in the thesis to a large extent meet the qualities of networking: clinical trial workers, who mainly are concerned with *knowledge work*, and the IT support staff, who mainly are *service workers*, seem to be reasonably *empowered*, highly *co-operative*, and rely significantly on *the use of IT*.

- …the close empirical exploration of a previously not analysed *conflict*, between on one hand the individual service person who relies on personal networks in providing close and continuous support services, and on the other hand, the need

for group work to, amongst others, share experiences and co-ordinate work. One main result of the thesis is the *close examination* of this conflict, exploring how it could be decreased by the use of CSCW technologies.

- …the design, implementation, evaluation and detailed discussion of the potential incorporation of the DARWIN application within the work of the IT support group, to enable group work in the networking environment without losing the advantages of close and continuous interaction with the customers, or the personal networks.

- …the MOSCOW development framework. MOSCOW takes a *unified* approach to CSCW technology use that reflects the empirical findings of dispersed and mobile groups in networking environments.

- …the in-depth study of IT as an integrated part of work in clinical trials. This is an important result as the investigation did not only confirm established CSCW requirements, but also shed light on and approached *emerging problems* not addressed elsewhere.

- …the exploration and development of the accessibility and awareness mechanisms, implemented in the *Collaboration Interface* prototype system. This is an important result since it makes an explicit suggestion for new IT use.

Further research

There are in particular two areas within which I suggest further research. First of all, there are suggestions made in the thesis that need to be explored and elaborated further. Most of the problems concerning the incorporation of CSCW technology use in work, have *not* yet been addressed. One challenge for further research is to investigate these problems in more detail, exploring how they could be decreased, or resolved, by new or improved IT use. As work seems

to become increasingly concerned with communication, I also suggest further research to explore how the mechanisms of the Collaboration Interface could be improved and what additional mechanisms that seem appropriate, to facilitate participants in the process of initiating IT mediated interaction.

Future work should also address the overall issues concerned in the thesis. In particular, I suggest further research on new kinds of working practices, such as networking, and the integrated and intertwined role of IT use in these. Inasmuch as work and the role of the IT expert in organisations co-evolve, developing new terms and concepts to explore, analyse and discuss new kinds of work practices and the role of IT in these, have strong practical incentives that apply to the view of informatics advocated in the thesis.

First paper

Supporting Mobility, Co-ordination and Sharing in Dispersed, Networking Groups

Co-author: Steinar Kristoffersen

Abstract

This paper examines the work of an IT support group to develop suggestions for how networking, dispersed groups can use mobile computing to work more efficiently. The members of the support group are located *with* their users, rather than in a dedicated space of their own. Thus, they find it hard to share experiences, co-ordinate work, and facilitate the training of new members. The support group aims not only to react to acute commissions by their users, but also to proactively suggest innovative applications and design new systems. Using mobile devices to access shared information spaces, the group can more efficiently co-ordinate work and share experiences.

Introduction

The objective of this paper is to suggest new and improved computing applications for networking, dispersed groups. Our proposals are based on an empirical study of an IT support group in a large pharmaceutical research company.

Within organisations, some individuals develop aptitudes with which they gain a position to enhance the use of IT in their group.

Local expertise, exhibited by users in the workplace, has received attention lately (Eveland *et al.* 1994). Competent users frequently inspire new adaptations and applications, as well as assisting their peers on a day-to-day basis. The availability of the local experts is generally not institutionalised, and thus almost invisible outside personal relationships. Eveland *et al.* (Eveland *et al*. 1994) thus found that such situated, proactive support took the form of a "help network," to the benefit of the organisation, and that it is constituted by a small set of work group based networks, liaising with the central IT support department. The local gurus are sophisticated computer users, but they appear to be sought out as much for their in-depth knowledge of the activities of the group, as for their technical qualifications (Eveland *et al.* 1994). This aspect clearly distinguishes the proactive help network from more reactive help desk support.

We conducted the empirical study presented in this paper at a research company in a multi-national pharmaceutical enterprise, in which the importance of local expertise has been recognised. Since last summer, a new IT support group has been put together, explicitly aiming to provide *in situ,* proactive support. Their objective is continuous support, enhanced by recommending improved use of existing applications and contributing to better computing for their users. Albeit members of the same group, each is located with the unit they support, thus affording easy access as well as developing good knowledge of the work domain.

Traditionally, work is conceived of as taking place within organisational boundaries. Increasingly, however, this framework has become too confined to describe what people do; going beyond organisational borders to maintain personal working relationships that are contingent, loosely coupled, temporal, autonomous, and flexible. In this way of working, people create and develop their own commissions and responsibilities. We describe this type of accomplishment of work as *networking*.

Some problems have been brought to the fore, however. Being co-located with the unit of the users, rather than the IT support group, makes it harder for members of the IT support group to share experiences, to facilitate training, co-ordinate work, etc. Support for

their own activities, in situations where one person cannot perform a given task, is harder to get since the group members are constantly on the move, and when in their offices they can be a considerable distance away from the caller. Setting up a shared database, the group aimed to improve its proactive support work, e.g., by sharing to-do lists and documentation of work. After four months, they had to admit that the database had failed, and another attempt was made to implement a similar design in Lotus Notes. Apparently, it is not being used much either.

The group already uses IT in their own activities, e.g., to maintain their informal contacts. Considered more important, however, is to assess the potential role of IT to compensate for losing the benefits of being a group, in a networked organisation. The idea is, according to the group manager, that the group should "display a collective competency that is larger than the sum of its individual members." They wish to be able to share their experiences, co-ordinate work and maintain the network as well as the group.

Facing an unpredictable variety of requests and assignments from the unit, developing the specialist competencies necessary to suggest innovative uses of IT has to be traded off against typical generalist skills. There seems to exist a dialectic contradiction (Bjerknes 1992) between proactive and reactive support, probably related to a contradiction between dispersed networking and group work. The workload in the network is personal and only with difficulty sharable, hence planning, e.g., to partake in development projects, is almost impossible. Also, spending more time co-ordinating work within the group to develop specialised competencies, inevitably reduces the time spent networking.

The problems of the support group can, arguably, be attributed to a lack of what is typically conceived as *group work*. By working closer together as a group, sharing experiences and co-ordinating work, the performance of the support group could be improved. However, due to the apparent contradiction between working in the group and the network, an interesting question arises, namely how can group work be improved without substantially weakening the network? Established in a research tradition with a concern for the development and use of IT (Ehn

1995, Dahlbom 1996b), we formed a research agenda asking; *how could the support group benefit from computing to work more like a group* without attenuating *the work in the network,* and *which requirements imposed by the nature of work would have to be considered in the design of such support?* Participant observations and interviews informed the design of a common information space (Schmidt and Bannon 1992); supporting the sharing of experiences, and a common task space; enabling the group to divide and co-ordinate work more effectively.

The rest of the paper is structured as follows. Sections 2 contains the research background, followed by our account of the work process (section 3). In section 4, we present some implications for future IT usage in the support group. Section 5 concludes the paper with a discussion of the group can network using new IT.

Research background

We conducted the fieldwork at a multi-national, pharmaceutical research company in Sweden. The Company has approximately 1000 employees and the turnover for 1994 was about $ 400,000 per employee. The activities of about 750 research staff span from basic research on cell biology, to innovation in pharmaceutical chemistry. The work is quite computer-intensive. For planning of experiments and statistical analysis of large experiments with hundreds of variables, a number of applications are used. Office systems and presentation tools, word processors, spreadsheets, as well as file transfer, email and bulletin boards are relied upon in the workaday activities.

Our research takes place at "Clinical Information and Data management, Education and Support" (CIDES). CIDES is the clinical division's IT support group and belongs organisationally to the "IT & Data Management" department (IT & DM). With approximately 325 employees, the clinical division continues research on drugs that have already passed through the pre-clinical research, evaluating them on human subjects. Researchers at this site are also managing

clinical testing of drugs before they are approved for regular use. The clinical trial programmes last for several years and involve institutions from all over the world. Evaluation of a new drug on humans follows stringent toxicological safety tests. In phase one a small number of healthy volunteers test the drug to establish optimum dose and establish a safety-profile. Next, patients with the objective disease take the drug, and the results are compared to that of a placebo. Third, the drug is subscribed to a large number of patients from a number of national centres.

Besides IT & DM, there is a central "Information Systems and Technology" department (IST). They deal mostly with the *horizontal* IT applications; word processors, spreadsheets, etc. "The work to make IT work" (Bowers 1994) is the responsibility partly of IST and their HelpDesk, and partly of CIDES. As we shall shortly illustrate, the members of the central HelpDesk work in close co-operation with, but are distinctly different from, the distributed CIDES support group.

Approaching our research question — how could this support group use IT to work more "like a group" — from an empirical perspective, we studied the work in detail. We would like to point out here, that from our point of view, exploring the nature of work is not the same as investigating the social. We maintain that it is impossible to study the social and the technical separately in the modern society (Simon 1981, Dahlbom and Janlert 1990). The reason is straightforward; we do not, for practical purposes, do anything without using artefacts! In the case of the support group, for instance, artefacts like computers, phones, networks, coffee machines, Xeroxes, faxes, etc., play a major role in the everyday performance of work: "When the computer network goes down, 99% of the work goes down...including ours...," as put by a member of the support group. Thus, the traditional distinction between the social and the technical, is a somewhat old-fashioned point of departure, maybe not suitable for research focusing on computing (Simon 1981, Dahlbom and Janlert 1990, Dahlbom and Janlert 1997). We have chosen to emphasise the use of artefacts, especially IT.

The fieldwork reported here was carried out in January 1996. By combining participant observations, interviews, and a group

discussion, we believe that we gained a reasonably elaborate picture of the nature of work in the support group. The approximately 75 man-hours of participant observation revealed many interesting observations into what the group does. We believe that these insights would have been hard to achieve otherwise. Our role as observers was commonly known. We observed the group members individually, and discussed the observations afterwards. Field notes were taken during the observations.

The participant observations were followed by semi-structured interviews. The interviews lasted for approximately one hour, and were all taped. A seminar was arranged in which we presented and discussed our findings from the fieldwork with the support group. The purpose of the seminar was to validate our findings and discuss our suggestions for future IT usage in the group. The discussions of the seminar lasted for approximately one and a half hour. The discussions were recorded.

The work of the IT support group

The support group consists of 9 people[16]: Steve, Peter, Cindy, Anne, Diana, and Jim who do regular support; Marie, who is the systems administrator for a VAX subnet; Alan, the group manager, and Cath, their secretary.

CIDES collaborate with, and is supported by, IST, who are centrally localised in an office space of their own. The members of the support group, on the other hand, are distributed; Marie, Peter, Alan and Cath are located in one smaller building, the others are in the main building with their allocated user groups — each person in CIDES has a set organisational and physical area to serve and is co-located with the users instead of their peers. There is a street crowded with traffic between the two buildings, and the distance is about 200 metres.

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[16]Names are changed for anonymity.

Steve is responsible for the support in *Clinical Science*, with approximately 40 persons. Diana serves *Human Pharmacology*, *Regulatory Affairs* and *Clinical Supplies*, a total of about 90 people. Human Pharmacology is closely co-located with Diana, much closer than Regulatory Affairs. Diana believes that she has much more frequent contact with Human Pharmacology. Simply because they are closer, she meets them for coffee, walking in the corridor, etc. Anne is responsible for the IT support in Clinical Research Management II (CRM II), with approximately 30 persons. In a similar manner to Marie she does some systems administration. Anne has specialised in AMOS and Lotus Notes, of which there is only one other expert, with IST. Cindy is responsible for support in CRM III. Peter is responsible for the users in this house, the Wang house. The biggest group here is CRM I.

The principle of the distribution is that support should be proactive. Support staff should be able to interact with users on a daily basis to anticipate problems, eliciting from them the problems considered, at an early stage, to be of minor importance. Co-location moreover adds to the support staff's knowledge of the business processes they are supporting, thus they are capable of suggesting new and better applications for a task, improving IT use, and developing new tools and methods.

The networked aspect of the support work is very important. Being co-located with the users results in closer personal relationships, and introduces the necessary confidence. The users dare ask questions that they perhaps believe are naïve. Being available is very important as well. Even if the problem is not acute, the users take the opportunity to ask when they meet their support person in the corridor. Anne commented on the importance of co-location saying that "I'd never be able to serve a chemist," i.e., someone in another unit. When Diana was off ill her users said that they might as well talk to the HelpDesk, as someone else in the CIDES group — clearly an indication that a centralised support is less appropriate for the clinical units.

The CIDES support group meets every Friday. During the week, issues for the agenda accumulate and some group members have made a habit out of writing them down. The group meeting is

basically the only opportunity to exchange experiences, plan the next week's work, and synchronise the information flowing from the group to the network of users, e.g., about operative system updates and network downtime.

The sections below illustrate characteristic aspects of the work of the support group, with emphasis on the local practices and situated accomplishments of the support group.

Group work and networking

Maintaining a broad customer *network* of users is essential to the work as IT support person — and a distinguishing element from ordinary IT HelpDesk functions because, ideally, the CIDES group are expected to deal with problems *before* clinical research comes to a halt due to IT failure. Making sure one is available is an integral part of working in a networked organisation.

> 09.00: Cindy leaves her office to go to Clinical Supplies to show JR (a clinical test supervisor) from CRM III, how to use CTMS[17] to create drug-related requisitions, which, when keyed in, are relayed to DORIS[18]. Most CIDES members would in a situation like this forward their desktop telephone onto the mobile phone, but instead Cindy logs out entirely, in order to get some peace while she is instructing JR. The reason she can do that is that she told her customers to send her an email if they cannot get hold of her. Moreover, being forced to put their problems in writing the users have to think them through, which Cindy thinks is beneficial. Taking this stance is probably a result of maintaining a large network of customers. "Shutting off" communication is one way of co-ordinating work.
>
> Before we went to the support session, Cindy got 4 calls within 15 minutes. Diana, who joined Cindy during this support session, however got "only" three calls during a three hour long support session. Diana commented on this some days later:

[17]Clinical Trial Management System, an application supporting the clinical test supervisors, and others, to manage clinical trials.

[18]DORIS, an application supporting the process of ordering drugs.

> "Before I became ill I hadn't a moment's peace. I had much more to do than now. But I have only been back for a short period, and you know, it takes some time to re-establish the network."

Networking has strong informal aspects. People do most things on their own initiative and talk to people when they need. This is the case when dealing with customers as well as other support or IT staff. We found indications of different networking practices in the group, some of which were mainly about solving the customers problems, others that were largely about soliciting assistance from peers. For the purposes of this paper, we suggest that members of the group partake in "customer networking" as well as "peer networking."

Cindy told us that one other member of the CIDES group was serving someone on the 5th floor. When she went away on holiday, Cindy substituted her. When she started on the mission a lot of people on the floor approached her about their own problems "now that you're here, do you think you could be asked to..." and so forth. The users took the opportunity when someone knowledgeable about PCs arrived. Even if the unit on the 5th floor is not part of Diana's domain, i.e., not part of CRM III, she does serve on a regular basis some of the users there: they are part of her customer network. In some cases the added workload becomes excessive, asking from her services that would require far to great resources, e.g., setting up and transferring data between phases of a study.

When people in the group get an assignment that they cannot solve, they usually ask one of the other group members for help. Some of them, e.g., Diana, keep a list of all the people that they know have particular skills or useful specialities.

The significance of the network was illustrated in the following manner:

> "Say a user doesn't know how to print from AMOS. Diana knows that Anne have experience with AMOS, and so she gets in touch with Anne (most likely on the mobile telephone). Anne tells her that as of yet not all printers are configured in AMOS,

> and that it is LS's responsibility. Thus, Diana has to contact LS in order to support the user."

Although Peter is located in another building, Diana has as much contact with him as with Anne, Marie, Cindy and Peter, perhaps because he knows Microsoft Access quite well. She is even in contact with MB and FK from IST on a daily basis. The support group, however, is considered to be "family," and the group lunches on Tuesdays and meetings on Fridays reify this.

Diana told us that she would like the support group to become more homogeneous towards their customer networks, e.g., in terms of releasing consistent information about new systems. She suggested that the Friday meeting could be used more consciously for this purpose. One should furthermore make procedures and responsibilities more explicit — she felt that currently these aspects of the group's work were a bit blurred. As an example she mentioned that the usage of the Notes database to collect and make available useful information to the group, i.e., an attempt to implement a *group memory* (see, Bannon and Kuutti 1996) for a critical examination of this concept), was not accompanied by protocols for how to use it. *But*, only inasmuch as this type of structure and guiding lines would not interfere with the flexibility that the support group enjoys today. According to the members themselves, this is the only way the group can work.

The case was presented to us as one of maintaining the group. Measures already taken by the group were social trips abroad, a weekly group lunch, and a weekly group meeting. Albeit vaguely, we understand that the group is not truly working as a collective ensemble, and that the manager in particular expects some important benefits from that if it could be achieved.

> "Being able to take one step into the corridor and shout for an answer, well, we're not entirely there yet, ..., telephones are not returned, ..., sharing experiences is even harder, ..., we look to making our competencies external, ..., moving knowledge from the head to the database."

The group is working on the move

Importantly, the persons of the support group are very mobile. They do most their work at the user's desk, and they are "assigned" many tasks serendipitously outside their offices, e.g., during coffee breaks, when running into someone in the corridor, or while supporting another "customer." Furthermore, users are frequently opportunistic when contacting a support person, typically when struggling with several smaller problems. These are generally not very serious problems — or the user would have contacted the support person earlier — but the user takes the opportunity to get them solved as well, when talking to the support person. Due to the importance of meeting users physically to be commissioned, some of the support persons go on rounds among their users on a regular basis. Alan, the support group's manager, has even encouraged them to "just hang around when they are out of work."

The "on-the-move" aspect can be illustrated with the following excerpt from the field notes:

> 08.30 Went on to do "the round" in Peter's unit, CRM I, all of which are in "Wanghuset." Peter relayed his desktop telephone onto his mobile phone. The purpose of the round is to check whether someone needs help, perhaps on issues too minor for them to make a call themselves. Often (he tells me), during the round, people come to him with things of little importance, "should I throw these manuals away," etc., and could help them. If it is a major "repair" Peter would make a note in his journal, and get back to it later according to how urgent and/or important it is.
>
> 10.20 Peter helps one of the secretaries (upstairs) to create a database in Microsoft Access to manage people who have taken courses, been given diplomas, etc., Peter teaches her to create the tables, well, at least he tells her what he's doing.
>
> 10.25 The mobile phone rings while Peter is working on the Access database. The caller cannot find, in her Microsoft Windows set-up, the network disks. Peter tells her, "I'll tell you what to do, select the log-in command in the start-up screen, write your user-name in the log-on screen, then go to file and

> select “refresh.” Mmm, are they empty as well,..., take it easy, I’ll come up soon if you want me to.”
>
> Returns to the “ad-hoc” design of the course DB. Peter has got the DB up and running, and tells the secretary to start entering data. If she encounters problems, “write them down on a note instead, and then we’ll do them in a “lump”.” He tells me, on the way back, that the secretary asked him, on her own initiative, for this database to support her in her work.
>
> 10.55 On our way out from the secretary’s office, the mobile phone rings again. “Hold on a second, did you enter AMOS first?” Peter asks her if she has been given sufficient access, and if it concerns entering a new study? Peter puts the mobile phone down and writes something in his book, “hold on a second, and I’ll check this.”
>
> 11.00 Went over to the user who had “lost” her disks, she “changed the network node yesterday, on her way out.” Peter does what he told her to do and the disks appear. She’s slightly embarrassed, Peter doesn’t seem to mind.

The excerpts clearly show how important it is that the CIDES support group, being networked, *with* the users, are offered portable tools to support their own work.

> Peter tries to reboot the machine, but it to no avail; the TCP/IP router is unavailable. The machines “hangs,” but Peter tells the user that it will have to be rebooted again and again until the TCP/IP router becomes available. “We might as well wait”; and so we proceed to the next place, the user for whom he created the new Access database this morning to see if she’d started using it. She has, and Peter gives advise. A colleague enters the office and asks “can you help me later? On his way over there, Peter’s mobile phone rings again, he walks over to the paper recirculation container, puts the journal down and makes notes whilst on the phone; “No,..., I’ve got something that I need to do first,..., did you email me already — then I can look at it later — or do you want me on-line…. I can look at it after lunch... yes, do that, email me.” To the database user he says, “call me this afternoon... but I might not have time, we have a meeting at 2.”

The use of journals

The members of the group use some sort of journal system, albeit highly personalised and flexibly. Steve writes down what he has to do on his Newton.[19] The Newton is used as a notepad, scheduler, and diary.

> 11.09 Steve tries to get hold of MB, who is responsible for PC and remote-mail at the IST. To get his telephone number he checks his Newton, even if a Notes database exists on the networked system, claiming it is quicker to use the Newton.
>
> 11.25 Steve calls Peter and announces he'll be late for group lunch. He has to install some software for a user, they talk a lot, and the user asks Steve if he can get him a reference manual. Steve makes a note of that on the Newton.

Diana maintains a journal of her assignments as well, using pen and paper. The entries contain the user who asked her, what the problem is, which project, etc. During the working day she expands on the existing entries and adds new ones to the list. When one mission is accomplished she writes the date in the journal. Before leaving work she keys everything into a text file — updating her diary to start off on the next day with a printed, proper version. Cindy maintains her journal of assignments very similar.

Anne uses pen and paper for her to-do list as well. New assignments are entered and struck through when she is done. A few more detailed aspect of her work, e.g., working procedures and "nice-to-knows" are printed and put into a cover. Some of these are also entered into the Notes database. Peter logs many of his assignments in a similar, manual journal.

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[19]Newton is a Personal Digital Assistant (PDA) from Apple.

Managing and sharing experiences

Diana keeps a file with descriptions of situations and experiences gained previously, for the applications that she works with the most. The binder is alphabetically ordered, with pointers to the most experienced people in the group or at IST regarding each application. She keeps a separate binder for "nice-to-knows," procedures to follow, e.g., when requesting a new PC for someone, etc.

After working with the support group for some months Diana felt that the type of information she was collecting should be made available to the other members of the group, as a common information resource. It would also play a role in educating new members. Diana talked to Alan about the idea, and when Peter started working with them he was assigned the job of implementing a shared database. The idea was to keep problems and questions with relevant solutions alongside — as a way of sharing the experiences made on the job and "working more as a group." The database was used a little to begin with, but the usage declined quickly and a critical mass of questions, answers and users was never reached.

Because the database failed, Anne set up another one some month ago, this time in Lotus Notes. Unfortunately, it seems that the Notes database is used infrequently too. Anne uses it occasionally to search for *her own* entries, in case she does not remember exactly what happened. For this usage, pen and paper would arguably function just as well. The issues entered in the database are situations, problems, and descriptions that she knows beforehand that she would never remember unless they were documented. She has never made a search for something entered by another member of the group; "the chances of finding something are too slim." To summarise her usage of the *organisational memory*: she knows upon entering information that it will be useful to her, she knows upon looking for something, that it is there, and she is not interested in the items submitted by others (perhaps because they are too few, i.e., the content falls short of critical mass).

In Diana's opinion the common information resources would be more useful for new members of the group. The experienced members know what to do, and they have established a network of

people that they rely upon for support, and of course, they have gained operative competencies of procedures; “what we usually do around here.” Anne asserted that because you can only document what is known already, thus there is scant incentive to document it at all.

According to Diana one problem is that the group has not yet agreed upon how to use this new database. Another significant problem is the amount of extra, and duplicate effort required to enter the information — inasmuch as most members of the group rely on a paper notepad for their mobile documentation work. The same problem was experienced in the process of entering proposals for changes in CTMS in the shared databases.

Diana briefly documents her own work. It is perhaps just an email printed out, with annotations made in the margin. It is quite likely that only Diana is able to understand what they mean. The implications are, that even if the annotations today made on paper could be moved directly to an electronic database, extra work would be associated with expanding, enhancing and clarifying the description to make it intelligible for everyone. For the person who made the annotation in the first place, it works well, simply because you remember the episode and your responses based on the cues provided.

Co-ordinating work

Diana documents everything: “It’s always nice to have things on paper.” Because screen savers have passwords, one is sometimes forced to figure out when it was last updated. Sometimes installing new versions of a program fails, and it is later discovered that one has to get the back-up tape form that date. Thus, Diana decided to write down as complete a record as possible of her activities.

We got the impression that Diana had many things going simultaneously. Many of her tasks were autonomous, but since she cannot resolve everything herself, because it falls outside her expertise or authority to perform the operations, etc., many other people in the organisation are involved in the work. This is

interdependence in her work. All commissions initiated have (in her journal) a status, e.g., denoting who Diana has been in touch with about the problem, when it is expected to be resolved, etc. When someone else promised to take care of the problem she has to contact that person regularly to monitor progress. Clearly, Diana assumes responsibility for the missions even if someone else does most of the work. If Diana can find out how to resolve it herself, she will customarily email the user to report on the progress.

Diana tries to organise her work according to the physical location of the users, simply to minimise the walking distance. Following the plan she walks her round trying to finish each task as she goes. If the user is not in her room or for some other reason is not available, Diana emails the customer to tell her that she has tried to get in touch.

When Cindy gets a mission that she cannot accomplish she gets in touch with IST. She will make a note out of it and contact the customer later to find out if the job has been done. In her experience this type of reporting is never done otherwise, neither from IST nor the customer. Cindy is curious and ambitious, thus she will often interview the customer of the IST representative about what the problem was and how it was addressed. She saves a description of the situation and the resolution of it: "Just in case the problem comes up again."

Work is unstructured and difficult to predict

The guiding principle is to keep work simple. Upon visual contact, shouting is the preferred mode of communication. When passing an empty desk, most people leave a post-it note. Meeting the user's office neighbour, one might as well ask her to hassle him about whatever. Working on the computer many people use email, and whilst on the move the mobile telephone is the only feasible option. Standardising networking does not seem to be straightforward. This aspect is enhance by the evolutionary development of the CIDES group; procedures and routines were never made explicit, but are being defined by the individual members of the group responding to the

requirements of the work and the customers they serve in the network.

Implications for design and use

Our aim is not to automate, rationalise, or reengineer the work processes, at least not in the radical change perspective advocated by, e.g., Hammer and Champy (Hammer and Champy 1993) or Davenport (Davenport 1993). Rather, our objective is to suggest applications enabling the group to do more proactive support work. By relating this discussion to how work is currently accomplished in the support group, we elicit, in this section, a set of specific suggestions and requirements of the future IT usage for the CIDES support group at the Company.

IT usage can enhance group aspects of the work

Below, we examine how the members of CIDES, currently working advantageously in the networked organisation, could take advantage of IT to work more like a group, e.g. by enhancing training of new members, sharing excessive or urgent workloads, and, developing and using specialised skills. Although hard to prove empirically or deal with analytically (Bannon and Kuutti 1996), the concept of *organisational memory* seems to fit our strategy well, inasmuch as "experiential knowledge is a key to competitiveness" (Stein and Zwass 1995).

A common information space supporting sharing of knowledge

Creation and sharing of knowledge in organisations has been widely recognised and discussed lately (Cook and Yanow 1993, Nonaka and Takeuchi 1995). Within CSCW and Information Systems this is reflected by the emergent discussion of "common information space," (Schmidt and Bannon 1992) "organisational memory information

systems" (Stein and Zwass 1995), and the like. Answer Garden (Ackerman 1994) and gIBIS (Conklin and Begeman 1988b) are two well-known applications supporting users in the process of sharing experiences. Commenting on this critique from a designer's point of view, is outside the scope of this paper. Our approach is a more pragmatic one. For the purposes of this paper, a common information space is a shared database which people in a co-operative work arrangement access and update jointly over time. Accessing and updating the common information space *is* "remembering."

There are several reasons why we suggest a common information space to serve the support group. First, by sharing experiences it is possible to reduce duplication of work within the group. Unnecessary work due to each support person "reinventing the wheel" or making the same mistakes could be reduced. Second, the common information space could be used to mediate potential problems, thereby reducing the risk of having to take urgent measures. For example, if a support person is told that the network will be malfunctioning during the weekend, e.g., because of maintenance work, she could make this information available to the group using the common information space. The information is passed on *for a purpose*; the support person knows that a clinical research project is rapidly approaching the deadline. Accordingly, the project members probably plan to work hard during the weekend. Mediated by a common information space, this information could enable the other group members to assess and influence collaboratively the situation to protect their users from disaster. One advantage of using a common information space for this, instead of for example email, is that all such information is collected in one place, making it easier for the group members to survey the situation. A third reason for using a common information space is documentation of work, which could be valuable in the process of initiating new people to support work. In other words, information about work that otherwise only would be in the individuals' note pads and minds, becomes to some extent externalised. Inasmuch as organisational memory is something more than the cogs and culture of the individual (Stein and Zwass 1995), externalising the

experiences for collective availability, could be a step in the direction of better group work.

One problem associated with the notion of common information space is the classical information systems problem, namely how to interpret data correctly in order to produce information (Langefors 1966, Langefors 1995). We presume that for any realistic working situation, for practical purposes, in situations involving *bona fide* competent CIDES group members, they will be able to make sufficient sense out of each others' brief documentation and annotations. Another, to some extent contradictory problem is that people, due to the power and advantages of having access to unique information, are not willing to enter it into the common information space for fear of being misunderstood, quoted out of context, or loosing the competitive edge (Orlikowski 1992). One can hardly argue, however, that these problems inherently will be associated with information mediated by computers, and that other media, in some sense, preserve the integrity of the data. The nature of the information, as well as the flatter structure and less competitive culture of the CIDES group does not indicate that problems similar to the ones reported on by Orlikowski are likely. The "prisoner's dilemma" is a third potential problem:

> "...if *everyone* acts to further his or her personal best interest, the result is worse not only for the group but also for each individual. With some discretionary databases, as long as someone updates them, one's best optimal strategy is to "freeload," but of course if everyone tries to freeload, the system is not used at all." (Grudin 1994b, p. 96)

Our suggestion of IT support for the CIDES group is informed by the way work is being accomplished today, and, ideally, it should offer the advantages of digital support even if only one person uses it. All group members take notes and schedule their working days already; albeit on a variety of media, their approach is similarly structured. The implication is that it should be possible to incorporate existing work habits as a subset of those offered by enhanced IT support. Critical mass (Grudin 1994b) is yet another potential problem

associated with the use of a common information space. Unless interesting information can be found in a database, it is less likely to be used (Grudin 1994b), and, thus, less likely to receive interesting information from active, skilful users. We believe that the preceding argument, to a reasonable extent, addresses the problem of critical mass.

A common task space supporting division and co-ordination of work

Division and co-ordination of work are two of the organisation's corner stones, which could be improved dramatically by IT (see, Sørensen *et al.* 1994, Migliarese and Paolucci 1995). Within the literature, the need for such applications is mainly motivated by an increased turbulence in the business environment, forcing companies to adapt rapidly to changes and improve co-ordination to survive and prosper (Holt 1988, Schmidt 1993). But what is the rationale for using *IT* for supporting division and co-ordination of work in the support group?

IT support work is mainly about responding to the immediate needs of the users. Usually this means a more or less constant interruption, making it very difficult to devote any longer coherent period of time to proactive support. Enabled to "offload" regular support work for a few hours, helping each other with routine tasks like installations or upgrades, in other words dividing and co-ordinating work, the members of the group could devote more effective periods of time to other aspects of their job, e.g., partaking in development projects and IT innovation. The support group could benefit from using IT to support division and co-ordination of work in several ways.

Specialisation. To keep up to date and increase its competence as a whole, the group members are encouraged to specialise in new IT. One of them has chosen to specialise in the Newton, another in Lotus Notes, and so on. Today it is hard to devote time to specialisation. In an open organisation, where people work individually and autonomously with their users, there is moreover the aspect of taking advantage of knowledge in the peer network. The physical distribution and lack of group co-ordination could make it

almost impossible to benefit from the competencies elsewhere in the organisation.

Innovative support. Due to the same problems as mentioned above, it has been difficult to devote time to innovative support. In contrast to traditional support, i.e., responding to needs perceived by the users, innovative support concerns the process of discussing and suggesting how and which IT the user could benefit from in the future. Such support work requires knowledge about the work. Innovative support is often performed in projects, and the support person must not only attend meetings, but respond consistently to the commitments. This is not possible today.

Utilisation of group dynamics. Since the workload of a support person varies a lot, the workload of the group as a whole is often imbalanced. Some have a high profile and demanding users, whilst others, due to the nature of the work in the unit they support, can improve their work distribution. Temporary high workloads could be adjusted by dividing some tasks to other group members, thereby utilising the group resources more appropriately.

Availability. By making the group members more available to each other the quality of the support group could be improved. A prerequisite is, of course, that each group member is made aware of the competencies of the others.

The common information space could be structured and accessed according to the ways of improving support work outlined above. Firstly, documentation of tasks is useful for training as well as "remembering" the procedures of the group. Members of the group already maintain personal and partly shared archives for such purposes. A bulletin board for offering and requesting the responsibility for aspects of reactive support work in a certain area for a period of time would be useful for support group members and users alike. Email is extensively used by clinical researchers to request assistance, but, due to the networked nature of support work, less so by the group's members. Motivated by the need to specialise for proactive support, the task space could afford some group functions to networking. This common information space aims at supporting specialisation and innovative support. There could exist a separate space for extraordinary questions, which probably only

specialised group members are able to answer. A possible solution to the co-ordination needed to exchange individual competencies would be to implement a news group or threaded space of questions and answers, similar to Answer Garden (Ackerman 1994). Negotiating assistance from group members or others to do routine, non-urgent, but critical tasks like for example software installation and upgrading, could take place in a separate space. Urgency and importance would have to be important criteria by which to order the group's information resources according to priorities.

Considerations imposed by the nature of work

Below we examine some requirements imposed by the nature of work, that we need to consider when discussing how the networking support group could use IT.

The members of the support group are often assigned tasks which they have to try to solve immediately, typically before they return to their own office. The implication is that group members have not had the opportunity to access the PC based common information space described earlier when they would have benefited from it. Certainly, this is to a great extent caused by a mismatch between the accessibility of the shared databases and the nature of work.

Not all tasks are assigned when a support person meets a user physically. Many of the users call or send an email when they face problems. Unfortunately, this sometimes means that a support person comes back to her office to realise that the user next door to the one just supported had a similar, relatively simple problem. Needless to say, this is not very satisfying. This observation indicates that new tasks should be accessible from everywhere in the buildings at the Company.

Due to the mobile nature of work, lessons learned and knowledge appropriate to document and share with other group members can appear in many places, many of these outside the support persons' office. It has, however, only been possible to update the experience databases at the office. Since most group members

document their tasks and experiences using pads, updating the experience database inevitably means extra-work. That is, compiled information has to be entered twice: (1) on a note pad or Newton, and (2) into the experience database. There are several reasons not to do that. One reason is that the support persons have access to the information without entering it in the experience database: "You only enter information you already know," as one of them put it. Another reason for not updating the database is lack of time. However, the main point here is that people are not willing to enter information more than once. Accordingly, information that potentially should be used electronically should be entered in electronic form directly. Indeed, this is the case for all information to appear in the common information space and the common task space.

Based on these observations we claim that the members of the support group should use *mobile computing*. The mobile device inevitably has to replace the note pads used today. Furthermore, the mobile device should be able to read and write information in the common task space and the common information space. In other words, the support group should have access to the two spaces independent of place. Both spaces must obviously also be accessible from a stationary PC.

The fieldwork also revealed that it is extremely important that the proposed IT is easy to use. This is of course a very general claim. However, due to the mobile nature of support work, a sometimes very high workload, and that tasks and experiences might have to be entered running in the corridor, while simultaneously thinking about the next task and talking to a confused user, the group members should have to enter a minimum of information.

Since support work to a great extent is about responding to needs of the users, the workload of the support persons changes constantly, making the work unstructured and difficult to predict. The work of the support group is interdependent on others, both within and without the group. Tasks or sub-tasks are often passed on to other people, and the support persons constantly wait for answers to requests, others' compilations of tasks, and so on. As a consequence, there are always many initiated tasks which are (not) accomplished in an arbitrary order.

Due to the unstructured nature of support work the proposed IT must not assume a certain way of accomplishing work. It should be possible to initiate many tasks, not being required to finishing one task before beginning to work with another, or impose any other sequences or automatically generated triggers.

Discussion: Using IT to work as "a group in the network"

In this paper we emphasise what we believe is a novel observation. The group and the network co-exist, but not unproblematically. First, it seems to be a relationship in which one side has to be the stronger, i.e., a dialectical one (Bjerknes 1992). If the group is co-located, maintaining the informal network of contacts with other stakeholders, customers, and organisational units becomes harder. Acting almost autonomously, the network member has be an all-rounder; back-up is harder to get and users soon loose faith in the ability to deliver if most assignments cannot be dealt with by the support person. Production of specialised knowledge and new designs seems to be potentially better handled by the group. Nevertheless, the activities and needs of the stakeholder organisation are better known to the member. This is a result of being independent and discrete; bringing in more people to do the job makes it more explicit, requires planning ahead, and delays the decision-making process.

From this brief discussion it appears that organisations, amongst other things, are phenomena in which networking and group aspects struggle for domination at each other's expense; the more time spent on working in the network, the less time could be spent in the group, thereby weakening it, and vice versa. In a strict dialectical interpretation, this means that it would be impossible to improve one of these incompatibilities without deteriorating the other. We argue, however, that in this particular case, unless we challenge the notion of inherent conflict between the two sides in the contradiction, a dialectical analysis will only limit our constructive efforts. Thus, we claim that the relationship between the group as a

group and the networked work with the users, can to a great deal be enhanced using IT. The likelihood of success depends on how much time and efforts are required from the group; if the group functions cannot be maintained lest the regular users suffer, the contradiction will continue.

We recognise the need to create IT support that enables people to cross boundaries of space and time. Exploring the possibilities to use IT to support fast and effortless group work, we have suggested a common information space and a common task space, supporting the processes of sharing experiences, and dividing and co-ordinating work respectively. Besides we have argued that these bases should be accessible through mobile IT. But what makes us think that the use of these two bases together with a mobile device should enable fast and effortless group work?

The accomplished nature of work has to be carefully considered when designing new technologies (Bowers *et al.* 1995, Rouncefield *et al*. 1995, Sachs 1995). This does not mean, however, that new IT should necessarily be adapted to impose a minimum of changes in the performance of work. The adoption of new IT is a good opportunity to change work practices. Changing the artefacts that people use is an effective way of changing their behaviour (Winner 1986). Having said that, not all change in organisations is for the better. Unsolicited change, as described by e.g. Bowers *et al.* (Bowers *et al.* 1995), imposes inconvenience and extra work. Our starting point has been to suggest new IT that could replace existing technology, namely pen and paper. In short, we are suggesting new ways of performing work that would otherwise not have been possible

In summary, we found that, first, people are only willing to enter information once, thus we maintain that all shared information would have to be entered directly (see, Grudin 1994b). Secondly, it should be possible to update the two shared resources outside the personal office, simply because the information has to be entered on the move. Thirdly, since people are assigned tasks on the move, and have to deal with most of them before coming back at the office, they should have mobile access to the information spaces. Fourthly, if a mobile device should replace pen and notepad, it should be extremely easy to use (Preece 1994). We believe that usability is especially

important in the case of the support group, due to the pace and mobility of the work. Fifthly, the mobile devices should require the user to enter a minimum of information. Sixthly, it is an open question whether the items in the information in the spaces have to include its originator. Seventhly, new IT should not assume that tasks are accomplished in a certain sequence, or that one task is completed before another is begun, since support work generally depends on the work of others, consists of many initiated tasks which are not concluded in any specific sequence, and creates a constantly changing workload (Bowers *et al*. 1995, Rouncefield *et al*. 1995, Sachs 1995).

Bringing these requirements together with the proposed two shared bases and the mobile device, we believe will form an appropriate basis for further IT development to support a group in the network. There is, however, much work to be done before we are able to present a detailed proposal of the functionality, interfaces, and other central aspects of the suggested IT. A more detailed suggestion is under development, but is outside the scope of this paper.

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Second paper

DARWIN: Message Pad Support for Networked, Dispersed Groups

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Abstract

This paper presents the design of DARWIN, a collaborative application for the Newton message pad. The purpose of the application is to help the members of the IT support group in a large pharmaceutical research company share information and co-ordinate their work in a networked organisation. The group members are geographically dispersed and perform most of their tasks outside their offices. Informed by a qualitative study, the design of DARWIN takes into consideration the practical, mobile nature of the work it is intended to support; requiring minimal data entry, running non-essential operations off-line or in the background, and offering a choice of co-ordination mechanisms. One important aim is to minimise the expected critical mass. Responding to a positive evaluation of this proposal, the continuing project will in the next stages be implementing and evaluating the application in use.

Introduction

In this paper we describe and reflect on the design of a message pad application for the information technology (IT) support group in a

large Swedish pharmaceutical company. DARWIN (**D**irect **A**ccess to **R**esources, **W**ork & **I**nformation in the **N**etwork) manages two common information spaces in which information items evolve to support co-ordination of work and information sharing. The company carries out, as part of a multinational enterprise, clinical research and testing of new drugs in co-operation with hospitals all over the world. Their operation is heavily dependent on computers; advanced applications are used to manage the trials, organise and analyse data, document the findings and present the results. In a recent project, digital message pads were used for "remote data entry," i.e., to collect experimental data from the operating theatres. The IT support group is considered integral in reducing the time needed before a drug reaches the marketplace after it has been submitted for clinical testing. Estimating their potential daily profit after world-wide introduction of a drug of up to $1 million, the company fully acknowledges the importance of IT.

Our involvement with the IT support group in this company aims to design and evaluate IT applications that can help the members provide more effective support. Inventing new applications to support people doing their work, our agenda is neither one of rationalising work processes (see, Davenport 1993, Hammer and Champy 1993), nor democratisation of the workplace (Greenbaum and Kyng 1991, Greenbaum 1995). Rather, our point of departure is to improve the IT applications, bringing to the fore questions such as: which IT should people use to better accomplish their work?, how could existing IT artefacts be improved to support people more suitably?, and so on. These thoughts, inspired by the work done by Dahlbom and Janlert (Dahlbom and Janlert 1990, Dahlbom 1995b, Dahlbom and Janlert 1997), are elaborated further in Kristoffersen and Ljungberg (Kristoffersen and Ljungberg 1996a).

For the purposes of this paper, we will loosely describe the practical ordering of the IT support group's activities as *networked* (Pfeffer 1982, Thompson and Frances 1991) rather than bureaucratised, bearing in mind that our agenda is one of *design*, rather than organisational theories. The most characteristic aspect of the networked support group is that they are geographically dispersed, *with* the users they support, and not co-located with the

group support functions. They are not assigned tasks by their manager, nor are they generally encouraged to perform their work in a particular way. Each member of the group acts partly according to personal interests and the needs in the user environment, planning and articulating their work locally, relying heavily on personal contacts rather than on group functions for commissioning and work support.

We found (Kristoffersen and Ljungberg 1996b) that the IT support group experiences problems that could not easily have been addressed by introducing other organisational models, hence an organisational solution is not straightforward. The networked and the bureaucratic organisation of work are difficult to reconcile. Sharing specialised competencies depend on group functions. At the same time these skills are more efficiently put to use in the user domain, with the specialist co-located with their users rather than the group. People need to be able to organise their time, but the needs of the users are paramount. There are many situations in which the group should present a common story to the users, e.g., regarding operating systems updates, but the ways in which such information is made useful will differ between units.

In a previous paper we discussed the general requirements for dispersed, networked groups to use IT to mediate group functions, i.e., benefit from the advantages of the bureaucracy, without necessarily losing the strengths of the network (Kristoffersen and Ljungberg 1996b). In this paper we continue this work, and introduce the DARWIN application. DARWIN consists of three parts; a shared experience base containing experiences gained in the group, a common task space supporting the co-ordination of work, and a Newton message pad for mobile use.

A significant body of research exists on how to create and share knowledge within groups and organisations (see, March 1991, Cook and Yanow 1993, Kim 1993, Bannon and Kuutti 1996), and concepts such as “common information space” (Schmidt and Bannon 1992) and “organisational memory information systems” (Ackerman 1994, Stein and Zwass 1995) have been invented to describe IT supporting these processes. Research on the division and co-ordination of work has been carried out more explicitly, e.g. in the

COMIC project.[20] The notion of "Mechanisms of Interaction," (Schmidt 1994b, Sørensen *et al.* 1994) later evolving into "Co-ordination Mechanisms" (Schmidt and Simone 1996), is a well-known approach to supporting division and co-ordination of work by means of IT. Similar approaches have been discussed by, amongst others, Migliarese and Paolucci (Migliarese and Paolucci 1995), Holt (Holt 1988), Malone and Crowston (Malone and Crowston 1992), and Winograd and colleagues (Winograd and Flores 1986, Medina-Mora *et al.* 1992). However, there has been little research on how to support dispersed, networked groups. On the contrary, we believe that much of the existing body of research has more or less consciously argued for bureaucratisation of work rather than networking.

The paper is organised as follows. The next section gives the background to the design of DARWIN. We introduce the research setting, followed by a description of how we conducted the fieldwork. Sections 3 outlines the requirements elicited from the empirical studies, and section 4 discusses DARWIN and its relation to CSCW (Computer Supported Co-operative Work) research.

Research background

The following section introduces the background for the study. A brief description of our research approach precedes the requirements and design considerations elicited from the fieldwork.

The Setting

The company in which we did this study employs about 1000 people. It is a significant player in the European market, with a $400,000 turnover per employee. About 750 employees are directly involved in research that spans from basic cell biology to innovation in

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[20]Computer-based Mechanisms of Interaction in Co-operative Work, Esprit Basic Research No 6225.

pharmaceutical chemistry. Our fieldwork focused on the "Clinical Information and Data management, Education and Support" group (CIDES), the clinical division's IT support group. Organisationally it belongs to the "Information Technology & Data Management" department (IT & DM). The clinical division, employing about 325 people, advances the research on drugs that have already passed through the pre-clinical research, by evaluating them on human subjects in collaboration with doctors in Sweden and abroad.

The IT support group consists of nine people; six persons working on *in situ* support, one system administrator, one secretary, and one manager. The six members working on direct support are responsible for one or two departments in the clinical division. One important aspect of the organisation of their work is that the support group members are co-located *with their users*. The manager of the support group, the secretary, the system administrator and one of the support people, are located in the same building. The other five support staff are dispersed at different floors and annexes in the company's main building. The distance between the two buildings is about 200 metres, crossing a busy through-road.

Method

Our core research objective involves drawing design implications from a real-world working situation. We therefore chose to do a focused, brief qualitative study. Emerging from the early stages of the fieldwork were the questions:

- How could the support group benefit from IT to "work more like a group," without attenuating the "work in the network?", and,
- Which requirements imposed by the practical ordering of their work would have to be considered in the design of such support?

Combining participant observation, interviews and a group discussion we believe that we gained a reasonably accurate view of how work is accomplished in the support group. Approximately 75 person-hours of participant observation (Patton 1990) were conducted individually by each of the two authors. Everybody in the support group was aware of our role as observers and the purpose of our fieldwork. We continued the fieldwork by interviewing all members of the group, except the secretary, since we had the opportunity to talk to her about her work quite extensively during the observation. An interview guide approach (Patton 1990) was applied, and the interviews, lasting for approximately one hour, were taped. The interviews were followed by a seminar, in which we presented and discussed our observations and suggestions to future IT usage with the group members. The main purpose of the seminar was to validate our observations and suggestions; the accuracy of our interpretations and the feasibility of our suggestions. The discussion at the seminar lasted for two hours and was taped.

The work in the network

Members of the IT support group respond to a wide variety of requests. It would be impossible for one person to know how to solve *all* possible problems. Not all members are allowed the privileges to do any set of operations potentially implicated by the commissions. For tasks that imply operations outside their domain, the support staff deal extensively with people external to the group. The implication for the support group members is that often they cannot immediately conclude a commission; they are *interdependent* on other members of the organisation at large (Schmidt and Bannon 1992, Schmidt and Simone 1995), not only to *have* a job, but also in *getting the job done*.

Being immersed in their area of responsibility, typically one or two adjacent departments, the people in the IT support group get to know their customers and the ways in which they do their job. Their knowledge of the work arrangements enables the members of the IT support group not only to perform *reactive support*, the norm,

but also what they call *proactive support* and user education. Ordinary, reactive support takes place when the users experience problems in the use of IT and get in touch with their support person, or the central help desk, to get help solving these problems. Based on the combined insights of how the researchers work and specialised competencies in IT, proactive support is largely concerned with suggesting how people could use IT better and more efficiently in their work. As indicated by recent research (Bowers *et al.* 1995, Sachs 1995), such work requires a thorough understanding of how work is actually performed, which is the most important reason for the support group, unlike an ordinary helpdesk, to be dispersed in the organisation.

The characteristics of work in the support group described above do not straightforwardly conform with traditional group work (see, Ciborra 1993) which often has been described as having a more regular nature, e.g., with pre-defined procedures for division and co-ordination of work (see, Schmidt 1994a, Carstensen *et al*. 1995). At the same time, however, the support group would clearly benefit from traditional group functions. Due to an unpredictable and changing workload, the members of the support group find it difficult to partake in design projects improving or designing new applications for the researchers. Project participation (25% is the goal of the group) is considered as a way in which the competencies of the support staff can be recycled into IT design. Partaking in projects is also thought of as a way of inspiring and educating the group. Members of the group currently never know, due to the way work is organised, if they can make it to the next meeting. Another aspect is that of specialisation. Sometimes very specialised skills are required, e.g., to maintain a Lotus Notes database, install new applications on a Newton message pad, or prepare a data file for statistical analysis. In a group, people can cover for each other to create free time in which people can specialise, and mechanisms to take advantage of someone else's competencies. In a networked, distributed organisation this has turned out to be rather problematic.

Requirements

The fieldwork from the research company is presented in more detail in (Kristoffersen and Ljungberg 1996b), along with a general discussion of how actors in a networked organisation of work could access the group support functions using IT.

Currently, the members of the support group take down the requests from the users, as they are made, in a notebook. If they want other people to help them perform a particular task, or wish to make their experiences available to the group, the chore of rewriting and elaborating their notes is inevitable. It must be possible to access the information outside the office, simply because most of the work happens elsewhere. The support staff are commissioned, and hence require IT support, in a variety of locations. For example, in their users' offices when encountering customers in the corridor, meeting customers at the coffee machine, etc. It must be possible to update the common information spaces independently of localisation. Many tasks are concluded even before the group member can access his own workstation.

We suggest using a digital message pad to replace the pen and paper journal. A premise for the introduction of a hand-held computer is that data entry should be at least as easy as using pen and paper (see, Preece 1994). Some requirements elicited from the fieldwork are:

- People can only be expected to enter information once (Grudin 1994b), and we therefore maintain that all shared information would have to be entered directly into a computer supported repository. The IT support group have twice tried to share work notes previously. Both applications were used initially, but soon failed due to lack of interest. Members told us they were required to enter the same information twice: first when they did the work, and later upon entering it into the database. Generally, few incentives exist to document one's activities for the benefit of others (Grudin 1994b). Information for a shared repository should thus be entered electronically

as part of a required and existing activity in the current organisation of work.

- Due to the mobile nature of the support work, a variable, but often very high, workload, and the fact that task descriptions and documentation often have to be entered whilst on the phone or already engaged with another user, the member should be required to enter a minimum of information. Several strategies could be combined to comply with this requirement, e.g., semi or fully-structured input formats with fixed semantics, and menus or radio buttons being the preferred alternative to freehand writing.

- Because IT support depends on the work of others, many initiated tasks that will often not conclude in any specific sequence. Members are faced with a constantly changing workload and interruptions are common. New IT must hence not assume that tasks are accomplished in a certain sequence or that one task is completed before another is begun (see, Bowers *et al*. 1995, Sachs 1995).

We suggest that the support group implements two common information spaces (Schmidt and Bannon 1992): one *shared experience* base containing task-related notes collected by the support group members, and one *common task space* supporting the co-ordination of work. Furthermore, *a Newton message pad* should be used for each member to facilitate mobile use and access to the shared databases.

The shared experience base would contain experiences recorded by the support staff during their work, e.g., how to solve a particular problem, who to deal with regarding new hardware, when to expect network maintenance starting next weekend, etc. The common task space could be used to offer and request the assistance of peers.

Information for the shared spaces should include its originator, for the following reasons:

- Since a minimum of information will be entered, it might be difficult to interpret the situation correctly,
- It is hard to express "lessons learned" briefly and at the same time clearly,
- The data could be hard to reuse correctly, even if the account was complete (see, Allen 1977, Schmidt and Bannon 1992, Langefors 1995).

Making it possible for the members to contact each other creates an environment for co-operative work which is, perhaps, more significant than resolving the problem of translating from data to information.

DARWIN

We are currently in the process of designing DARWIN. The following section outlines the proposed functionality. It is illustrated with screen dumps from the Newton Development Kit, mocked up with a drawing tool to suggest features not yet implemented.

The data entry operation

The data entry operation provides support for entering new commissions, as well as updating and keeping track of the ones already initiated.

To replace the manual notepads that the support staff currently use to keep track of the status of initiated tasks, the main design requirement for the data entry operation is that it should be at least as easy to use as this manual system. Responding to this, we propose a minimal set of optional fields on the message pads data entry view. The fields we propose are commonly used in the manual journals people currently rely on.

If the support people cannot instantly deliver the service requested of them, they typically want to enter the name of the customer, i.e., *who* wants something done. Since the support staff are dispersed with a smaller group of users whom they regularly serve, it makes sense to let the label be a selection menu when tapped, containing the names of the people who have been previously served, i.e., the so-called "customer network."

This strategy can be replicated in the fields below (see figure 1). For instance, describing *What* the user asked for using keywords *that are already in use manually and in the group conversations*, lends itself nicely to the same selection menu approach. The selections of keywords could be externalised into a common database or merged across message pads, thus functioning as a common resource or *thesaurus* of the problems and needs responded to by the group. A more homogenous use of concepts within the group could, arguably, improve the accomplishment of co-operative work. This is due to the fact that the support staff are often forced to write down the customers problems and contact someone in their "work-mate network" for assistance. These contacts might, thus, be carried out more effectively and smoothly by using a similar vocabulary.

The next field describes the *Actions* (to be) taken in order to resolve the problem. Insofar as a keyword based approach is feasible it could be implemented here as well, but it must be expected that a more elaborate action description is called for. One way of combining the approaches would be to insert "one-word-on-a-line" into a selection menu, leaving the apparent descriptions as free text attributes to the record. Writing down the actions taken in this way should be the most important way of making experiences persistent and possible to share within the group. It should be possible to update the shared information from a desktop PC as well, since the message pad is hardly optimal for complicated editing of elaborate texts. Most of the time, however, that will not be an issue.

A *Priority* slider is offered for the user to specify the relative importance of the request. The handling of the record in the common information spaces relies heavily on this attribute, as we will show below. The *When* field should be set to today's date when a record is initiated *and* when the *Done* box is ticked off. In this way, the data

can signify either the date of commissioning, date of completion, or, if the member changes the field manually, the date-to-do-by, affording meaningful interpretation at a minimal number of keystrokes.

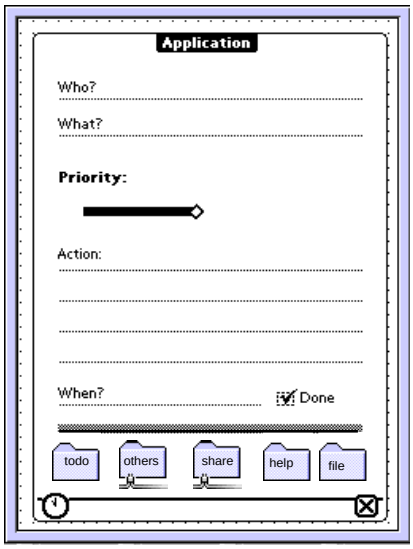

Figure 1. The data entry view of DARWIN.

Beneath the data entry part of the view is the application toolbar, each action is represented by a folder. By tapping the desired icon the view changes, but the status information is stored so that the user can return to the data entry view again easily.

Looking up previous entries

The message pad application supports the process of sharing experiences amongst the support people through the management of a local instance of the common information space, consisting of successfully completed work by the members of the support group.

By helping the group to share experiences, we believe that the amount of work which "reinvents the wheel," which appears to be quite common today, will be reduced. When users press the *Help* icon, this feature of DARWIN takes the keywords entered in the record as arguments to a query searching for similar records in the experience base. The significant attributes of the record in this situation would be:

- *Who* did the work, in case the member will need to make contact to get additional information about how the problem was resolved. This is partly due to the fact that DARWIN is designed to require the user to enter a minimum of information, which might make the process of interpretation harder (Langefors 1995). Another reason for recording who did the work is proposed by Schmidt and Bannon (Schmidt and Bannon 1992). They argue that people apply different heuristics and problem solving strategies which leave persistent traces in the information they take down. Accordingly, they claim, it is important to know and consider the originator of information in the process of interpreting the content of a common information space.

- Which *Action* was taken in terms of redefining the problem, requiring external expertise, or replacing software or other resources. Besides hints concerning how to solve the problem this field also gives the support staff important information to consider when estimating the effort needed to accomplish the task. Considering the history of information has, furthermore, been suggested as an approach to reducing the risk of misinterpreting the content of a common information space (Kristoffersen 1995). Although applicable to all attributes of the record, we believe this one is the most important for that purpose.

- *When* the problem was addressed could be significant in terms of program versions, updates and configurations that are no longer relevant, or getting software off back-up tapes. Problems with PCs appear to often be due to installations of new applications, updates, etc. — operations often performed by the support staff.

- *Time-to-resolve*, calculated as the difference between date-of-commission and date-of-completion, could be an invaluable piece of information inasmuch as it helps members plan their working day. Clearly this would be an extremely imprecise indication of the complexity of the problem, revealing more

about the how busy the support person was, who responded to it than the demands of the tasks. Nevertheless, since the philosophy of this application is to avoid unnecessary data entering — such as the time actually spent resolving an issue — it is well worth a try. Much of the work carried out involves action taken by personnel external to the group, and it might be that a significant portion of the time-to-resolve stems from this aspect, in which case it could be a useful heuristic if "they" as a group display average delivery times.

It is probably not important to find out who the user was, or which priority the problem was assigned. Figure 2 shows our suggestion for a "relevant previous requests view."

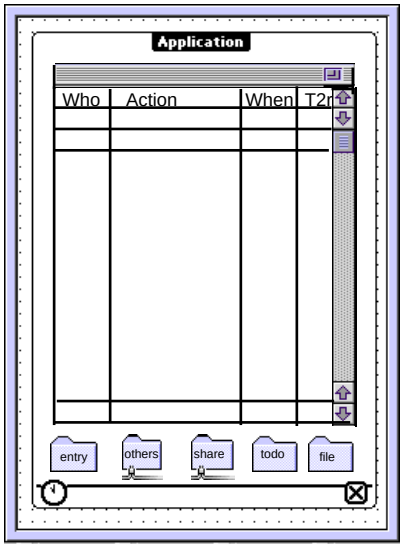

Figure 2. The view of previously completed tasks after a query to the common information space.

It could be useful for the group as a whole if entries which, upon inspection, were decided to be interrelated, could be linked to facilitate a group discussion, e.g., by imposing a newsgroup like structure to the common information space.

A personal to-do list

In the simplest mode of use, DARWIN should be an electronic equivalent to the manual notepads already in use. However, browsing sequentially through all the entries in the local space would be inconvenient and time-consuming — much as navigation through the chronological journal on paper. Hence we suggest an alternative view on the data, a personal to-do list. Arguably, the full record should not be displayed, through consideration of the screen size. We suggest that the implementation makes it possible to tap on an item in the list to see the record in full.

According to our examination of the current use of manual to-do lists, the *Who, What, Priority, When,* and *Done* fields all appear important. Tapping on one of these headings, the to-do list becomes sorted accordingly.

Denying the user the possibility to change the fields in the list might encourage more elaborate record keeping in the data entry view, but only a practical, long-term evaluation will show whether this assumption is sound. The view is illustrated in figure 3 below.

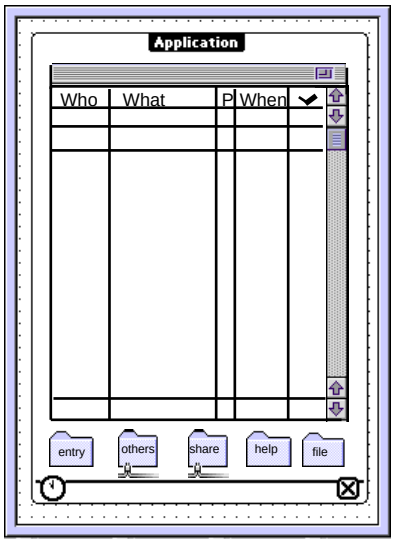

Figure 3. A personal to-do list.

Co-ordinating work directly

Here we suggest a simple implementation of person-to-person co-ordination of work. Going from any of the other views to the *others* view should keep track of what is the current record. The display shows a folder for each of the other group members. The simple view for sharing work with group members is shown in figure 4 below.

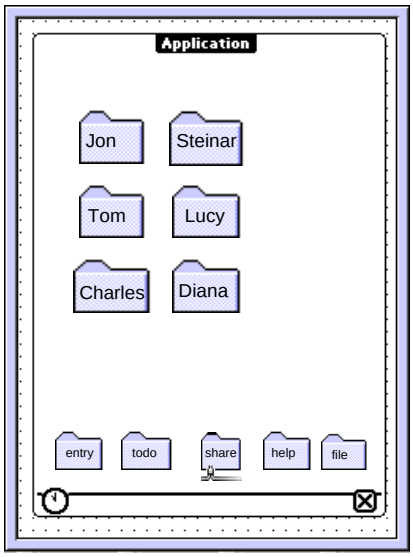

Figure 4. The view for sharing work with peers

When tapping the folder, the entry is transferred to the to-do list of the corresponding person across an infrared "beam" connection, leaving behind a *shadow* record to aid the book-keeping of the originator. Importantly, in a customer-based organisation, trust and commitment are valuable and personal elements, hence it is not recommended for a member of the support group to forfeit all control with a commissioned task — lest the task not be completed to satisfaction. The most important aspect of the direct transfer of work, is that it cannot be made unless negotiated with that person. If a connection cannot be made, e.g., because the intended receiver is not present, the operation should fail.

The issue was raised during our interviews and in the evaluation meeting about whether high-priority commissions should be transferable. Our recommendation is that the person-to-person synchronous transfer should be allowed no matter what, because it

has to be negotiated and accepted by the receiver. Aware of the risk of designing inflexible IT that people do not use, we suggest that social protocols (Ellis *et al.* 1991, p. 51) will deal with aspects of commitment appropriately.

Sharing the workload with the group

Moving commissioned requests into the common task space of the group should, in contrast to the person-to-person mode of sharing described above, be guided by rules implemented in the software. The reason for this is that it relies on a hitherto unknown member of the group, at some time determined by the individual, to assume responsibility for a task. In the first implementation we suggest simply that the *priority* given to a task by the originator, determines whether it can be transferred at all, for how long it can lie idle in the database without someone picking it up, and who should be warned about it if nothing happens. We suggest the following functionality:

- Tapping the *share* icon, if the message pad is not connected to a workstation, marks the items for transfer to the common task space.
- When connecting to a workstation, the application should automatically transfer the items that are contained in the *share* folder into the common task space.
- Tapping the icon after the message pad application has confirmed connection to a common work task space, should display the *group to-do list*, similar to the personal to-do list, containing all items currently waiting for takers.
- The group to-do list should allow transfer of items to the personal to-do list, on the initiative of members who are willing to be commissioned.

- When connected, the application should also update the database of concluded tasks, making them retrievable as shared experiences for the group.
- New items from the shared experience database should be merged into the message pad's local information space.

There are two kinds of tasks in the common task space. There are not yet initiated tasks, i.e., tasks that have been entered into the information space but not yet checked out by anyone. The other kind are tasks that have been checked out but are not yet finished. Upon conclusion, tasks are not stored in the task space, but in the common experience space.

We do not believe that the nature of the work is such that an immediate, real-time update of the two global databases, or the local information spaces on the mobile device, is called for. Besides, and equally important, such a solution is not technologically straightforward today because real-time access to the — "real" — information spaces would require the use of mobile telephony. Albeit already in use by the support staff, such a solution is not feasible for accessing the information spaces, since it forces users to connect a mobile phone to the Newton, dial a number, and finally gain access to the spaces. Our discussions with the members taught us that they would find that too cumbersome.

We propose a batch-oriented matching between the local and the central information spaces for the following reasons. First, the support staff need to access these databases frequently, yet the operations are tiresome and time-consuming to perform, and they do not always succeed. Second, the operations do not fit well with the everyday life of the support staff — it does not seem appropriate to perform these operations while running in the corridor.

In the next section, a life-cycle perspective is taken to describe the use of the DARWIN collaborative application.

The life-cycle of a commission

The members of the IT support group are customarily approached by users whilst moving about in *their* workspace or common areas. As a result, unless the matter can be settled immediately, they usually take down the essential information about the query, and return to it after finishing the present task. Sometimes other more important jobs, thus having a higher priority, are inserted into the queue of jobs to be done. Interruptions are frequent, but some jobs are of such a nature that they can be postponed for a good while, e.g., software upgrading. The mixed nature of assignments requires work to be planned, even if the plan is only used as a resource (Suchman 1987). Using the proposed application, the message pad would replace the notebook typically used today, and upon commissioning to do a job, the data would be entered into a local task space with minimal effort. The member now has five options.

1. She can follow the user back to his workstation, get on with the job and tick the entry off in DARWIN as *Done* (see figure 1).

2. She can promise to get back to him later, in which case the entry will appear in her personal to-do list (see figure 3).

3. At this stage or later, she can tap the *help icon* (see figure 1) to see if there are other, similar requests already resolved by other members of the group, in which case she knows what to do (see figure 2). This might change the way this particular entry is articulated into the plan for the work.

4. At this stage or later, she can tap the *share* icon to submit the entry to a common task space (see figure 1). No real-time connection thus exists, so until the message pad is linked to a workstation the entry is simply marked for transfer.

5. If she wants someone else to do this particular job, she has to find him first. Typically the group meets for lunch once, or twice a week, or they get in touch with each other over the

phone. If her colleague agrees to take the job, the entry can be beamed across an infrared connection.

When someone has assumed responsibility for the task, it appears in her personal to-do list, and sits there until it is deleted. It can only be deleted if it is ticked off as concluded. In some, but not all cases, the member will elaborate on the problem description, e.g., if the user interpreted the situation wrongly, and if judged to be of common interest, the details about how the case was solved are entered. Ticking off the *Done* box marks the record for transfer to the shared experience database as soon as the message pad is connected to a workstation. The flow of the commission managed by the DARWIN application is illustrated in figure 5 below.

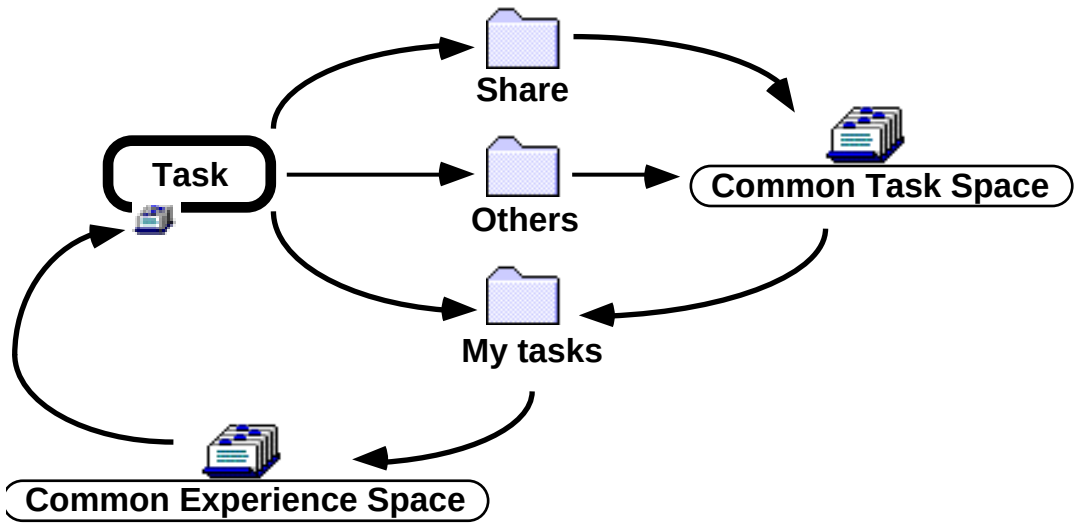

Figure 5. Overview of the DARWIN application.

The finished jobs are merged into the local space on each of the group member's message pads when they connect, hence becoming shared asynchronously. As mentioned above, it should also be possible to update the experience base from the PC, e.g., if the actions taken to solve the problems could not comfortably be entered using the Newton. The premise of the automatic update is that the group members, before finishing work, connect their message pads to the PC. At this point the shared databases, one for unfinished requests and one for concluded tasks, can be accessed. The DARWIN

application downloads the item marked to be transferred from the *share* folder and the personal to-do list, and uploads records from the shared experience database into the local information space.

We suggest that this asynchronous updating process is concluded by the message pad displaying the global to-do list, while it is still connected to the workstation. When the members of the group arrive at work in the morning they can decide whether entries from the global list can be fitted into their plans for the day and eventually transfer them to their personal to-do list. Tasks that have not been allocated until their expiration date are transferred back to the originator's message pad automatically. Clearly, there will be a need for some database-administration in order to maintain a steady flow of work through the network. Ideally the system should be transparent to the users, and maintain the responsibilities that people have committed themselves to, e.g., by warning the originators if an entry with high priority is not taken on the first morning. We expect an empirical evaluation of the use of DARWIN to reveal a whole new set of requirements that to a larger extent take into consideration the social ordering of the workplace into which it is introduced.

Discussion

In the following section we present the results from a preliminary assessment of the design proposal presented above.

A preliminary validation of DARWIN

To validate the appropriateness of DARWIN, a seminar was arranged in which we presented and discussed the application with the group members. The meeting lasted for more than two hours and concluded with a request from the manager of the group if we could present the proposal to the managerial group of the department. He encouraged us to initiate a project to develop the application. The support group

as a whole acknowledged the suggested application as a feasible approach to improve the way they worked.

One exception was the secretary. When the manager asked for her opinion she argued that DARWIN seemed to be "quite messy," from her point of view. She could not really concretise what appeared to her as messy, which perhaps, she argued, "is because I don't actually work with support." Some of the support staff, quite vigorously supporting the suggested application, emphasised the complex and messy nature of support work. They see the work as composed of many initiated tasks, a rapidly and unpredictably changing work load, getting commissioned "everywhere," and so on: "I mean, the reality is messy for us, you know, it's the nature of our job," as one of them put it.

During the seminar one group member told us that he had tested many different systems to organise work, both paper-based and computerised. None of them had, however, been appropriate, but rather caused extra work or had simply been impractical. Paper-based approaches offered little support for overall organisation and co-ordination of work, he argued. He always ended up with "a million paper slips and PostIt notes of which it is impossible to get an overview." The computerised approaches, on the other hand, had consistently failed to address the mobile nature of his work forcing him to first take down information about a task on paper, only later entering it into the computer. This member saw a great potential in overcoming these problems using a digital message pad as we had proposed.

Another issue raised at the seminar was how the common task space should be used. The group concluded that it would not be desirable to enter tasks with high priority into the task space. The space should not accept tasks that required a detailed understanding of the customers' work. It would be more suitable for routine tasks like updating system versions and programming macros.[21] The issue of tracing the responsibility of tasks was also raised, and the group came to an agreement that the member given the task is responsible

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[21]An interesting comment inasmuch as we think programming macros for a user would benefit from a *proactive* approach.

for it, until it is checked out from the task space. And although tasks should not be left in the task base forever — some kind of mechanism alerting the originator after a period of time was discussed — the base is more suitable for commissions that are not time critical. Another important aspect discussed during the seminar was that the support staff should not be using the task space if they knew someone who could do this job well. A better alternative would be to use the mechanisms for direct co-ordination of work, i.e. the *others* view, or forfeit using DARWIN altogether.

Although the support group responded positively to our presentation of DARWIN, some critical factors were issued during the seminar. First, to establish a homogenous use of concepts to describe central aspects of the support work, e.g., the problems of the customers or the actions taken, which could be crucial in the processes of discussing and sharing work within the support group, it would be important to agree on which categories to be used and when. It was also argued that it would be very important to establish these categories *before* the support group take DARWIN in use — it would require much greater efforts to change the use of categories afterwards. Second, it was argued that it was important to establish the use rationale *before* introducing the application. According to some support group members, a lack of common understanding of the use partly explained why the previous experience data bases in the group had failed. Third, it would be essential that the support staff were trained in the use of DARWIN, as well as the Newton. Fourth, the application must not force the user to "write the same word five times before the machine understands it." The first version of the Newton operating system was criticised for its poor handwriting recognition. However, this problem seems to be considerably alleviated in a more recent version. Fifth, as we have argued above, DARWIN should be as easy to use as possible, and extravagant features should not be added to the first version of the application.

Supporting work with this class of IT applications is potentially interesting *beyond* the IT support group for this research organisation, as many of its work groups and units are dispersed geographically.

IT support for networks and groups

Wagner (Wagner 1994, p. 5) takes a perspective on the *networked organisation* as fundamentally based on computer systems that offer the technical infrastructure for "connecting many actors and for accommodating the fluidity of people and spaces within and between organisations." The proposed application for co-ordination of work and sharing documentation seems to fit nicely into this conception. Wagner distinguishes between so-called *emergent* communication networks; denoting ensembles that continuously are established and dissolved on an ad-hoc basis, and formal networks. Emergent networks can be work groups (task centred), as in our example above, coalitions (political) or cliques (social). In our case-study organisation, the network is clearly task-oriented with a set of support requirements to a technology that can help them access the group functionality from a geographically distributed location.

For the purposes of design, the question of whether the network is a distinct social form is probably not essential. We depart from the notion that all organisations have some aspects of different *ideal types* in them (see, Thompson and Frances 1991). The question is rather: what can be elicited about the work, that is relevant to the use of an application such as the one outlined above, using the perspective on the organisation as networked? Wagner claims that the network is typically loosely coupled, meaning that the ties between the actors are weak. This is certainly true in the decentralised organisation of work in the research company. Few formal structures exist to initiate and control work activities and reward proper behaviour (Kreiner and Schultz 1993). The level of activity is to some extent determined by the members of the IT support group themselves, and they are already planning and managing their working day on an individual level. Since the network is already based on commitment and trust (Ciborra 1993, p. 58), there is less danger of items getting stuck in the common task space than might be expected. A bureaucratic organisation of the work is not a feasible alternative since it would reduce the potential of the members to carry out *proactive* support work.

Similarly, because of the loose coupling in a networked organisation, people have different ways of accomplishing their work. It is paramount that applications intended to support networks do not *require* all of the members to use it all of the time. Grudin (Grudin 1994b, pp. 101) argues: "A word processor that is immediately liked by one in five prospective customers and disliked by the rest could be a big success. A groupware application to support five nurses that initially appeals to only one nurse in five is a big disaster." Supporting "networking" and group work, DARWIN will only have to be used by *one* person, as a substitute for the manual notepad, in order to be useful since it affords more ways or organising and navigating in the data. Our intention is, however, to create common information spaces as active resources for the whole group.

DARWIN does not unnecessarily bureaucratise the support network because each commission remains the responsibility of the member who agreed to do the job. Unless they chose to put the request into the open, common task space, it remains fully under their control. If it is submitted to the group, it becomes part of a more bureaucratic handling of the flow of work, required to stop items from disappearing. There is no increased control or reporting associated with this however. In the DARWIN design, items that go past their expiration date are simply returned to the sender, for renewed attention locally — an alert mechanism similar to the ones in the Coordinator (Winograd and Flores 1986). The person-to-person share involves face-to-face negotiation of the division of labour, and does not open the work item up to further bureaucratisation.

The concerns raised by Orlikowski's (Orlikowski 1992) well-known study of the use of a shared information space, are less relevant to this setting, we suspect, because of the nature of the workplace. The networked organisation is based on mutual trust and there is little to be gained for the individual member by misinterpreting information supplied by others (Ciborra 1993). After all, the option existed not to inspect or accept the work item. Competition is not a big issue, the positions available in the group are products of their physical localisation and active "networking" with a set of users in the organisation. The chances of IT support group members misunderstanding or not being able to use the

information because it is interpreted out of context are less than in the case described by Orlikowski, because the tasks are less complex. Also, while they are dispersed in a network, the group members do know about each other's work and are, in a sense, *in context* through doing similar work themselves.

Summing up and future work

In this paper we have presented the design of DARWIN, an application aimed to support the networked, dispersed IT support group to co-ordinate work and share experiences. The design is based on participant observation, interviews and a group discussion. DARWIN consists of three parts, a common task space and a common information space, and a Newton message pad enabling mobile use and access to the information spaces.

The support group intends to begin using DARWIN. Designing, implementing and introducing the application, we, at the end of the day, aim to study DARWIN in use. Lessons learned will be applied to later versions of the application. Due to the risk of designing IT that at a first glance seems to be appropriate but in practice makes the accomplishment of work even harder for the users (Bowers *et al*. 1995, Sachs 1995), we believe it is wise to not try to add too many features in the first version of DARWIN. Instead, an evolutionary approach is taken (Bentley and Dourish 1995). We are primarily interested in IT in a use context, and would like to see future redesign based on experiences from use. Unlike artefacts that force themselves upon people, e.g., the overpasses on the highway to Long Island described by Winner (Winner 1986) and the workflow system explored by Bowers *et al*. (Bowers *et al*. 1995), the support staff do not *have* to use DARWIN to accomplish their work, hence the positive effects have to be immediate and the negative ones minimal.

Acknowledgements

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Third paper

MOSCOW: Unified Support for Mobile Networking

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Abstract

This paper presents MOSCOW (Mobile Sharing and Co-ordination Of Work), a development framework which in a novel way offers unified support for mobile networking. MOSCOW is based on ethnographic studies of an IT support group in a pharmaceutical research company. Taking important social considerations within CSCW into account, this project provides a simple message-passing protocol and flexible client-server architecture that reflect the requirements of mobile and networking people. To illustrate the use of MOSCOW, we present a prototype application called DARWIN (Direct Access to Resources, Work & Information in the Network). DARWIN supports sharing of experiences and co-ordination of work in the IT support group studied.

Introduction

In this paper we describe MOSCOW (Mobile Sharing and Co-ordination Of Work), a flexible, client-server architecture and simple message-passing protocol that reflect the requirements of mobile and networking people. The main objective of this research is to explore

new ideas of CSCW technology use in dispersed, mobile, and networking groups. Existing CSCW systems fail to provide the lightweight, flexible and highly mobile technology needed in such groups. Informed by ethnographic studies of members of an IT support group in a Swedish research company (see, Kristoffersen and Ljungberg 1996b), we recognised the need for a *unified* approach to support mobile work in the networking group. The empirical work informed the design of MOSCOW, a development framework dedicated to the design of mobile CSCW applications.

Problem and requirements

Mobile jobs are, indeed, different from stationary work, and the fragmented, discontinuous and situated nature of what we call networking (Dahlbom 1995a, Kristoffersen and Ljungberg 1996b) has to be carefully considered.

The IT support group investigated aims to offer proactive IT support services to their customers. In order to achieve its goals, members of the group need, by their own accounts, to be able to co-ordinate tasks and share experiences effectively. The group has failed to do so up to now, primarily, it seems, because its staff are dispersed; co-located with their user community rather than the group members. Centralising the group is not an option, however, since close and continuous interaction with the users is a necessity for proactive IT support. Previous attempts in the group to resolve this dilemma by means of traditional CSCW technologies, have failed.

Our fieldwork in the company suggests that existing computing offers insufficient support for such a loosely coupled, dispersed and networking organisation of autonomous, mobile participants. Most applications are heavyweight, cumbersome to use, and resource-demanding to manage. Responding to local needs in a dispersed organisation of work, whilst relying on some traditional group functions, the members of the IT support group require collaborative technologies that are both lightweight and mobile.

Based on the empirical work we suggested the DARWIN (Direct Access to Resources, Work & Information in the Network) application, supporting co-ordination of tasks and sharing of experiences in the IT support group. The empirical work and the evaluation of DARWIN implied the need for taking a *unified* approach to the development of an underlying architecture and protocol addressing the requirements of dispersed, mobile, and networking groups. The five "gaps" (see, Ishii and Miyake 1991) that do not seem to sit well with the work in these kinds of groups, and which we therefore wanted to unify, are:

- Synchronous and asynchronous interaction
- Individual and co-operative work
- Co-operative work and networking
- Stationary and mobile computing
- Current and future (evolving) use of computing

The design and assessment of a message-passing protocol and an open architecture, traditionally conceived as low-level and technical, will, in addressing the issues listed above, clearly raise important CSCW concerns. Therefore, rather than framing the reflection on MOSCOW in a distributed systems perspective, we approach its design and use from a CSCW point of view.

Suggestions and novelties

The members of the IT support group investigated do most of their work *in*, and *walking between*, the offices of the users. Distinctively requiring a lightweight, easy-to-use solution, the continuously mobile and situated nature of their work effectively disqualifies the use of even laptop-sized portable computers, since they cannot be used while moving and standing up. Within the technological constraints of today, even attaching and dialling a mobile phone to achieve

synchronous connections from portable computers to collaborators would be prohibitively cumbersome, because members' work is too swiftly articulated and frequently interrupted to warrant such transaction costs (see, Rouncefield *et al*. 1995).

At this stage of the project we therefore propose using asynchronously updated central databases, combined with lightweight, handheld devices (figure 1).

Figure 1. The mobile and situated nature of IT support work informed the choice of project platform.

Detailing and elaborating on the underlying model of DARWIN, i.e., the application designed for the IT support group investigated, we in this paper introduce a development framework called MOSCOW: a client-server architecture and message-passing protocol that address the requirements of dispersed and networking groups in mobile environments. Identifying common structures and messages in the detailed specification of the architecture and protocol, we aim to contribute to elaborated conceptions of computing use in mobile and networking organisations (Kristoffersen and Ljungberg 1996a). This paper represents an early attempt to generalise the findings from the field study and design exercises described in previous papers (Kristoffersen and Ljungberg 1996b, Ljungberg and Kristoffersen 1997).

This paper takes a novel approach to CSCW technology use in dispersed, mobile and networking groups. MOSCOW offers a *unified* approach to CSCW design which reflects the conditions and

constraints of mobile networking, as well as yielding a technical result. The unified approach taken is new and, according to our empirical work, highly relevant. The work presented in this paper is also novel in the sense it attempts to *bridge* the two very distinctive strands of CSCW research: the empirically oriented social science research focusing on co-operation and IT use, and the technically oriented engineering research concerned with technical issues in groupware systems (see, Whitaker 1992). In trying to bridge the gap between the empirical and technical research, we seek to make a technical contribution based on empirical work.

The structure of the paper is as follows. The next section describes related work. We briefly recount our fieldwork in section 3, emphasising in particular the requirements coming out of the empirical work and the novel approach to unified, mobile computing thus developed. Section 4 describes the architecture and the protocol. Section 5 describes how MOSCOW could be used by describing DARWIN, a prototype application designed on the suggested architecture and protocol. Section 6 discusses the possible applications of the architecture and platform, and section 7, finally, concludes the paper.

Related work

There is an extensive body of research on protocols, architectures and toolkits in CSCW. The focus has, however, been on synchronous communication and related problems, especially sharing and concurrency (Ellis *et al*. 1991, Prakash and Knister 1992, Choudhary and Dewan 1995).[22] Because the capacity of storage and processing of mobile devices is lesser than that of desktop computers, it cannot generally be assumed that the shared data will be complete or consistent at any time. Mobile users are likely to cache only the (anticipated) relevant parts of any database. Hence, in a multi-user

[22]See Munson and Dewan (Munson and Dewan 1996) for a review of existing research on the topic.

system, multiple and partially overlapping sets of data are likely to co-exist. In a similar fashion, there is always a possibility that mobile devices become unreachable from their collaborators, causing confusion about who is receiving and acting according to the messages being multicast. Even a framework supporting multiple degrees of consistency cannot be expected to perform well in these situations (Munson and Dewan 1996), since the granularity of transactions will become unbearable when users gain access to objects by downloading them to the mobile devices and then, eventually, disconnecting and disappearing for extended periods.

Cortés and Mishra (Cortés and Mishra 1996) suggest a dedicated programming language, DCWPL, for describing collaborative work, providing mechanisms for easy adaptation of synchronous co-ordination mechanisms. Using a dedicated co-ordination language requiring a runtime engine running on each host would not, however, sit well with our ambition to provide a unified, open architecture. The support for persistence, and hence asynchronous communication is not yet emphasised in DCWPL.

The Co-operative Application Systems Toolkit (COAST) supports the design of CSCW applications by providing basic building blocks and generic components (Schuckmann *et al.* 1996), admittedly, however, support for asynchronous work is limited. Periods of disconnection in a mobile, networking system, will most likely lead to conflicts between partly overlapping, or suboptimal, partitions of the common information spaces. Schuckmann et al (Schuckmann *et al*. 1996, p. 37) maintain: "The longer a user works on a shared document without a network connection, the higher the risk of later conflicts (and thus the possibility of loss of work) when the connection is re-established." As this quote shows, the COAST toolkit is primarily concerned with shared documents, a situation that would arise seldom in the domain reported in this paper.

NSTP (Notification Service Transfer Protocol) aims to support the sharing of state in synchronous multi-user applications (Patterson *et al.* 1996). It was explicitly designed to be useful for ephemeral, not persistent states, which is always required for mobile computing inasmuch as it cannot be guaranteed that all the devices will be synchronously available (Patterson *et al*. 1996).

Corona is a communication service for reliable multicast (Hall *et al*. 1996), but does not seem to take into consideration one of the specific problems of highly mobile computing: arbitrary orderings of the information spaces and the infrastructure itself.

Research on asynchronous support for co-operative work have resulted in some very interesting prototypes (see, Baecker 1993, pp. 397 - 579). Unfortunately, however, there is, judging from recent conference proceedings and journals, little research carried out on general architectures and open protocols for supporting asynchronous interaction. In our work, we primarily seek to transcend the frontiers between synchronous and asynchronous co-operation, individual and co-operative work, co-operative work and networking, stationary and mobile computing, as well as current and future (evolving) use of computing.

We align our approach and results with those of Bellotti and Bly (Bellotti and Bly 1996), and Kristoffersen and Rodden (Kristoffersen and Rodden 1996), whose empirical studies examine the importance of mobility in the workplace. Our endeavour to discern a unified framework for mobile computing furthermore addresses established requirements of transparency, consistency and gracefulness (Dix and Baele 1996) in an integrated fashion. The suggested architecture and protocol can be used with Lotus Notes as well as Newton Soups, the protocol communicates across local area networks as well as wireless radio, and the borders between asynchronous and synchronous media can be seamlessly bridged.

Research background

The empirical study that this paper is based on, was conducted at a research company of a multi-national pharmaceutical enterprise. The company carries out, as part of a multinational enterprise, clinical research and testing of new drugs in co-operation with hospitals all over the world. The IT support group investigated had been assembled from consultants and programmers to provide extensive, proactive IT support services, advising professional users about new

and existing applications, correcting technical failures, and partaking in design and development projects. The IT support group is important in reducing the time needed before a drug reaches the marketplace after it has been submitted to clinical testing. Estimating their potential daily profit for a drug after world-wide introduction to $1 million, the company fully acknowledges the importance of IT use.

Research method

An ethnographic approach was adopted for the empirical investigations. The aim of ethnography is to describe what happens in a selected setting, from the participants' own perspective (Hammersley and Atkinson 1993). The distinguishing characteristic of this approach is describing the circumstances, practices, conversations and activities that comprise the real world character of everyday work settings, through prolonged involvement with the organisation. The goal of such investigations is to provide a rich understanding of what takes place in the workplace during an ordinary working day. Ethnography relies on the participation of the researcher in the daily life of the organisation, collecting — through observation, listening, and questions — any data that might add to the understanding of the research question. The naturalistic approach suggests that the object of our study should be the phenomenon of interest in its "natural state," opposed to an experiment designed to control and isolate variables. Besides ethnography, the empirical studies comprised qualitative interviews and evaluation sessions.

IT support work

Work can be organised in many different ways. Managers and researchers often try to characterise and implement the most efficient principles. Simultaneously, organisations adapt to a dynamic, changing environment. Several organisational forms can be

identified. Traditionally, organisations have been conceived as comprising formal structures contained by physical boundaries. Changes in the business environment and the promises of new technologies, have, in many instances, brought to the fore a more flexible, geographically dispersed, and loosely coupled organisational form (see, Ciborra 1993, Sproull and Kiesler 1993, Wagner 1994, Hebler 1995).

For the focus of this paper, the important aspect of the organisation of the IT support group's work is that the members are co-located with their users. The IT support group consists of six people working with *in situ* support, one system administrator, one secretary, and one manager. The six members working with direct support are each responsible for one or two departments in the clinical division. The manager of the support group, the secretary, the system administrator and one of the support people, are located in the same building. The remaining five members are dispersed in the main building of the company.

The group's objective is continuous, situated support, enhanced by recommending improved use of existing applications and novel development projects, thus contributing to better computing practices in the company. The members of the group are physically located within the unit of users they support, affording easy access as well as developing good knowledge of the work domain. On the down side, however, what is usually considered as the group support functions becomes attenuated. Our fieldwork revealed that the group experienced problems related to the dispersed organisation of work. Being co-located with the users, it was harder for members of the group to co-ordinate work and share experiences.

Group members are continuously mobile, and their offices can be a considerable distance away from each other, physically as well as organisationally, since end-user unit affiliation was encouraged, being essential to provide proactive support services. The IT support group's organisation of work will in this paper be described as *networking* (see, e.g., Kreiner and Schultz 1993). Their work relies on personal working relationships that are contingent, loosely coupled, temporal, autonomous, and flexible. In the network, people create and develop their own commissions and responsibilities.

Organisational solutions are hardly straightforward because of the constraints and contingencies of the group's work: proactive support requires deep knowledge about the tasks and procedures of end-users, their workload and scheduling, e.g., disengaging the local area network during the week before an important deadline would for instance not be a good idea. Furthermore, support work is, by definition, unpredictable as it mostly deals with unexpected and erratic situations.

The group had already tried to address these problems by sharing to-do lists and documenting problems in so called common information spaces (see, Schmidt and Bannon 1992). These systems had unfortunately failed to be adopted. Discussing these failures with the group's members in interviews, we discovered that the databases never reached a critical mass; people did not find what they were looking for (see, Grudin 1994b). Only one of the members had substantially been contributing to the databases. The reason why seemed to be that the common information spaces were only accessible through the desktop computer. Entering data into these systems therefore implied an additional workload. People usually have to record information when it occurs in order not to forget and most relevant information emerge outside the office, when the information spaces thus were not accessible. The motivation to do such extra work is generally low (see, Grudin 1994b).

The group wanted to be able to share experiences and co-ordinate work as effectively as if the they had been co-located, *and* at the same time, maintain working in the individual networks with their "customers." We were approached by the group's manager, who solicited research into how the group could be made to function "more like a group," and "display a collective competency that is larger than the sum of its individual members."

MOSCOW

In this section we recapitulate the rationale behind taking a unified approach in the development of MOSCOW, followed by a description of the architecture and protocol of the framework.

A unified approach

Approaching the challenge of developing an underlying architecture and protocol that address the requirements of groups in dispersed, mobile, and networking environments, we observed the need for taking a unified approach. The empirical studies imply that the many gaps introduced by current CSCW approaches do not sit well with how people actually accomplish their everyday work in the dispersed, mobile and networking group. The empirical investigations shed light on five gaps that our development framework has to consider, and ideally unify. These seems are between:

- Individual and co-operative work. Individual tasks are for different reasons not seldom handled over to others. Applications that comprise tasks should therefore facilitate the process of making individual tasks co-operative, and vice versa.

- Co-operative work and networking. Actors sometimes hand tasks over to others in their personal network, but because trust is integral to networking they keep the responsibility towards the customers that the tasks are being carried out appropriately. Handing over tasks to others does not, accordingly, always mean handing over the responsibility. Applications that manage tasks should therefore enable users to keep track of records transferred to others.

- Stationary and mobile computing. Work is both mobile and stationary. Users should therefore be able to chose to work in the mode that is most appropriate in the particular situation.

- Synchronous and asynchronous interaction. Collaboration among people often take place using a mix of synchronous and asynchronous co-operation, and the user should therefore not be restricted to using one particular mode only.
- Current and future computing. Users are likely to change the way they work with, and within a distributed system of several mobile applications. This implies the importance of an open architecture, which enables future integration and adaptation.

Architecture

The MOSCOW platform and architecture consist of a mobile client (the MobileClient, e.g., running on a Newton message pad), three servers (the PresentationServer, the TaskServer and the DistributionServer) and three databases (the ContactProfiles, the TaskDB and the ExperienceDB). It could be implemented on a variety of mobile devices, using the company's LAN, or, for development and evaluation purposes, the Internet.

The mobile client replicates parts of the information spaces in two local databases. One of the local databases contains the personal to-do list of tasks, while the other contains the finished task descriptions from the ExperienceDB. It would be possible using existing technology to enable radio-based synchronous communication between the mobile clients and the remaining platform. We have chosen not to depend on the use of synchronous communication. This is mainly due to high cost of implementation, and the additional overhead of users having to carry and operate telecommunications equipment.[23] Therefore, MOSCOW works equally well with asynchronous, user-initiated updating of the local

[23]A more detailed discussion of these concerns can be found in Kristoffersen and Ljungberg (Kristoffersen and Ljungberg 1996b, Ljungberg and Kristoffersen 1997).

and central information spaces. An overview of the architecture is presented in Figure 2.

One of the novel aspects of this architecture is that it suggests an abstract, message-passing protocol. Different media and connection types should be handled uniformly. Person-to-person exchange of task specifications (and other information) could be mediated using the DistributionServer, the TaskServer and the TaskDatabase. The DistributionServer transmits the task to the TaskServer and sends a notification message to the receiver according to his contact profiles (stored in the ContactProfilesDB). The TaskServer stores the commissions in the TaskDB. Commissions can also be addressed to anyone in the group. The PresentationServer and the TaskServer handle the operations when a user wants to browse, check out and take responsibility for open tasks.

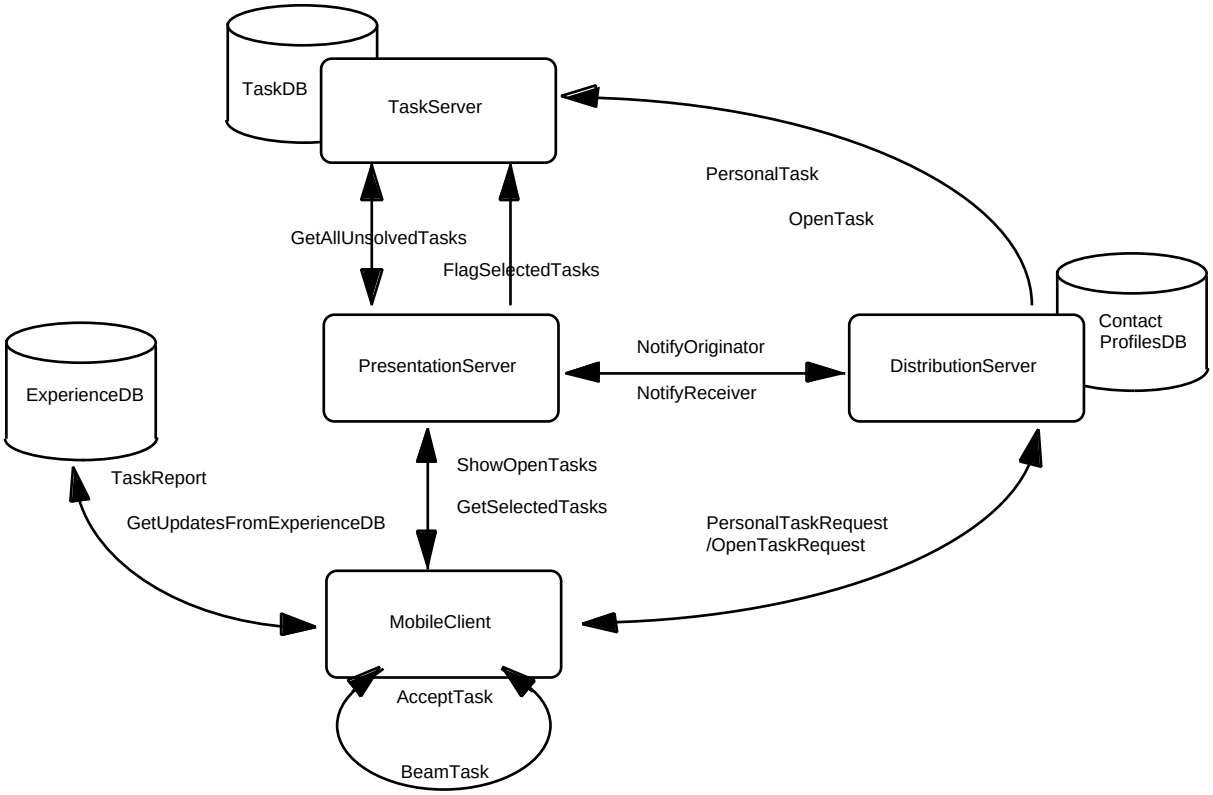

Figure 2. An overview of the MOSCOW architecture.

Protocol

The current version of the protocol is mainly concerned with supporting the asynchronous exchange and update of task data in the TaskDB and the ExperienceDB. In later versions, negotiating the evolving task data, especially in the ExperienceDB, and supporting commitments and scheduling using agents will be considered. Mobile devices are connected to the users' personal workstations. In the following section, the protocol implementing the architecture is outlined.

The protocol is simple. Each server handles a small number of messages expressed in a context-free grammar. Each message can be dealt with without prior knowledge of the interaction, i.e., it is a stateless protocol. The asynchronous and asymmetric nature of the architecture contributes to the simplicity of the protocol by not requiring clients to be signed on and off in order to maintain lists of the current clients for each server. The servers simply respond to requests from the clients, the only exception being the NotifyOriginator message that is initiated from the DistributionServer when a messages has been held beyond its deadline. In this respect it can be conceived as a preliminary design of an agent for the network. Only the DistributionServer needs to know about which participants could exist, and the ways in which to contact them. Maintaining consistency and backing up data is the responsibility of the database manager used by the servers.

The following is a definition of the protocol syntax in BNF (Backus-Naur Forms) (see, Louden 1993):

<Message> → <BeamTask> ç<AcceptTask> ç <PersonalTaskRequest> ç <OpenTaskRequest> ç <ShowOpenTasks> ç <GetSelectedTasks> ç <TaskReport> ç<UpdatesFromExperienceDB> ç <NotifyOriginator> ç<PersonalTask> ç <OpenTask> ç <GetAllOpenTasks> ç<AllOpenTasks> ç <FlagSelectedTasks>

<Task> → <Customer> <Problem> <Priority> <Solution> <When> <From>

<Customer> → text

<Problem> → text

<Priority> → integer

<Solution> → φ çtext

<When> → date

<From> → text

<BeamTask> →beam-task <Task>

<AcceptTask> → accept-task true <From> ç false

<To> → text

<PersonalTaskRequest> → personal-task-request <To> <Task>

<OpenTaskRequest> → open-task-request <Task>

<ShowOpenTasks> → show-open-tasks

<GetSelectedTasks> → get-selected-tasks <TaskIdList>

<TaskIdList> → φ ç<TaskId> <TaskIdList>

<TaskId> → integer

<getUpdatesFromExperienceDB> → get-updates-from-experiencedb

<TaskReport> → task-report <TaskList>

<TaskList> → φ ç<Task> <TaskList>

<UpdatesFromExperienceDB> → <TaskList>

<NotifyOriginator> → notify-originator <TaskId> <Flag>

<NotifyReceiver> → notify-receiver <TaskId> <Flag>

<Flag> → <TaskCompleted> ç <TaskNeglected>

<TaskCompleted> → task-completed

<TaskNeglected> → task-neglected

<PersonalTask> → personal-task <To> <Task>

<OpenTask> → open-task <Task>

<GetAllUnsolvedTasks> → get-all-unsolved-tasks

<AllOpenTasks> → <TaskList>

<FlagSelectedTasks> → flag-selected-tasks <TaskIdList> <FlagList>

<FlagList> → φ ç<Flag> <FlagList>

Table 1. The syntax of the MOSCOW protocol.

All messages should be preceded by an unsigned integer representing the message length, and terminated by a carriage-return line-feed

character pair. This is not included in the specification above, to keep it simple. The following table summarises the messages and briefly explains their purpose relating to the architecture, as seen from the mobile clients' point of view:

Message	Receiver	Action
beam-task <Task>	MobileClient	Upon prior agreement, transmit a task object
accept-task true <From> ç false	MobileClient	Report status of transmission
personal-task-request <To> <Task>	DistributionServer	Pass task object to receiver via TaskDB
open-task-request <Task>	DistributionServer	Pass task object to any via TaskDB
show-open-tasks	PresentationServer	Download all the open task requests
get-selected-tasks <TaskIdList>	PresentationServer	Return the selected tasks from the list of open task requests
task-report <TaskList>	ExperienceDB	Upload task descriptions to the ExperienceDB upon completion
get-updates-from-ExperienceDB	ExperienceDB	Download recent updates from this DB

Table 2. A selection of messages from the mobile client.

Ignoring the autonomous task of maintaining priority and deadline constraints in the TaskDB, in which *notify-originator* could be called, the remaining messages are invoked from the servers upon receiving the requests specified in the table above. The notify-receiver message would be generated in a similar fashion. The messages received by the TaskServer are listed in table 3.

Message	Sender	Action
personal-task <To> <Task>	DistributionServer	Store the task in the TaskDB
open-task <Task>	DistributionServer	Store the task in the TaskDB
get-all-unsolved-tasks	PresentationServer	Request all the tasks that are not flagged as taken

flag-selected-tasks <TaskIdList> <FlagList>	PresentationServer	Flag tasks as taken

Table 3. A selection of messages to the TaskServer.

Using Moscow in CSCW design

Having outlined the architecture and protocol of MOSCOW, we wish to examine how the development framework could be used in design. We do so by outlining the main features of DARWIN, the CSCW prototype application designed to support co-ordination and sharing in the IT support group at the pharmaceutical research company.

DARWIN

DARWIN is a prototype application designed to support the IT support group in the pharmaceutical company described above (Ljungberg and Kristoffersen 1997). The design of DARWIN has been positively evaluated and a project is being set up by the company to complete the design and implement the application.

Sharing experiences with DARWIN

When IT support group members encounter difficult problems, they record the commission in a fairly uniform format: who is asking, about what, when it have to be completed, how important is it, etc. It can be difficult to remember what the solution is straight away, and a similar problem might already be solved by somebody else. The distributed nature of the support group makes it difficult to share these experiences, hence, time and effort are sometimes spent on problems that have already found a solution elsewhere. The *sharing of experiences* feature of MOSCOW is used to implement the sharing of successfully completed problems in the group.

The MobileClient enables the support staff to capture experiences anywhere — no additional work is thus required to share the data later. When the support staff cannot instantly deliver the service asked from them, they record the commission: who wants something to be done, what it is about, the priority, etc. This is done in the Data Entry operation of DARWIN (figure 3). When the task is completed the support staff enter a brief description of the solution, and a completion date is automatically set.

When the MobileClient is connected to the workstation, the local ExperienceDB updates the central one, and vice versa, using the MOSCOW protocol. The rest of the group can then access the records produced. When a new task is recorded it could be matched with the local ExperienceDB. This is done by pressing the "help" icon in DARWIN, which takes the current problem description as argument in searching all previously completed tasks stored in the local ExperienceDB, listing the best matches for the user.

Co-ordinating work in DARWIN

Tasks that are entered in the Data Entry form represent the support person's to-do list. Tasks not yet completed can also be transferred to others in the group, e.g., because of temporary high workload or different areas of expertise. This is typically proceeded by negotiation, e.g., using the telephone. If the two parts meet physically, tasks can be transmitted directly between the devices by using an infrared "beam" communication function (BeamTask) implemented by the Mobile Client. Tasks can also be mediated by connecting the Mobile Client to the workstation and use the TaskDB. The task is transferred to the TaskDB via the DistributionServer which automatically sends a NotifyOriginator message to the receiver, according to his preferences (the ContactProfilesDB), e.g., a standard message sent to the mobile phone or mail. The next time receivers connect the MobileClient to their workstations, they receive the task. When the receiver has completed the task and this is transferred to the ExperienceDB, the sender of the task is notified. This is an important aspect of co-ordination, e.g., because the customer often

asks the originator of the status of the task even though it is re-assigned to somebody else.

Tasks that can be carried out by anyone in the group, e.g., updates of software, can be openly broadcasted. These tasks are sent to the TaskDB via the DistributionServer and TaskServer. The group members can browse and check out tasks addressed to Anyone. The TaskDB is accessed via the PresentationServer and the TaskServer. These tasks are typically not time critical, but the originator of a task addressed to Anyone is notified if the task draws close to its deadline (a NotifyOriginator message).

The flows of tasks

The arrows in figure 3 below outline the main flows of tasks in DARWIN. We have deliberately excluded the servers and the "ContactProfilesDB" in the figure in order to make it easier to grasp.

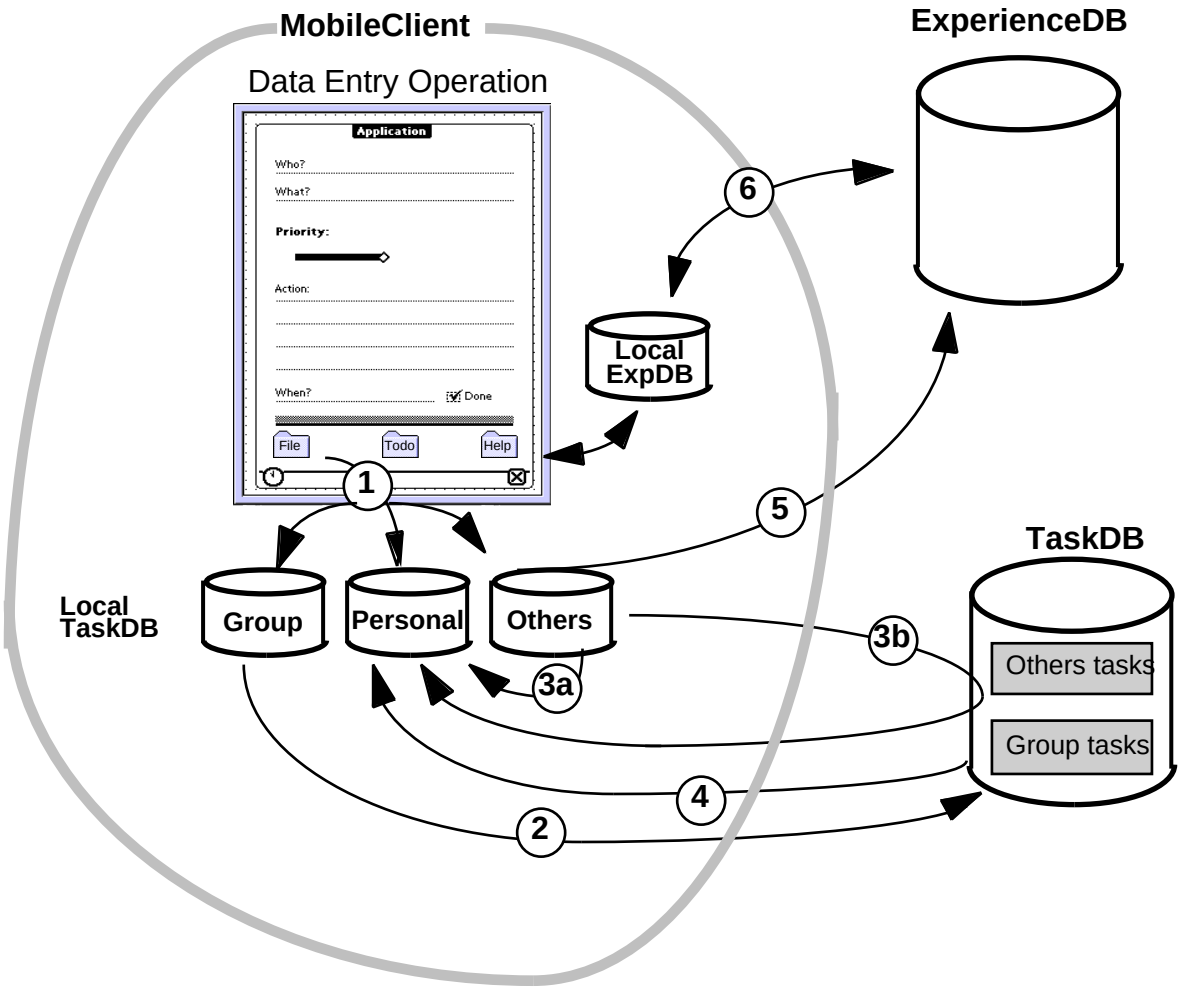

Figure 3. The main flow of tasks in DARWIN.

The main flows in DARWIN are (arrows in figure 3):

- 1: Pressing the “file icon” the current task is saved, pertaining to the user in question (“personal”), somebody in particular (“others”), or anyone in the group (“the group”).
- 2: Tasks addressed to “group” are transferred asynchronously to the TaskDB when the mobile client is connected to the network.
- 3a and 3b: Tasks classified as “others” are transferred to the individual in question after negotiation, either using the beam function (arrow 3a) or via the network (arrow 3b).

- 4: Anyone in the group can browse and check out group tasks from the TaskDB.
- 5: Completed tasks in the group are asynchronously transferred to the ExperienceDB.
- 6: The local experience database and the central ExperienceDB update each other, enabling the members to take part of successfully completed tasks in the group.

Discussion

The suggested development framework reflects and supports a general subset of the IT support work in the company: sharing experiences and co-ordinating work. Not every aspect of these functions are supported. The negotiation preceding the hand-over of a task is one example that people seem to prefer to carry out using alternative groupware or face-to-face meetings, simply because so many strategies and considerations can be imagined. Although the architecture mediates task specifications, and notifies members involved, following-up the responsibilities involved would in the current version have to be handled manually. The work of the IT support group relies on trust, and the network of users and peers will quickly deteriorate if a task is not attended to as promised. Tasks addressed to "Anyone" require some systematic support, however. Otherwise, tasks could be left in the TaskDB after the deadline, without anyone assuming responsibility. We suggest a monitoring process in which the originator will be notified by a NotifyOriginator message when such a task is drawing close to its deadline.

Since the notification messages (NotifyOrignator and NotifyReceiver) represent severe situations, it is important that the user is immediately within reach. The ContactProfilesDB provides the users with the possibility to register how they would prefer to be contacted, e.g., pagers, emails, voice mail, or mobile phone, reflecting

the established requirement of individual tailorability in CSCW systems (Turoff 1991).

Database administration will be necessary as the information spaces evolve. The MOSCOW architecture does not cover these issues, since the benefit of local strategies and tools outweigh the challenges of database management. Several items of the databases could relate to each other over time. A hypertext implementation was considered. We believe, however, that a hypertext approach runs the risk of making the databases harder to maintain. Therefore, we propose an approach where the items of the databases are associated with each other by the information retrieval methods used by the mobile client (Belkin and Croft 1992). Thus, different clients could implement different strategies according to local needs.

Conclusions

The main motivations for this research were the apparent emergence of mobility (Kristoffersen and Rodden 1996) and networking (Dahlbom 1996a, Kristoffersen and Ljungberg 1996b), the weak support for such work provided by current CSCW applications (Bellotti and Bly 1996), and the lack of research addressing the topic from a design perspective.

The MOSCOW development framework constitutes of an open architecture and message-passing protocol, which in a novel way offers support for mobile networking. MOSCOW addresses the empirically observations outlined above, as it takes a unified approach to dispersed, mobile, and networking groups, insofar as it aims to enable:

- Seamless support for implementation and use of synchronous and asynchronous communication, i.e., unifying synchronous and asynchronous CSCW.

- Multi-platform support entailing uniform design and use across desktop workstations, laptops and handheld devices, i.e., unifying stationary, semi-mobile and mobile computing.
- Easy exchange of individual tasks, i.e., unifying individual and co-operative work.
- The possibility to track tasks that to different degrees are handled over to nodes in the personal network, i.e., unifying co-operative work and the conditions of networking.
- Integration with other applications. In the organisation studied scheduling packages and distributed programming with CORBA would have to be taken into account, i.e., unifying CSCW systems based on MOSCOW and other applications.

Our contribution could be seen as an attempt to bridge the current gap in CSCW between socially oriented research, primarily investigating work practices in organisations, and the technologically oriented research, mainly focusing on technical issues in groupware systems. We have tried to reconcile our observations from studies of practices and problems in emergent forms of organisations with state-of-the-art of computer technology, and evaluated the result in meetings with practitioners. The result of this endeavour is MOSCOW, informed by empirical studies of real world practices (see, Hughes *et al.* 1993, Hughes *et al.* 1994), and the design of the DARWIN application (Ljungberg and Kristoffersen 1997).

Future work involves a full implementation of DARWIN using MOSCOW, in the pharmaceutical research company. A thorough evaluation of the application in use will follow.

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Fourth Paper

Communicating @ work: Problems in making IT work

Abstract

The use of information technology (IT) supporting communication is increasingly important in much work. The empirical study presented in the paper shows that such IT does not provide appropriate support for the full range of situations where it currently is being employed. Hence, problems occur as the use of IT cannot be aligned effectively with work activities. Deficiencies in the support were found in six areas: tracking and resuming not completed activities, modes of communication, the initiation of conversations, notification of incoming messages, information overload, and "junk mails." We analyse the problems and elicit brief requirements for design.

Introduction

One of the main trends in office work the last 50 years or so, is the increased incorporation and reliance on communication as an important part of work. In the 1950s, one of the main rules for office work was "…that the working day should proceed as quiet as possible" (Conradson 1988, p. 148). The reason why was to not "interrupt work." Silent communication was allowed in corridors and

in locked rooms, but only if it strictly concerned work. Secretaries were supposed to manage the main part of the communication to "the outside," and employees did not usually have personal telephones.[24] Today, offices are usually not very quiet places. Co-operation is common (Rouncefield *et al.* 1995), even among companies (Ciborra 1993), and communication often constitutes a very important part of work (see, Boden 1994). "Superconnectivity"[25] has been used to describe the outcome of this "communications revolution" (Hiltz and Turoff 1993), of which we currently, it has been argued, only have seen the first signs (Dahlbom 1996b).

This change is obviously due to many reasons, including changes in norm systems (see, Conradson 1988), new ideas in the organisation of work (see, Davidow and Malone 1993), the emergence of the service (or knowledge) industry (see, Barnatt 1996), but perhaps most important, the development of information technology (IT). IT such as cellular phones, video conferencing, and pagers, that were not even invented 20 years ago, hardly commercially available ten years ago, are today used in many organisations. IT is here defined as computing and telecommunication technologies that aim to support communication among people. Other research areas concerned with this category of IT are, amongst others, Computer-Mediated Communication (CMC) and Computer Supported Co-operative Work (CSCW).

When IT becomes increasingly incorporated in everyday work, then the variety of IT use starts to evolve. (see, Mackay 1988). Unfortunately, however, there seems to be reasons to believe that IT does not provide appropriate support for the plethora of situations where it currently is being used. Let us consider one example.

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[24]This description is based on Conradson's (Conradson 1988) ethnological study of how office work has evolved from the 1920s to now.

[25]Hiltz and Turoff (Hiltz and Turoff 1993, pp. 455) use the term "superconnectivity" (after "superconductivity") to describe their impressions of the impact of IT on people, groups, organisations, and society. Superconnectivity is defined as "1. The phenomenon of almost perfect transmission of communication and information throughout the human habitations of the universe, via computers. 2. The interconnections of all social and economic institutions as a result of communication via computer networks."

Arriving at a recent meeting one of the participants argued that he was expecting "a very important telephone call," and for that reason, he "*had* to keep his telephone switched on." In other words, he wanted to use the telephone to be accessible for one particular person. Not surprisingly, however, it turned out that telephone he used was not really designed for such use. What happened was that the person in question received several calls during the meeting, but *not* the important one, and due to the many interruptions caused by the calls, the meeting was not very successful.

This observation, which indeed is not unique, questions if today's IT actually provides appropriate support for all situations where it currently is being used. Existing research, outlined in section 2, mainly concerns problems in the use of email, in particular the information overload problem, and obstacles like the one experienced at the meeting, have not been reported so far. This paper aims to extend the literature on the fusion of communication, work and IT use, by reporting fieldwork from a pharmaceutical research company, exploring obstacles in the alignment of IT (supporting communication) and work. In particular, we focus on *problems that people experience in their work originating from inappropriate mechanisms provided by the IT they use*. The focus of the study was on IT supporting individuals to communicate, e.g., email, not IT supporting entire groups, e.g., meeting support systems. We also limited our interest to situations where people "receive communication." The aim of this paper is to outline overall problems and discuss their preliminary, and indeed brief requirements, and in doing so, provide a starting point for constructive research to resolve these problems. The long-term goal of the research is to provide new and improved mechanisms to enable a smother alignment of communication and other work.

Research

There is a rather extensive body of research on IT use and communication. Most of the contributions are found in the fields of

CSCW and CMC. Below we outline the main problems that have bee reported in this research so far.

Information overload (Toffler 1970, Schneider 1987) has received much attention in IT research. The problem has been described as the delivery of too many information chunks (Davis and Olson 1987), i.e., a situation where the amount of information displayed for an individual exceeds his information processing capacity (Schneider 1987). Information overload occurs in the use of many different kinds of systems, ranging from UseNet news and other information spaces (Fischer and Stevens 1991) to the use of email and similar applications (Palme 1984, Hiltz and Turoff 1993). In research on the use of email information overload is usually described as occurring when the user logs on the system and finds an inbox overfilled with new messages (see, Hiltz and Turoff 1985).

Closely related and sometimes used interchangeably is the *junk mail problem* (Denning 1982). The junk mail problem is that people receive messages that they are not interested in, and it does not concern the delivery of too much information. However, inasmuch as what people consider as junk mails correlates with the amount of messages they receive, the two problems are related.

Another related problem is *the information sharing problem* (Malone *et al*. 1987b, p. 390): "...which has to do with disseminating information so that it reaches those people to whom it is valuable without interfering with those to whom it is not." The difference between information overload and the information sharing problem is that the latter includes the dissemination of messages to people to whom they are interested.

Email overload is yet another problem. Whittaker and Sinder (Whittaker and Sidner 1996) conducted an empirical study exploring the use of email in an organisation. They found that email currently is being used for other functions that it originally was developed for (see, Mackay 1988). Besides asynchronous communication, the original idea of email, important functions were: archiving documents, delegating tasks, and tracking tasks. Whittaker and Sinder coined "email overload" to describe that email is being used for these additional functions, which it does not explicitly provide any support for.

There is also a considerable amount of research that reports from problems and experiences from the use of cutting edge IT, e.g., Media Spaces (Bly *et al*. 1993, Heath *et al*. 1995, Dourish *et al*. 1996), Ubiquitous Computing (Buxton 1995, Cooperstock *et al.* 1995, Yamaashi *et al*. 1996), and virtual environments (Greenhalgh and Benford 1995b, Bowers *et al*. 1996, Nakanishi *et al*. 1996). Because our research focuses on problems experienced in the everyday use of IT in practice, this research falls outside the scope of our investigation.

Research background

This section briefly describes the research approach and setting of the fieldwork.

The organisation

The empirical study took place at a subsidiary of a pharmaceutical research company in Mölndal, Sweden. The company is multi-national and has approximately 1000 employees. The turnover last year was about $400,000,000 ($400,000 per employee). Approximately 750 of the 1000 employees are pharmaceutical researchers. The research spans from basic research on cell biology to innovation in pharmaceutical chemistry.

The company is organised in three divisions; the pre-clinical division, the clinical division and the pharmaceutical division. The clinical division employs approximately 350 researchers of which 50 work at "the third Clinical Research Management department" (CRM III), where our research took place. The research activities at the clinical division concern evaluation of drugs that have passed through the pre-clinical research by investigating them on human subjects. Because the authorities certify drugs for certain indications, not the drug *per see,* much clinical research is about exploring new indications for already approved drugs.

CRM III is organised in project groups served by administrative staff and the Data Management group. The project groups, also called research programs, are assembled on a three to six years basis, to manage clinical trials investigating a set of related hypotheses. The project groups consist of a group manager, clinical trial managers and secretaries. The clinical trial managers are responsible for one clinical project each, but they usually also do some work in other projects. The trial managers are assisted by the secretaries, who do much of the administrative work, e.g., order and distribute equipment for the trials. The group managers are responsible for the overall work in the groups.

The fieldwork reported in this paper has mainly been conducted in the Dyspepsia group at CRM III. Employing six people; one group manager, three clinical trial managers, and two secretaries, the research in this group concerns dyspepsia: "an asynchronous or recurrent abdominal pain or discomfort centred in the upper abdomen" (Talley *et al.* 1991). Broadly speaking, this means that people have serious stomach ache without any symptoms of gastric ulcer. The hypothesis of the Dyspepsia group was that the stomach ace, albeit purely symptomatic, is caused by acid and therefore could be recovered by Losec, an already certified drug.

The clinical trial process

The clinical trial process comprises several distinct steps.

Composing the study protocol. In collaboration with experts on side-effects, statisticians, quality of life, health economy, medical project leaders, marketing subsidiaries, etc., the trial manager compose a "study protocol" describing what the study concerns: what to study, variables, patient criteria, etc. This is a truly collaborative endeavour involving many people. Interaction among people involved takes mainly place electronically.

Composing the Clinical Research File (CRF). A CRF is designed based on the study protocol. The CRF contains a detailed description of the trial, e.g., when it starts and when it ends, and the questionnaires that will be used in the study. The trial manager designs the CRF in co-operation with medical experts, statisticians,

and others. Data co-ordinators from the Data Management group assist the trial manager in producing the questionnaires, using a dedicated module in FormFlow.[26] It is often necessary to go back and do updates in the study protocol after the CRF is designed.

Preparing the study. Secretaries assist the trial managers in preparing and distributing equipment for the trial to the local monitors in the countries involved in the project (10 to 15). The monitors manage the project activities in one country, where they are employed at the company's local subsidiary, and they handle most of the contacts with the clinics.

Initiating the clinical trial. The trial manager, in collaboration with the group manager, medical experts, etc., arrange meetings in all countries participating in the study, where they describe the details of the study for the local monitors and testers (doctors).

Collecting data. The testers ask potential patients to participate in the study. The medical examination takes place, and the tester sends the CRF to the local monitor.[27] The monitors check the CRFs and return the files that are not correct to the testers. Validated CRFs are sent to the trial manager. The trial manager edits the CRFs and returns incorrect files to the monitors, who distribute them to the testers responsible, and so on. A project management application is used to keep track of the CRFs, the inclusion of patients, etc. Correct CRFs are handled over to data managers from the Data Management group. They enter the CRFs in a database that has been set up by data co-ordinators, also from the Data Management group. When all CRFs have been entered, the data co-ordinators test the consistency and logical order of the data. This process, as well as the entering of the data, often detects errors, and the CRFs are returned to the trial manager, and so on. CRFs that cannot be corrected are excluded. When all data is checked and

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[26]FormFlow (Symantec Corporation) is a PC application for the development of electronic forms.

[27]There are large variations between different studies, from 100 patients that have to be examined once, to 10 000 patients that have to be examined 10 times during a period of three years.

invalid CRFs are removed, the "clean file" stamp is set, which means that the data must not be updated any longer.

Analysing the data. The Statisticians analyse the data and present a statistical report of the study.

Writing the clinical report and apply for a new drug or indication. Based on the statistical report, the trial manager and the group manager write a clinical report concluding the study. If the hypothesis are confirmed then the company applies for certification to the authorities.

The work in the clinical trial projects

The work in the trial projects is situated (see, Suchman 1987) and relies much on the participants ability to act appropriately in new situations. For example, the trial managers spend most of their time in the trials resolving problems experienced by project members, especially during the collection of data. Situated work in this context does not mean deviating from a redefined work process, but to rapidly take apt actions to resolve ambiguous situations and make a large project organisation meet the deadlines. To cope with unpredictable situations and make the right decisions the trial managers consult others. Collaboration occurs not only among project members and people in the same research group, but also informally among people from various departments, projects, groups, etc. It is important to establish, and maintain, a personal network of peers with different experiences (see, Kreiner and Schultz 1993). Collaboration among distributed people, many of them highly mobile, requires IT. Problems experienced by testers, monitors, and other distributed project members, are mediated to the trial manager using IT. To resolve such problems, but also to discuss other issues in the projects, the trial manager often consults people they cannot access without the use of IT.

The trial managers and the people they communicate with in the projects is described in the figure below.

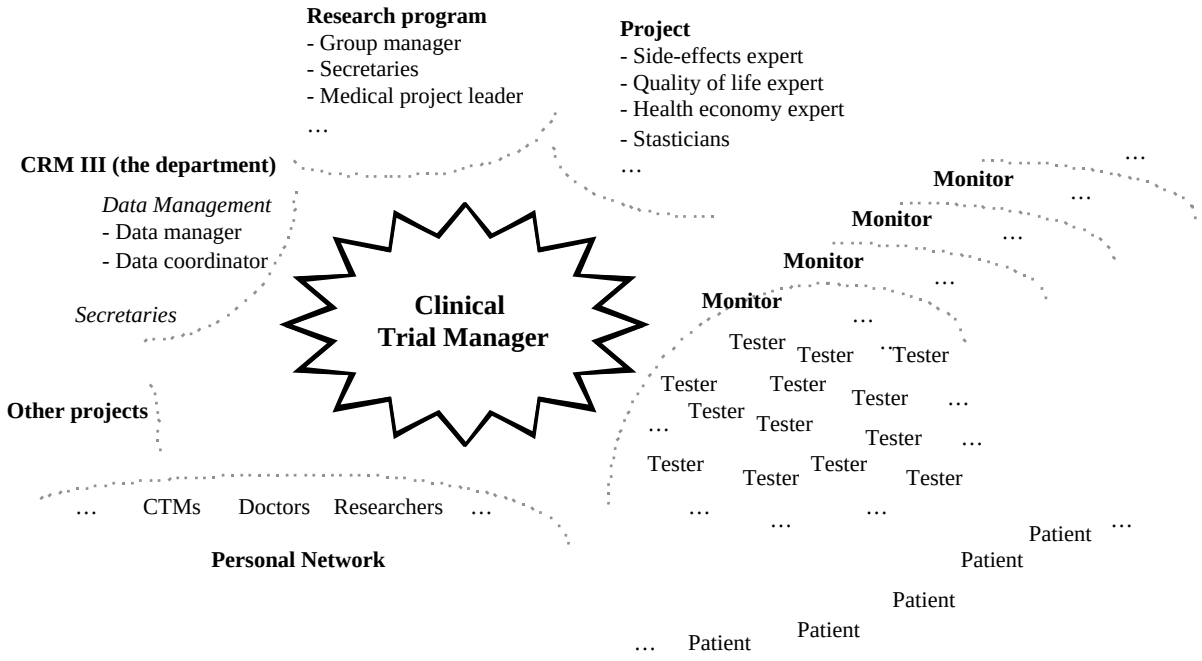

Figure 1. The Clinical Trial Managers communicate with many people in the clinical projects.

Research method

The empirical study reported here was carried out between November 1995 and January 1996. Participant observation of the Dyspepsia group was the main mode of inquiry. We spent approximately 80 man-hours doing close participant observations, i.e., following every single move of a particular person (Patton 1990), and about 240 man-hours doing site observation, i.e., talking to the group members, checking who was doing what, etc. (Patton 1990). Everybody was aware of the research and its purpose, and field notes were taken continually (Patton 1990). This research methodology applied owes much from ethnography (Hammersley and Atkinson 1993), which can, even when based on a single setting, contribute to constructive research (see, Kristoffersen and Ljungberg 1996a). Participant observations were complemented by qualitative interviews (Mason 1989). To gain a more exhaustive insight in the phenomena of study we did not only interview the Dyspepsia staff, but also three clinical trial managers from other groups, two other

group managers and the manager of the department. We used an interview guide approach for the interviews, prescribing that the general topics of the interviews should be specified in advance but that the particular course of each interview directs the exact wording and sequence of questions (Patton 1990). We conducted 12 interviews lasting between 45 and 90 minutes. All interviews were taped.

Problems

In this section we report the findings from the empirical work. The question we explore is: *Which problems do people experience in their work, originating from inappropriate mechanisms provided by the IT they use*? We focus on the problems experienced from the *receivers* point of view. IT is here used to denote IT supporting *communication* among people, and the distinction between synchronous IT, e.g., the telephone, and asynchronous IT, e.g., email, is used (Baecker *et al.* 1995). The technologies explored are: email, telephones and simple groupware applications.

Tracking and resuming not completed activities

According to our empirical work, people have problems keeping track of, and resuming work they have suspended. The problem seems to occur in at least four situations, which relate to the use of IT in four distinct ways. This illustrates the current lack of mechanisms assisting people in keeping track of and resuming activities they have not yet concluded.

Coping with tasks received by email

We found that people have problems to keep track of tasks requested in emails, and as a consequence, they often choose to approach such tasks immediately when they are received. People fear to forget about such tasks because they tend to overlook emails that pass from sight

in the inbox. Why is it a problem to approach such tasks immediately? The answer is that it does not have to be a problem, but it could be. It is a problem when people feel that they *have* to interrupt their current work and approach the task requested in the email *although* it had been much more appropriate to do the requested task later. However, we do not view this as a serious problem, but rather as an indication that the use of IT in work could be improved by mechanisms helping people to keep track of and resume their activities.

Failing to complete asynchronous conversations

A related finding is that people sometimes have difficulties keeping track of asynchronous conversations that are not completed. There are many reasons why people sometimes leave emails that need to be replied later, e.g., they are interrupted or they cannot answer a question at the moment. The problem is that they sometimes tend to overlook those uncompleted conversations. The email application used at the company did not provide any support for people to mark or highlight messages they needed to reply to and staff often coped with the problem by placing a printed copy of such messages at their desktop. As in the problem above, this directs our attention towards the current deficiency of IT assisting people in keeping track of and resuming their work.

Failing to resume interrupted work

The third example of the problem concerns activities that have been interrupted by synchronous IT. When people receive synchronous communication, e.g., when the telephone rings, they have to make an immediate decision whether they want to accept the request or not, i.e., if they want to interrupt their ongoing work or decline the conversation. The problem is that people do not always remember to resume the activity that was interrupted by the conversation, especially when the communication lasts for a long time. One reason why could be that people upon receiving a telephone call, do not have any time to assure that the activity is resumed later — they have to

act more or less instantly. The problem often becomes apparent when people are reminded about the activity, e.g., when someone else asks about the result.

Forgetting about commitments

We also found that people sometimes have problems to remember commitments made in synchronous communication. Consider the following example from the fieldwork. While reading a protocol, the manager of the Dyspepsia group accidentally came to see the name of someone who she had promised to send an important fax to. Upon seeing the name of this person the group manager was apparently reminded about the fax: she exclaimed the name of the person, while at the same time calling the secretary of the group, who works in the office next to here, asking here to immediately come to her office to "compose the fax to Mrs. X!". The group manager explained later that she a couple of days earlier during a telephone conversation with "Mrs. X," had promised to send her a fax compiling important information about her involvement in a trial project. However, the group manager explained, other things turned up directly after their conversation and the fax came to nothing. When she saw the name of the person in the protocol she was reminded about the fax, and because the study that "Mrs. X" potentially should participate in soon were going to start, she had to go about the fax immediately. The group manager also pointed out that if she had been reminded about the fax some days later, then it would probably have been too late to incorporate "Mrs. X" in the trial project. Similar problems seem to occur when people are engaged in long communication sessions, specially when they cover many different topics. To resolve the problem people used note books and PostIt notes.

Discussion

IT is becoming used in situations it was not designed for. When the telephone was developed it was hard to predict that people in the future would have problems to resume activities interrupted by it, or forget commitments made while using it. It had been equally difficult

to predict that people in future organisations would overlook tasks received by emails, and fail to resume email conversations that are not completed (see, Whittaker and Sidner 1996). Still the fieldwork suggests that people in the pharmaceutical company experience these problems. These problems are due to people failing to resume activities interrupted by IT or in IT environments. Thus, the overall requirement is mechanisms enabling people to *keep track of and resume interrupted activities more effectively*.

Functionality assisting people to manage tasks received by emails could be integrated in the email application or the scheduling system, but also implemented in a standalone application, such as a "to-do list." The support provided by such mechanisms would have to make it possible for people to deal with the work they believe is most appropriate at the moment without being afraid of overlooking tasks. Organising emails according to conversations instead of single messages could be one way of reducing the risk of overlooking uncompleted conversations (see, Goldberg *et al.* 1992b, Whittaker and Sidner 1996). Another strategy would be to enable users to mark emails as "not completed," and list the inbox according to such criteria. Signals alerting users when a conversation has been idle for some time is another possible solution. It seems less obvious how to provide support for resuming activities interrupted by IT, e.g., a telephone call. The main reason is the immense amount of potential activities that could be interrupted. One strategy could be a light-weight desktop application enabling receivers to mark their current activity when they receive conversations. Using ubiquitous computing (see, Weiser 1991, Buxton 1995) could be another possibility. It is far from obvious how to support people remembering about commitments made in synchronous communication. Applications enabling users to easily take down agreements, etc., could be one solution.

Modes of communication

The empirical study revealed that communication is ineffective when it is carried out in an inappropriate mode. Current IT does not

provide any explicit support for managing modes of communication in interactions. We view this problem as an indication of how communication mediated by IT could be improved in the future. Below we give two examples of the problem, first a situation where a wrong mode of communication is applied, and second, a situation where people would have benefited from a combination of modes.

Wrong mode of communication

Different modes of communication fit different kinds of conversations. Participants pointed out that the telephone, providing synchronous "live communication," enable them to effortlessly bring order into misunderstandings, easily interrupt each other and ask clarifying questions, relatively rapidly reach conclusions, etc. (see, Kraut *et al*. 1990, Clark and Brennan 1991). Communications that require such interaction, e.g., conversations covering complex problems, issues that the participants are not familiar with, etc., should therefore, be carried out in a synchronous mode to be effective. Otherwise, such conversations tend to provoke "a huge amount of exchanged messages during a too long period of time" (JC, Clinical trial manager).

The synchronous mode does not sit well with communication covering much information that mainly is transferred from person to another. One example is a secretary who told us that she occasionally receives orders from the project members by the telephone. The orders concern laboratory equipment for the trails and are communicated by testers and co-ordinators involved in the study. The orders contain much information "that only should be mediated from A to B, from them to me," and for that reason, she maintained, "the telephone is not the best medium." When she, nevertheless, receives orders by the telephone, she has to "convert" them to an asynchronous mode, which "makes the conversation inefficient for both parties: the caller has to wait while I write it down."

The insufficiency of one mode of communication

We found that people sometimes fail to make explicit the agreements they make during a conversation. Consider the following examples of

a 30 minutes long telephone conversation between a trial manager and a co-ordinator. In the beginning of the conversation a decision about the organisation of a local study was made. After the decision was made, the trial manager told us later, the co-ordinator gave a description of the state of affairs in the clinics participating in the study that "inevitably would have changed the decision" about the local organisation of the trial. Neither the trial manager or the co-ordinator took notice of that however, and the decision previously taken was not questioned. When the trial manager came to think about the upcoming study some days later, he did not really know what decision they had made. They had agreed upon one decision in the beginning of the conversation, but according to the subsequent and main part of the telephone call another decision would have been more feasible. However, since this was not articulated clearly the trial manager did not really know what was decided, and perhaps more seriously, what the co-ordinator thought was decided. Therefore, he had to contact the co-ordinator. This is only one out of several similar observations.

These problems seem to occur mainly due to people having problems to keep relevant aspects of an ongoing conversation in mind, i.e., the support for synchronous communication is apparently not sufficient. To resolve the problem, everybody we observed used additional tools, e.g., dedicated notebooks and post it notes to take down decisions, and dictating machines to record important issues after the conversation. Furthermore, the participants of a telephone call sometimes agreed that one of them should type the decisions made in the session and distribute to the other. Inasmuch as the problem occurs even though people apply these means, there is obviously a need for more elaborate mechanisms.

Discussion

The fieldwork indicates that certain modes of communication are appropriate for certain conversations, and that communication carried out in an inappropriate mode is ineffective. The fieldwork also implies that one mode of communication does not have to be sufficient. People involved in synchronous communication sometimes

fail to keep all important aspects of the conversation in mind, and in doing so, they forget to make agreements explicit, complete relevant discussions, etc. Participants try to resolve this problem, or rather counteract it, by taking down main points, i.e., combine the synchronous mode, which is essential but apparently not sufficient for the conversation with the asynchronous mode. The two problems concerning modes of communication call for more effective support for *managing modes of communication in conversations*.

To reduce the risk that communication is initiated in a wrong mode, we could let people prescribe their preferred mode of communication for particular kinds of conversations. This would require a dedicated application that handle all incoming communication. How to make such support practical is far from obvious, but needs to be explored further.

Current IT does not really obstruct people from combining modes of communication. In fact, we made several observations of how people combined modes of communication in conversations, e.g., sending an email to someone *and* calling the same person. We also observed that people often "switched" mode of communication within conversations, e.g., someone who instead of replying an email contacts the other part using the telephone. We also observed how people abandoned the compositions of an email message as it turned out to be an inappropriate mode for the conversation in question, and started the conversation using the telephone instead. However, although today's IT does not exactly prohibit people from combing and switching modes of communication, it does *not* offer much support. And inasmuch as the current support does not seem to hinder problems to occur, there is definitively room for new mechanisms providing more sophisticated support for combining and switching among modes of communication.

The initiation of conversations

Excerpts from the fieldwork, included below, suggest that people experience problems in coping effectively with the initiation of synchronous conversations, e.g., telephone calls. Telephone calls only

notify receivers that someone wants to talk to them, but not who wants to talk to them, about what, if it is important, etc. Furthermore, callers are not provided with much information about the receivers' current activities; if they are doing something that is inappropriate to interrupt, if they are accessible, etc., and they have therefore difficulties to know if their calls are appropriate or not. Poor mechanisms for handling the initiation of conversations seems to be the main reason why inappropriate conversations occur, or, from the receivers point of view, that they reluctantly become involved in synchronous communication. Below we describe two situations where this problem occurs.

Abandoning important work for less important

The trial processes are organised in projects which are divided in certain steps with *deadlines*. The deadlines are very important, e.g., for economical reasons, and the priority of tasks naturally increases upon approaching their deadlines. Because the research groups often have a very high workload, they try to postpone less important tasks and put their efforts on the more urgent ones. The group members often have a considerable amount of highly prioritised work to complete close to deadlines, forcing them to put a very large part of their efforts on the projects and work very co-operatively, e.g., share the workload among each others as far as possible, to assure that the group resources are optimised. IT plays an important role in this work, both to support co-operation within the research groups, and to make the group accessible by distributed projects members.

What sometimes happens in these situations is that the research staff are contacted by people who want to discuss *other* issues, e.g., future trial projects, that is, issues that have nothing to do with the tasks they work so hard to complete in time. Such interruptions are recurrent, amongst others because researchers often are involved in several projects, but also because work at the company often relies on personal networks transcending the formal organisation. However, in situations such as the one described above, the researchers are for obvious reasons not very interested in interrupting their work and start exploring other issues.

Nevertheless, this is not seldom what happens. DJ, a trial manager, describes the problem:

> "For example, the monitor of one country called when we were doing the "clean file" work, and he wanted to discuss something that was going to happen in half a year... About a meeting we were going to organise. And I felt... it was uninteresting and very frustrating to spend my time discussing that meeting, because I had 1000 other very important things to do. " (DJ, Clinical trial manager)

We interpret DJ's description of the situation as follows: While she is working hard to meet the most important deadline in a trial project (i.e., "clean file") she receives a telephone call from someone who wants to discuss issues that do not concern the deadline. Because of her current work situation: the important deadline, the heavy workload, etc., she gives a very low priority to the topic that the caller issues, and at the moment she does not want to spend her time and efforts on discussing it. Nevertheless, she becomes involved in the conversation. This does not mean, DJ emphasised, that the topic did not concern her, but that she has to prioritise in her work: "...we have so much to do that we *have* to prioritise in order to get the work done." Consequently, because DJ gave the telephone call a very low priority for the time being: "The discussion felt like a waste of valuable time" (DJ, Clinical trial manager). Another trial manager commented on the problem by arguing: "If you work "24 hours a day" to complete a project, for instance, then you don't really care about a meeting in France next summer...".

Less important communication disturbs intellectual work

Even though communication and co-operation is very important at the company, people also do individual work. Some examples are editing CRFs and writing research reports. Participants made a distinction in their individual work, between *routine work*, such as editing CRFs, and *intellectual work*, such as writing research reports. While routine work typically is iterative in nature and easy

to resume, intellectual work takes time to get into, and requires cognitive efforts and continuity to push forward.

Intellectual work does not usually sit well with interruptions like telephone calls. This is especially true when the communication sessions, or the activities they initiate, are long and require the receiver's full attention. The problem does not become apparent when people are interrupted, however, but when they try to resume the interrupted work. Two obstacles seem to be experienced in these situations. First of all, and perhaps most important, it often takes a long time for people to acquaint themselves with the problem. The second, and related problem is that people sometimes do not manage to re-establish their analysis (see, Dix and Baele 1996, Dix and Beale 1996).

The following excerpts from the fieldwork documents the tension between IT and intellectual work.

> "Let's say I'm at my office writing a journal paper and I'm interrupted, e.g., by a telephone call or someone coming in to my office. Let's say she wants to discuss something, and it takes ten minutes. When she has left you cannot immediately go back to work. First you have to acquaint yourself with the train of thoughts. This is sometimes impossible, indeed it is, or takes a very long time... especially if the interruption was long and you had to think about something carefully. The longer interruption, the more difficult it is to go back to work […] I think every single interruption is negative when I do such work... especially when it takes time and I have to think… even if it is about something you have waited for or are interested in... It doesn't only take the time of the interruption, but more. [...] But when I do more... administrative work, routine work,, e.g., check patient journals, it doesn't really matter if I'm interrupted. I've no problems to continue immediately." (OI, Clinical trial manager)

> "It's difficult to come back to the same... state of mind. […] It's not just the interruption *per see*. There are so many details in our work, so... it is so... very important to, when you start working, to "get on the track." It is very important, then, the continuity." (RB, Clinical trial manager)

It is nothing inherently undesirable in disrupting intellectual work, however. If a conversation is very important, e.g., a doctor articulating serious problems in an ongoing trial, then an interruption is worthwhile.

> "If I'm working on something important, I think about something and I'm absorbed by that, and... Then I could ask her ["the sender"] if I could contact her later. But I do so very seldom, though… never, to be honest. However, if it seems to very important, highly prioritised work, you often feel if it is, then you have to interrupt what you do. Her work takes the priority over what I do, and that's the way it should be, I suppose..." (DJ, Clinical trial manager)

Exploring the tension between brain work and IT, we once again noticed the importance of the interruptions' *length*. "The train of thoughts do not disappear immediately, but gradually," as a trial manager put it (see, Dix *et al*. 1993). An interviewee said:

> "If I receive a mail, for instance… a short reply is OK. But, if I have to articulate something, arguments, explain something, and... check files, etc., then I definitively become disturbed. […] Then it often takes too much time to "re-start." And perhaps you had a "nice thread"… which is very difficult to find then." (HF, Secretary of the Dyspepsia group)

People also maintained that "short" communication (see, Tang *et al*. 1994, p. 23 "lightweight communication") normally concerns issues that do not require extensive cognitive efforts of the receiver. This could be another reason why length of interruption seems to be crucial.

Discussion

As communication becomes increasingly important in many organisations, it is often necessary for people to be accessible during a large part of their working day. This does not mean, however, that people are interested in becoming interrupted in their work by all

communication. In the two examples described above, the problem is that people reluctantly become involved in communication that for different reasons does not sit well with the particular situation. One important reason why this happens is the poor support for the initiation of communication provided by current IT. When the telephone rings, for instance, people cannot (usually) know whether they wish to start the conversation or not. The receiver does not know who is calling, what he wants to talk about, if it is important, etc., only that someone wants to talk about something, and the possibilities to screen communication is currently quite limited. Furthermore, the possibilities for the sender to know if he interrupts the receiver in an inappropriate situation are close to non-existing. Inasmuch as people try to make their actions visible and intelligible for others (Suchman 1987), the receiver's actions play an important role in the initiation of communication. The overall requirement suggested by this problem is more sophisticated mechanisms for senders and receivers to *manage the initiation of conversations*. Such mechanisms would have to deal effectively with people's wish to be accessible for "short communication."

To enable receivers to automatically screen communication, similar to automatic filtering in email systems, senders would have to, at least partially, state the overall "topic" of the conversation, their "identity," etc. Because screening impedes communication that could be important, it might also be necessary to in some way transform screened communication to an asynchronous form, similar to the answering machine, enabling the receiver to consider it later. Whether it is practical to state "the topic" and make synchronous communication persistent, have to be explored in more detail in further research. The sender could very well play an important role in reducing the problem.

Notification of incoming messages

This problem concerns the notification of new messages in asynchronous applications. We found that applications that do not notify new messages cause a problem, namely that people fail to take

part of new messages as soon as they want to. Moreover, as people appear to make distinctions between different kinds of communication, they do not wish to be notified about new messages on an individual basis, but which *kind* of new message they receive. Current IT provides poor support for that.

Applications that do not notify new messages

The pharmaceutical staff complained about asynchronous applications that do not announce new messages. The problem people articulated was that they fail to check for new messages as often as they need to, and as a consequence, messages become lying unnoticed for a too long period of time. A trial manager argued:

> "Several of our new applications don't provide this hint, the notification. We are required to log on the systems ourselves and check for new messages. In AMOS [an application developed in-house], for example, we often write down questions about patients. We do so, and the doctors too, and so on. And now, we have to do a search on every single patient, instead of a flag saying if there is anything new in the system. And many of our new communication systems are designed like this, which indeed is inappropriate. The drug ordering system is another example. We use that system to order drugs from another department, and there are some messages sent back and forth in the ordering process. We have to log in on the system to check if there is anything new. It's not announced. And that's stupid. If they want me something, they have to let me know. Otherwise I won't do it, because I won't remember it. A flashing light, or what-so-ever." (JC, Clinical trial manager)

This problem is well-known, and mechanisms notifying new contributions is by know a well-established requirement for groupware (Ackerman and Starr 1996).

Mixing different kinds of communication

We found that people distinguished between different kinds of messages that they cope with quite differently. One distinction made

by several participants was between "for-your-information emails" (FYI) and work emails. FYI emails mainly aim to inform people. They are often sent to a large group of people and they are not usually time critical. Furthermore, it is not always extremely important to read them carefully. Work emails on the other hand, are typically addressed to one person, or a small group of people, and they usually concern the receiver's work explicitly. Upon receiving such messages people often take action immediately.

The pharmaceutical staff received approximately 30 emails per day, without subscribing any mailing lists or similar. Inasmuch as people are at their offices when these messages are delivered, they interrupt their doings just as many times. This means that they are not seldom interrupted in their work by FYI emails, i.e., by messages that are *not* addressed to them directly, that do *not* concern their work directly, that are *not* time critical, and *not* always important to do. Participants complained about that, maintaining that they wanted the system to distinguish between different *kinds* of messages.

One application used at the company that reflected people's preferences in this respect was "Inforum." Inforum was used by management to inform the employees about company-wide matters. The application was running on Vax, but the Vax terminals had been removed a long time ago and today people have access to the system using their PCs. What people essentially liked about Inforum was the way the system notified them about new messages. Inforum was connected to the telephone system and new messages where acknowledged by a light on the telephone. Compared to the email application, this gives the users very rich information: the kind of message is FYI, the sender is management, and the communication is not time-critical. Using the email system people are only notified there is *any* new message.

Inforum was also integrated with the email system running in the Windows environment, and when management post important message — not time critical, but rather important in the sense that everybody should read them — people are notified the next time they log on the email application, usually the following morning (or earlier if the PC hangs; then they have to restart the PC and log on the

email application). Accordingly, they do not have to think about the possibility that new messages are time-critical and have to be read immediately.

Discussion

The two problems discussed above concern the notification of asynchronous communication. The first problem, which has been discussed by others (see, Ackerman and Starr 1996), suggests that users wish to be notified about new messages, while the second problem adds the importance of being notified about message type. It should be noticed that the distinction between FYI and work messages is broad, to say the least, and does not, amongst others, cover messages that are sent to many people asking them to do something, e.g., check all applications at their PCs, as we described above. However, we do not believe the distinction *per see* is the point here, but rather current IT's *incapacity for reflecting different kinds of messages*. Inasmuch as most applications only notify there is *any* new message, and the options to make this interaction richer often are limited, current IT appears to be based on the assumption that *people want to cope with all messages in the same way and therefore want to be notified about all new messages in the same way*. The empirical study contests this assumption, suggesting that people wish to distinguish between different kinds of communication that they wish to cope with in different ways. Therefore, people would probably benefit from mechanisms *acknowledging new messages in more sophisticated ways*.

Information overload

Information overload is when the amount of information displayed for people is beyond their capacity (Davis and Olson 1987). We found that people normally check new emails continually during the working day, and by doing so, the number of unread messages displayed for them do not usually cause any problems. Still information overload sometimes occurred, however only as a result of

people being *restricted or restrained* from reading new messages as often as they wanted to.

One example is when a trial manager went back to work after some days of illness. The trial manager had failed to access email from her home, and upon logging on the system, all messages addressed to her during her absence were delivered in one go. She did not feel comfortable about that, maintaining that she could not "survey the situation," i.e., she could not know "which emails were most important, most time critical, and so on." The problem was, she argued, that she could not access her new emails rationally (see, Marcusohn 1995).

People thus normally read new emails as soon as possible: if they are at the office, when the email application announces new messages; if they are temporary out, when they come back to the office; and, messages delivered during the night are considered the following morning. Because people read new emails continually, they usually have no problems to cope with the amount of new messages, thus information overload does not occur. The problem does occur, however, when people for some reason *have not been able access* their email continuously, as was the case for the trial manager described above. This implies that the problem would be resolved by enabling users with *continuous access to email*, not by better techniques for retrieval (or filtering) and visualisation of information, which normally is proposed.

Continuous access would probably not be sufficient, however. One reason could be that people not always want to access their email continually, and therefore, still would experience situations where the inbox is overfilled with new messages. Another reason could be that current IT does not make it practical to have continuous and instant access to email, e.g., when travelling, especially by air plane, and for highly mobile jobs. For these reasons, and others, continuous access to email will not be enough; there will still be situations where people experience information overload. Therefore, there is still a need of more appropriate mechanisms enabling people to take part of large amount of messages according to the priority they give to them, i.e., *better methods for retrieval and visualisation of information*.

Because most email systems enable senders to give priority to messages and receivers to create filters to match incoming emails, the information overload problem partly stems from the users failing to utilise features in current systems. However, the reason why could very well be that today's email applications do not offer relevant support. For example, to what extent could senders give priority to their messages in a way that is practical for the receivers, to what extent does senders' and receivers' priority of messages agree, and, if they do not, which preferences should be relied on? Raising these concerns we do not claim that priority mechanisms and automatic filtering cannot be useful, only that there are room for additional mechanisms *helping people to take part of new messages according to which priority they give to them*. There are some promising work in this area, amongst others, Marx and Schmandt's (Marx and Schmandt 1996) research on "dynamic personalised message filtering."

"Junk mails"

The pharmaceutical staff experienced the "junk mail problem" (Denning 1982), i.e., that they receive and spend time considering messages that turn out to be uninteresting. The flow of what we previously called "FYI emails" was huge at the company. What exactly constitutes a FYI message is perhaps not well-defined, or even unproblematic, however, examples of such messages could be notifications about new PC applications, and upcoming seminars and conferences. Upon receiving emails from people they know, participants often knew very much about the message by just looking at the header ("From," "Subject," etc.). Unfortunately, this is not always true for FYI messages. In addition, FYI emails often concern topics that people do not know very much about, e.g., new PC applications. Staff argued that on one hand, they often conclude that reading a FYI message was a waste of time; they do *not* want to install the application, attend to the seminar, etc. On the other hand, which is the dilemma, new applications could very well improve their work *significantly*, a seminar could be *very* relevant, etc. The

problem is, people maintained, that they experience that they spend too much time considering FYI messages that turn out to be worthless, i.e., junk mails.

This problem is due to the fact that people receive emails that they are not interested in, which is one part of the more general *information sharing problem* (Malone *et al.* 1987b) mentioned previously. The delivery of uninteresting messages originates from senders being unaware of who is interested in what message, and receivers failing to screen unwanted messages. With some exceptions (see, Malone *et al*. 1987a), current applications do not provide much support for senders to locate interested receivers — although techniques have been available for a long time (see, Houseman and Kaskela 1970). The receiver's possibilities to screen "junk mails" is slightly better as automatic filtering features have been incorporated in most email systems. The reason why the researchers rarely used filtering could be poor design or ineffective mechanisms, but also that they did not suffer from the problem very much. The preliminary requirements suggested by the information sharing problem is mechanisms that more effectively enable *senders to increase the chance to only send messages to people who are interested in them*, and *receivers to screen a larger amount of the "junk mails" they receive*.

Discussion

The use of IT supporting personal communication is very important at the pharmaceutical research company, and in many other of today's organisations. The trial managers, for example, need to communicate continually with staff within their projects, the research program they belong to, "nodes" in their personal network, other projects, etc. Much of this communication relies on the use of IT, amongst others, because participants are geographically dispersed. The empirical study explored the use of quite simple IT: email, telephones and simple groupware applications. The fieldwork suggests that this IT does not offer sufficient support for the range of

situations where it currently is being used. The emergence of "super connectivity" (Hiltz and Turoff 1993) and the increased reliance of communication in work (Dahlbom 1996b), seem to impose new requirements on the technology; new mechanisms are required and old assumptions have to be reconsidered.

So, which problems do people experience in their work originating from inappropriate mechanisms provided by the IT they use? The problems found and the brief requirements that could be elicited from them, are as follows:

Tracking and resuming not completed activities. Problems found concerned keeping track of and resuming (1) tasks received by email, (2) not completed asynchronous conversations, (3) work activities interrupted by IT, and (4) commitments and agreements made in synchronous conversations. The first two problems were partly found by Whittaker and Sinder (Whittaker and Sidner 1996) in their study of email usage in a computing research lab. Their suggestions to resolve the problems are features assisting people in tracing tasks and organising messages according to conversations. Similar mechanisms, perhaps less sophisticated, have been implemented in Information Lens (Malone *et al*. 1987a) and Active Mail (Goldberg *et al*. 1992b) respectively. Whittaker and Sinder did not find, however, that people decrease the options in their organisation of work as they feel forced to resolve new tasks delivered by email immediately. This is arguably not a serious problem, neither a major finding, yet the observation seems to be novel. The importance of reminders in office work has been stressed by others, e.g., Malone (Malone 1983) and Dix *et al.* (Dix *et al.* 1996b), and applications offering such support have been developed (see, Stifelman *et al*. 1993). In spite of that, it seems that problem 3, and especially problem 4, have not been approached explicitly by others. Inasmuch as communication carried out using IT becomes increasingly important in work in general, it could be assumed that these problems will growth in the future. However, we cannot presently offer any detailed suggestions of how to resolve these problems.

Modes of communication. Certain modes of communication are appropriate for particular conversations, and communication

carried out in a wrong mode is less effective. This suggests that it would be effective for people to prescribe modes for certain kinds of communication, but it also implies the importance of being able to easily switch between different modes within conversations. The problems of managing all aspects of an ongoing conversation — to come to agreements, avoid unclear decisions, etc. — shed light on the potential benefit of combining modes of communication within a conversation, but also to provide other mechanism for coping effectively with threads (etc.) during ongoing sessions. Current IT does not really prohibit combination of, and switching between modes of communication, but it does not offer much support either. Inasmuch as problems concerning communication modes seem to occur, this is apparently not enough. Issues concerning flexible and effortless management of communication sessions have been discussed in the use of video-supported systems (see, Kristoffersen and Rodden 1996). As far as we are concerned, studies of "less sophisticated" IT have not reported this problem.

The initiation of conversations. The design of current IT assumes that people either want to communicate, and then they switch on the technology, or they do not want to communicate, and then they switch off the technology. This assumption was perhaps valid previously, but not today. We found that people virtually *always* need to be accessible by their IT, *but* that only certain communication is appropriate in a particular situation. This is not enabled by today's IT, and undesirable conversations occur accordingly. We argued previously that this problem could be resolved by mechanisms dedicated for the initiation of conversations. Such mechanisms would enable people to articulate and take part of each other's current preferences, screen communication, etc. Heath and Luff (Heath and Luff 1994) and Belotti and Sellen (Bellotti and Sellen 1993) report a similar problem experienced in their use of a media space research prototype in a lab environment. Our field study adds that this problem occurs outside the research lab and in the use of commercially available IT.

Notification of incoming messages. Firstly, we found that people fail to read new messages in applications that do not notify new contributions. This recapitulates the already established

requirement of notifying important events in groupware applications (see, Bly *et al*. 1993, Fuchs *et al*. 1995, Ackerman and Starr 1996). However, as the second problem suggests, it does not seem sufficient to notify new messages *per se*. A novel observation seems to be that people make distinctions between different *kinds* of messages that they (wish to) cope with in different ways, and for that reason, they want to be acknowledged about which *kind* of communication they receive. Current IT does not provide such options, thus there is a need for new mechanisms offering such support.

Information overload. A novel observation seems to be that people experience information overload when they have been *restricted* from accessing their email. Staff checked their email continually, normally immediately upon being notified, and in doing so, the amount of new messages displayed for them was never excessive. From this it would follow that information overload is resolved by offering people continuous access to their email. For reasons mentioned above, people would probably still experience information overload, thus "classical approaches" to the problem, such as better techniques for retrieval and visualisation of information (see, Belkin and Croft 1992, Foltz and Dumais 1992), would still be relevant.

The junk mail problem. People experienced that they spend too much time considering messages that turn out to be uninteresting, i.e., junk mails. Coined by Denning (Denning 1982), the junk mail problem has been approached in many different fields. The problem is part of the information sharing problem (Malone *et al.* 1987b), and the overall requirements are therefore more effective mechanisms for senders to find potential receivers and receivers to screen uninteresting messages. Many different strategies have been used to resolve this problems, e.g., filtering (see, Belkin and Croft 1992) and techniques for disseminating information (see, Foltz and Dumais 1992), and intelligent agents to manage incoming emails (see, Maes 1994).

There are some brief comments that we wish to make based on the empirical study. First, the results of the study imply that people rely extensively on the use of IT in their work. Issues like "inappropriate

communication," "modes of communication," "kinds of messages," etc., had probably not been brought to the fore otherwise. Second, the nature of email usage at the company questions (see, Kristoffersen and Rodden 1995) the traditional distinction between synchronous and asynchronous communication (see, Baecker *et al*. 1995). When people do not check their email once in a while, but as soon as they are notified new messages have been delivered, and when the emails they send often are replied within five minutes, do they actually use email asynchronously? Third, all the problems outlined in section 2 were confirmed in the study, however only the issues covered by "email overload," which were found in a recent study of email usage in organisations, seemed to be serious at the pharmaceutical company. This could be due to contemporary changes in the use of IT in work.

The results of the fieldwork are of course difficult to generalise. At the same time it would be rather surprising if people in similar settings would not experience similar problems. Therefore, rather than continue to explore whether these problems are experienced in other organisations, we believe that it would be more interesting in further research to explore how the problems and deficiencies reported in this paper could be resolved by means of new and improved technological artefacts.

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Fifth Paper

A "Collaboration Interface" to CSCW

Abstract

We conducted a field study of CSCW technology in clinical trial projects. The field study implies that people need mechanisms that help them to cope more effectively with the process of setting up CSCW sessions. Based on the empirical experiences we designed the *Collaboration Interface* prototype system. The Collaboration Interface comprises two general mechanisms that are applicable to all CSCW systems that do not launch sessions automatically. The *accessibility mechanism* enables participants to implement plans for who they wish to be accessible using what CSCW system, while the *awareness mechanism* helps people make their actions visible for each other in the actual process of setting up CSCW sessions. In this paper we outline the problem, argue for the two mechanisms, and describe how they are being implemented in the Collaboration Interface.

Introduction

The pharmaceutical staff we have investigated manages clinical trials comprising large project organisations of participants dispersed all over the world. Most of the interaction among project members is mediated by rather unsophisticated CSCW technologies, primarily

email, fax, simple groupware systems, the telephone, and occasionally a meeting-support system. The empirical investigations did not only document that communication and collaboration among remote participants is essential in the trial projects, but also that staff experienced problems in this respect. One problem that we have investigated concerns the interface between CSCW and other work, or more specifically: the process of setting up CSCW sessions (Ljungberg 1996a, Ljungberg 1997).

Managing world-wide trial projects, the pharmaceutical personnel are involved in much co-operative work with remote participants. Their role as managers makes it important for them to be accessible by project members, for instance, to discuss and rapidly resolve problems in the trials to meet the deadlines. Communication from project members, and other remote participants, always interrupts an ongoing activity, as CSCW technology use is embedded within a larger work context. This is often desirable, but not always, depending on many different issues that only partly could be defined in advance.

The unfortunate interruptions seem to be due to the lack of mechanisms for managing the process of establishing sessions. Let us consider the process of setting up a telephone conversation. When the telephone rings, "the receiver" does not know who is calling, what she wants to talk about, if it is important, etc., only that *someone* wants to talk about *something*. At the same time, the possibilities for the sender to know if she interrupts the receiver in an inappropriate situation are close to non-existing. This makes participants turn their telephone off in situations where they fear to receive unfortunate communication. Not only does this screen calls that would have been unfortunate in the particular situation, but also calls that would have been very relevant. One conclusion of the empirical work was that staff currently experience problems in incorporating CSCW technology use within their overall working context, as they cannot effectively manage the process of setting up sessions.

The current high implementation rate of more sophisticated CSCW systems in organisations seems likely to make this problem increasingly common. The reason why this is a sensible prediction is,

first, that the outcome of this process inevitably is that CSCW technology use becomes even more integrated and ubiquitous in work, but second, that neither these systems offer mechanisms that facilitate participants in the process of establishing sessions. Against this background we entered the process of design, using our experiences from the fieldwork to answer the question: *How could we provide participants with technological means to cope more effectively with the process of setting up CSCW sessions*? The outcome was the "Collaboration Interface," a prototype system designed to serve as a unified entrance point for interfacing with collaborative work in computing environments. The prototype offers support for prescribing *accessibility plans* and achieve *awareness* among remote participants. Accessibility is here defined as people's possibilities to prescribe *who* they wish to be accessible using *what* CSCW system, and awareness concerns remote participants' possibilities to make their work and intentions visible for each other, thereby affecting each others' behaviour, to increase the chance for appropriate sessions.

This paper seeks to argue for and present the idea of the Collaboration Interface. The paper both comprises lessons learned in the empirical work *and* design suggestions, which makes it challenges the current distinct focuses of CSCW: the "computer-support" focus of the engineering disciplines and the social scientists' emphasis on "co-operative work" (Whitaker 1992). The paper cannot therefore compare with neither the social science contributions in terms of empirical details, nor the computer science contributions in terms of implementation details. At the same time, the paper offers *design suggestions based on empirical investigations* done by the author, and in doing so, it goes beyond pure technological implementations in terms of empirical work, and work analyses that conclude with overall design implications in terms of design.

The paper first outlines the research activities that have been carried out in the project. It then explores how to enable participants to manage the process of setting up CSCW sessions more effectively, followed by a description of the Collaboration Interface. The paper then discusses and concludes what has been argued in the paper.

Research context

This section outlines the context of the empirical investigations in the project: the research site and methods.

Research site

The empirical studies were carried out at a research subsidiary of a multi-national pharmaceutical company in Sweden. The subsidiary has about 1000 employees and a turnover last year was about $400,000,000. Approximately 750 of the 1000 employees are concerned directly with the pharmaceutical research. The company is organised in three divisions; the pre-clinical division, the clinical division and the pharmaceutical division. The clinical division employs 350 researchers of which 50 work at the third Clinical Research Management department, or "CRM III," where the main part of our fieldwork was carried out. The clinical division does research concerning the evaluation of drugs that have passed through the pre-clinical research by investigating them on humans. Because the authorities certify drugs for certain indications, not the drug per see, much clinical research is about exploring new indications for already approved drugs.

CRM III is organised in project groups served by administrative staff and the Data Management group. The project groups, also called research programs, are assembled on a three to six years basis, to manage clinical trials investigating a set of related hypotheses. The project groups consist of a group manager, clinical trial managers and secretaries. The clinical trial managers are responsible for one clinical project each, but they usually also do some work in other projects. The trial managers are assisted by the secretaries, who do much of the administrative work, e.g., order and distribute equipment for the trials. The group managers are responsible for the overall work in the groups.

The empirical work

Two empirical investigations have been carried out in the project so far. The first study was brief and exploratory. It comprised qualitative interviews with people from different sites at the clinical division: clinical trial managers and project leaders concerned with the pharmaceutical research, as well as designers at the local IT department. Relying on a criterion sampling approach (Patton 1990) saying that the objects of study should use much IT and be engaged in much collaborative work, nine people were chosen for interviews. Qualitative interviewing was chosen as mode of inquiry (Mason 1989). The study is described in more detail in (Ljungberg 1996a, Ljungberg and Sørensen 1996).

The second empirical study was more extensive. It was carried out during a period of three months, and it was primarily concerned with the work in the Dyspepsia group. Employing six people; one group manager, three clinical trial managers, and two secretaries, the research in this group concerns dyspepsia. Participant observation of the Dyspepsia group was the main mode of inquiry in the latter study. Approximately 80 hours were spent doing close participant observations, i.e., following every single step of one particular person (Patton 1990), and about 240 man-hours were spent doing so called "site observation," i.e., talk to people, explore what was happening, etc. (Patton 1990). Field notes were taken continually, and everybody was aware of research and its purpose (Patton 1990).

The observational part of the empirical work owes much from ethnography (Hammersley and Atkinson 1993). Ethnography seeks to "present a portrayal of life as seen and understood by those who live and work within the domain concern" (Hughes *et al.* 1993, p. 125-126), which requires the involvement of the researcher in the setting under investigation. Even though ethnography investigates one particular setting only, the implications for design it produces are often typical (Hughes *et al*. 1994). Despite the descriptive focus and sociological orientation towards interpretation, ethnography has been reported to be useful in constructive research (Bentley *et al.* 1992). At the same time, our use of ethnography, which aims at

developing ideas of the use of IT, differs radically from the agenda of traditional social sciences.

The observations were complemented by qualitative interviews (Mason 1989). We did not only interview the Dyspepsia staff, but also three clinical trial managers from other groups, two other group managers and the manager of the department. We conducted 12 interviews lasting between 45 and 90 minutes. All interviews were taped. A more extensive description of this empirical study is found in (Ljungberg 1997).

Approaching the problem

Based on the empirical work and CSCW research, I now wish to approach the problem considered in this paper. Thus, the question asked in this section is: *How could we provide participants with technological means to cope more effectively with the process of setting up CSCW sessions*? The problem and its consequences are elaborated on in (Ljungberg 1996a, Ljungberg 1997), while initial design suggestions are presented in (Ljungberg and Sørensen 1996).

Planning accessibility

The problem is partly caused by deficiencies in session management mechanisms, i.e., the computing mechanisms in groupware systems that determines the manner in which users can join together in a CSCW session (Patterson *et al*. 1990, Edwards 1994). A very simple but illustrating example is the telephones used at the pharmaceutical company, which were designed assuming that people only need two overall modes of accessibility: they want to be accessible by everybody or nobody. This does not agree with the empirical work, which suggests that the pharmaceutical staff virtually *always* need to be accessible, but not by every single potential caller. Seemingly because people could not prescribe for who they want to be accessible, they had to choose whether they want to receive *all* or *no* calls, that is to

say, run the risk of missing important sessions or receiving unfortunate calls. Real-world observations of staff imply that this is not sufficient; it causes various problems that people wish to resolve. This suggests that CSCW systems should incorporate mechanisms that enable people to prescribe their accessibility, i.e., implement plans describing with *who* they wish to join together in a potential session. We use the term *accessibility mechanism* to denote a computing feature that offers participants such support.

The option to prescribe actions in advance, as an accessibility mechanism does, provides the user with the possibility to make things happen according to a plan. The relation between people's plans and what they actually do, or want to do, is indeed a complex topic, that has been debated in CSCW (and elsewhere) for some time by now. One observation that has been increasingly accepted in this respect is the potential difficulties in only letting people prescribe their actions in advance, such as many of the old office automation system did (see, Bannon 1993). It is often very challenging to consider all pertinent issues, even if the work process is seemingly easy to define (Gasser 1986, Sachs 1995), and what actions are most applicable in a particular situation partly derives from the local, and often unique circumstances (Suchman 1987, Bowers *et al.* 1995). These insights imply that accessibility mechanisms only partly would decrease the problem addressed in this paper.[28] This conclusion is supported by critique that has been directed towards the use of (other) filtering mechanisms to avoid "information overload" (Hiltz and Turoff 1985) and "the junk-mail problem" (Denning 1982). Filters are basically user-implemented plans that are executed automatically under certain conditions. This has shown to be very effective in many situations (Malone *et al*. 1987a, Mackay 1989), but has also been criticised: filters only take into consideration what the user specifies initially (Maltz and Ehrlich 1995). Thus, if a particular situation differs from what was calculated, then there are

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[28]It should be noted that this paper does not aim to join the debate on how to best understand the human being and its action (Button *et al.* 1995). Rather, the difficulties associated with only prescribing purposeful action in advance, is here used as a practical experience informing the design of computing artefacts.

probably more pertinent actions than those the filter actually executes.

Facilitating "the actual" process

The ethnographical work captured several situations which we believe could inform the design of mechanisms that, compared to accessibility mechanisms, operate closer to the actual situation when someone tries to launch a CSCW session. One such illustrating situation is how the pharmaceutical staff sometimes uses secretaries to "filter" their incoming telephone calls.

Some employees had the use of secretaries, to whom they more or less frequently re-routed their telephone. The main reason for doing that seemed to be that they did not want to be accessible for all telephone calls for a period of time, for instance, when hosting a meeting at the office, without having to be inaccessible for potentially important calls, some of which might be known in advance. Employees argued that the secretaries often were very "good filters," maintaining that they often "simply knew which calls to let through."

The secretaries were often aware of the receiver's work, e.g., what it concerned and who they usually co-operate with, but also more situated issues such as: why they had re-routed their telephone to them, which they often were told when the telephone was re-routed; if their current work was important, which they often knew by experience, and in situations were the secretary was situated close to the person in question and could monitor his actions; how the work actually proceeded. When the secretaries answered re-routed calls they sometimes realised *immediately* that the call should be re-routed to the person in question, e.g., they were explicitly told to re-route particular calls, they knew by experience that the caller was a very important person, or they knew that the meeting, for instance, was completed, e.g., by having seen the staff saying god bye to visitors, but that their collaborate had not yet re-routed back her telephone. On occasions when this was not clear, the secretary often told the caller that the person she wanted to get hold off was busy at

the moment, and surprisingly often "why," asking her if she wanted to leave a message. This often triggered the caller to express why she was calling, often in some length. The outcome of this was that the secretary sometimes decided to let the call through, sometimes to screen it. This decision was, participants thus argued, virtually always right, and, according to the secretaries, callers seldom questioned if they were not offered to talk to the person they sought. We also found examples of the person who had re-routed her telephone to the secretary passing by the secretary's office while she was talking to a caller who wanted to get hold of her, realising that a person she wanted to talk to was trying to reach her, making the secretary aware of that and handle over the head-set to her.

So, what could we learn from these observations about how staff coped with telephone calls *for the purpose of designing better computing artefacts* that help people to decrease the real-world problem addressed in this paper? Firstly, we fist wish to notice that the empirical work sheds light on the presence of *both* plans and situated action in the process of coping with telephone calls: the secretaries *are* provided with some instructions concerning which caller to "let through" *which they seem to follow*, but that decision seems *also* to be based on local knowledge, experiences, the caller's explanation of why she is calling, etc., i.e., situated issues that do not make much sense to try to detail in advance. To us this indicates, first, that the accessibility mechanism discussed previously ("plans") promises to offer relevant support, but also, and second, that such mechanisms probably would need to be accompanied with features that operate closer to the actual process of negotiating CSCW sessions.

With the ambition to "ground" the design of such artefacts in the empirical investigations, we wish to point out two important issues in the process of coping effectively with telephone calls, namely the seemingly importance of

- *making the sender aware of the receiver's work and intentions*. It seems as if the sender is able to understand whether it is appropriate or not to launch a session with a particular receiver based on information about what she

currently is doing and what her plans are. According to the secretaries, callers virtually *never* complain about not being offered to talk to the person to whom they wish to get hold when the secretaries have told them about what the sought person currently is doing: "They [the callers] understand that other things are more important," as one secretary put it. At the same time participants argued that the secretaries most often let through calls that are "important enough."

- *making the receiver aware that a particular person wants to join together with her in a session.* It seems as if the secretaries, and the receivers, are able to draw various important conclusions only from knowing *who* is trying to establish a session. One example is the situation where the receiver accidentally happened to understand that a particular person was trying to reach her. Similarly, the secretaries know by experience that certain persons should be re-routed to the receiver.

To us the above observations indicate that to decrease the problem explored here by means of new computing artifacts that, opposed to the accessibility mechanisms, support participants in *the actual process* of launching CSCW sessions, it could be a good idea to offer

- senders, when trying to set up a session, with information about what the person with whom they wish to join together in a session is doing, and what are her plans, and,
- receivers with information that a particular person is trying to set up a CSCW session with them.

We use "awareness mechanism" to denote computing mechanisms that offer the sender and the receiver such support. Awareness[29] has

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[29]The notion of "awareness" has been used in many different contexts in CSCW, amongst others, to denote: Objects' knowing of each others in collaborative virtual environments (Benford and Fahlén 1993, Rodden 1996), awareness among dispersed actors working in the same "media space" (Bly *et al.* 1993,

been defined as "…an *understanding of the activities of others*, which provides a *context for your own activity*" (Dourish 1993, p. 107). We believe this definition agrees with what the awareness mechanism seeks to achieve: make the sender understand the receiver's doings, and vice versa, in the process of setting up CSCW sessions. The assumption is that such an understanding would decrease the problem addressed here.

Summing up

Based on empirical work and considerations to existing research in CSCW, the above section claims that the so called

- "accessibility mechanism," enabling people to prescribe their accessibility, seems likely to decrease the problem addressed here, *but*
- considering the problems of only planning purposeful actions in advance (Suchman 1983, Gasser 1986, Suchman 1987, Bowers *et al.* 1995), and the situated nature of work documented in the empirical investigations,
- it would probably be even more effective if accessibility mechanisms could be accompanied with mechanisms that rely more on the actual situation, which, according to our fieldwork, the so called
- "awareness mechanism" seems to be able to do, i.e., a mechanism that, put simple, makes sender and receiver mutual aware of each others' doings in the process of setting up a CSCW session.

Dourish *et al*. 1996), social awareness among participants at the same workplace (Tollmar *et al*. 1996), co-ordination of activities in synchronous groupware (Baecker *et al*. 1993, Guttwin *et al*. 1996), notification of past activities in CSCW systems (Fuchs *et al*. 1995).

On these assumptions we decided to design the "Collaboration Interface" prototype system.

A "Collaboration Interface" to CSCW

The "Collaboration Interface" is a prototype system that seeks to decrease the general problem approached in this paper by enabling people to, first, prescribe their accessibility for, and second, become aware of each others in, the process of negotiating CSCW sessions. The system aims to serve as a unified interface to collaboration in computing environments; thus, "interface" is here used to denote participants' interface to co-operative work rather than the computer systems offering such support (see, Bødker 1991, Grudin 1993).

The idea

The basic, and indeed simple idea is that the Collaboration Interface should serve as the entrance point to all CSCW sessions, i.e., the user starts all sessions from the system, *not* the groupware she wants to use. This does not only offer the user with a nice overview of her groupware systems, but enables also the implementation of general features for accessibility and awareness management, as operations informed by upcoming sessions can be performed *before* they actual start. Before exploring what benefits this actually brings, let us examine the overall functionality of the Collaboration Interface (see figure 1 below). When the user has chosen "who" to co-operate with using "what" system (1 in the figure below), the following happens: the Collaboration Interface sends a request (2) to the receiver's Collaboration Interface: first, asking about her available system (for the sender in question) and her plans for the day; her schedule and optional messages to collaborates, and second, notifying her about that the particular sender probably wants to set up a session (3). The returned request (4) is displayed for the sender together with her available systems matching the receiver's

preferences, and the sender starts a session simply by selecting a system from the list (5).

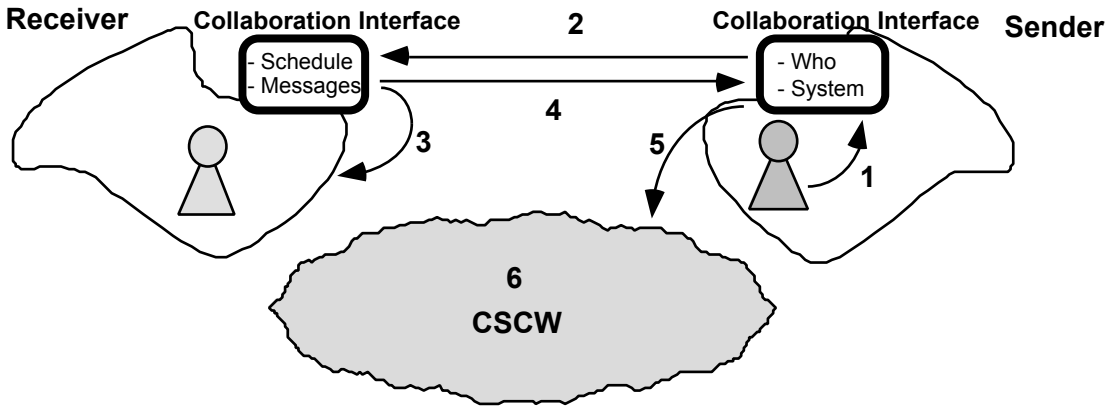


Figure 1. The overall functionality of the Collaboration Interface.

The fundamental idea behind the Collaboration Interface, i.e., to serve as a general interface through which all CSCW sessions would start, brings the possibilities to perform operations informed by upcoming sessions before they actual start. The design of the two main mechanisms in the system; the accessibility and the awareness mechanisms, is essentially based on this possibility.

The accessibility mechanism

The basic feature of the accessibility mechanism is to offer participants to prescribe *who* they wish to be able to launch a CSCW session with them using *what* system. The mechanism lets people select in which systems "everybody" should be able to reach them, and in which system they wish to be accessible for "certain participants" only. The systems accessible for everybody can either be "running" or "started on request." The latter simply means that a not running system automatically is launched when a sender requests it. The main reason is to enable people to be accessible by any amount of CSCW systems without running out of internal memory. The same technique is used to enable participants to specify for who they wish to be accessible using a certain system. In this case, the receiver's

Collaboration Interface simply matches the identity of the sender, obtained from the request (2 in the figure above), with the receiver's preferences, and upon finding a match, i.e., that person P is allowed to start a session in system S, it starts the system in question. The receiver is then accessible when the sender subsequently launches a session using the particular system. After the session the receiver simply terminates the system. This is the only way we are aware of to enable *general* filtering of CSCW sessions. When the Collaboration Interface invokes a system on request, then it starts a counter that terminates it if nothing happens within one minute, or unless the user tells it not to do so.

The figure below shows the Accessibility Manager window. In this case, there are two running systems that anyone can access (Eudora and Chat), and there is one system that starts by anyone's request (CUSeeMe). The picture also says that "Meeting support system" starts when requested by the participant "Steinar Kristoffersen."

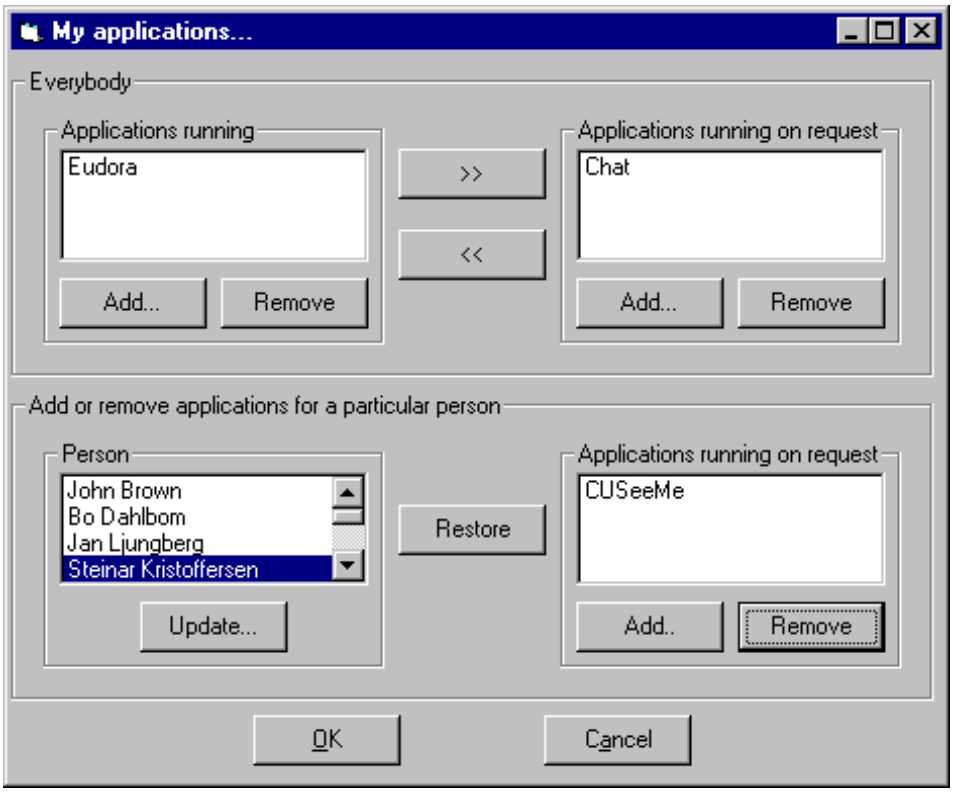


Figure 2. The Accessibility Mechanism in the Collaboration Interface.

The Collaboration Interface thus provides filtering mechanisms for all CSCW sessions that are started using the system. Furthermore, it enables the users to overview and easily update their accessibility, which otherwise requires tiresome operations; activate the system, find the accessibility mechanism, and change the accessibility.

The awareness mechanism

The awareness mechanism tries to make "the sender" and "the receiver" mutual aware of each others' activities in the process of setting up a CSCW session. It seeks to inform "the sender" about "the receiver's" work; more specifically, her schedule for the particular day and two optional messages, and notify the receiver that a particular person wishes to join together with her in a session. Taking seriously the mobile nature of much work at the pharmaceutical company, which has been investigated elsewhere (Kristoffersen and Ljungberg 1996b), we have also tried to implement awareness features for the mobile actor.

Making the receiver aware

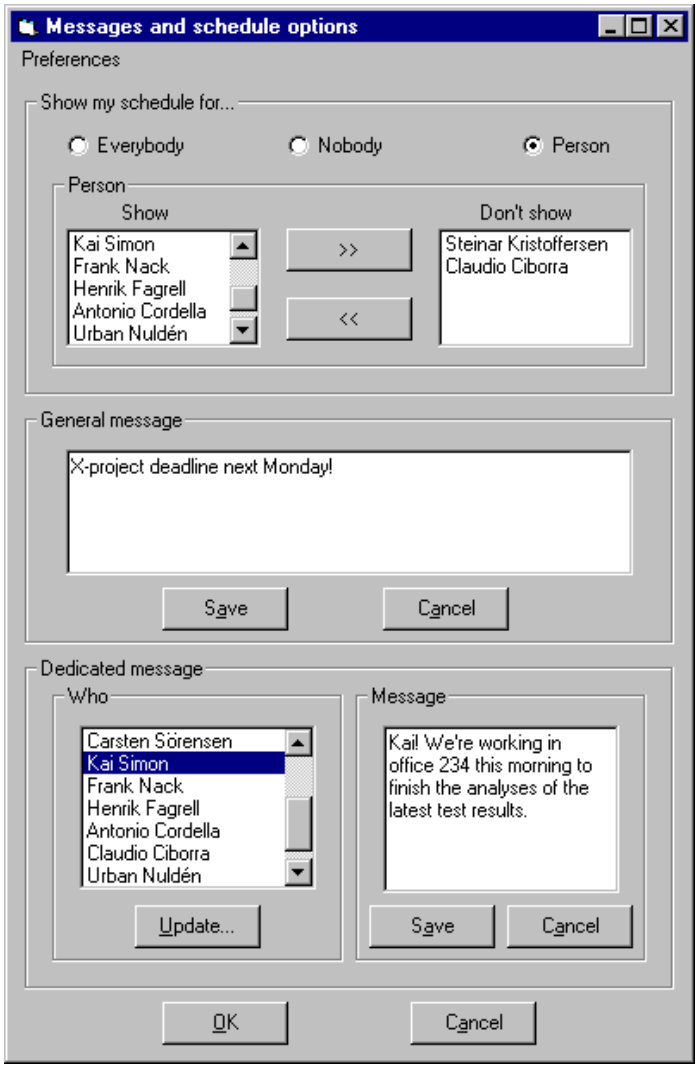
This part of the awareness mechanism is concerned with making participants aware of others who submit a request to their Collaboration Interface, that is to say, others who probably want to join together with them in a CSCW session. Requests can currently be notified on the PC, on a cellular phone, or both. If the user selects to be notified on a cellular phone, then the Collaboration Interface replies all, or certain, requests as SMS (Short Message Service) messages, containing the name of the sender, to the dedicated phone, which displays it for the receiver making a "beep." In the PC environment requests are currently notified as the name of the sender being displayed in the menu bar of the prototype system. Usability tests will be conducted to explore whether or not more notification options would be desirable.

Making the sender aware

In supporting the sender's awareness of the receiver's work and plans, we decided, at least initially, to not use a real-time video connection, such as the "glance" function used in many video-mediated systems (Dourish 1993, Tang and Rua 1994), but textual representations of work. The main reason why is that video does not sit well with the accessibility mechanism (i.e., filtering). For example, what if the sender after a glance realises that the other part, who seemed to be out of work, does not want to interact with her? Another issue that could be raised against video is the privacy problem (Bellotti and Sellen 1993, Hudson and smith 1996).

In trying to offer textual representations of work to facilitate awareness, we wanted to, as far as possible, and unlike other systems offering "textual awareness" (e.g., the "@Work" (Tollmar *et al.* 1996)), rely on already existing information, to not require participants to do extra-work from which they would not, at least initially, benefit (Grudin 1994b). Such information can be found in electronic calendars. Calendar systems were once used as the standard example of "why groupware applications fail" (Grudin 1989), but are, according to more recent empirical investigations, including ours, used in organisations today (Grudin and Palen 1995). Information from the calendar system is transferred daily to the Collaboration Interface, which sends it as a reply to requests from those senders for who the user wants to expose here working plans. Users can currently choose to show her schedule for "everybody," "nobody," or "certain persons."

Additionally, the prototype lets the user put together two kinds of messages to be replied along with the schedule. The *general message* is exposed for everybody, while the *dedicated messages*, not surprisingly, are addressed to certain senders. The messages would typically be used for "pre-interaction co-ordination" (Tang *et al*. 1994), i.e., to co-ordinate the process of setting up successful sessions, e.g., inform certain participants that one works in another office for the particular day.



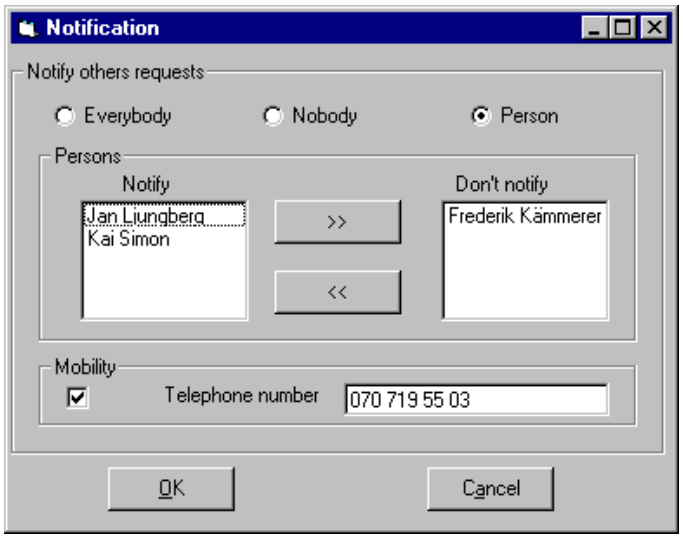


Figure 3. Options for making the sender aware.

Setting up a CSCW session

For the user the Collaboration Interface would appear as a small window instantly on top of the desktop (see 1 in figure 4). To initiate a session the sender either double clicks on the name of the receiver, or selects "Start…" in the "Prefs…" menu (2).[30] To make a request for the selected participant the user presses "enter" immediately when the "initiation window" emerges. Alternatively the user selects another person in the address book, or make a new entry ("Update…" button). Pressing the "OK" button (3) the user sends a request to the receiver in question, asking for her schedule and the two messages. The receiver's Collaboration Interface makes a notification about who is making the request by displaying her name and beep (4). The sender then receives the reply on her request according to the receiver's preferences (5), and simply by clicking on the appropriate system, she initiates a session. In the below example the sender selects a video-conferencing system that, when she clicks it, launches its own set up operations, in this case, sends a request to the receiver (6) asking if she wishes to accept the setting up of a session with the sender. If she accepts the invitation the session starts (7).

Implementation

The Collaboration Interface was implemented using Windows Open Service Architecture (WOSA). The WOSA model consists of three components: the client API, the API/SPI interface (usually a DLL) and the Server SPI.[31] The DLL interface acts as a translator between the client and the server, which brings well-known advantages like isolated development and upgrade protection (Amundsen 1996). The databases were implemented using ODBC (Open DataBase Connectivity). ODBC provides a client API that communicates with

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[30]All preferences are found in the "Prefs…" menu, e.g., the accessibility option.

[31]The abbreviations mean: API = "Application Programming Interface," DLL = "Dynamic Link Library" and SPI "Server Programming Interface."

the ODBC DLL (often called “driver manager”), which exchanges messages with the DBMS drivers via the ODBC SPI (Dooley 1996). Most parts of the prototype have been implemented and tested out locally, however there are some modules left to be resolved to be able to implement the system in a larger user community. The languages used in the development were Visual Basic, C and C++ in the Windows95 environment. The communication between the prototypes was tested out using the RPC (Remote Procedure Call) technique. Systems were invoked using the AppActivate instruction in Visual Basic and information from the scheduler was fetched using OLE. The SMS messages sent from the prototype to cellular phones were transferred from the Internet via a gateway to the wireless net (GSM).

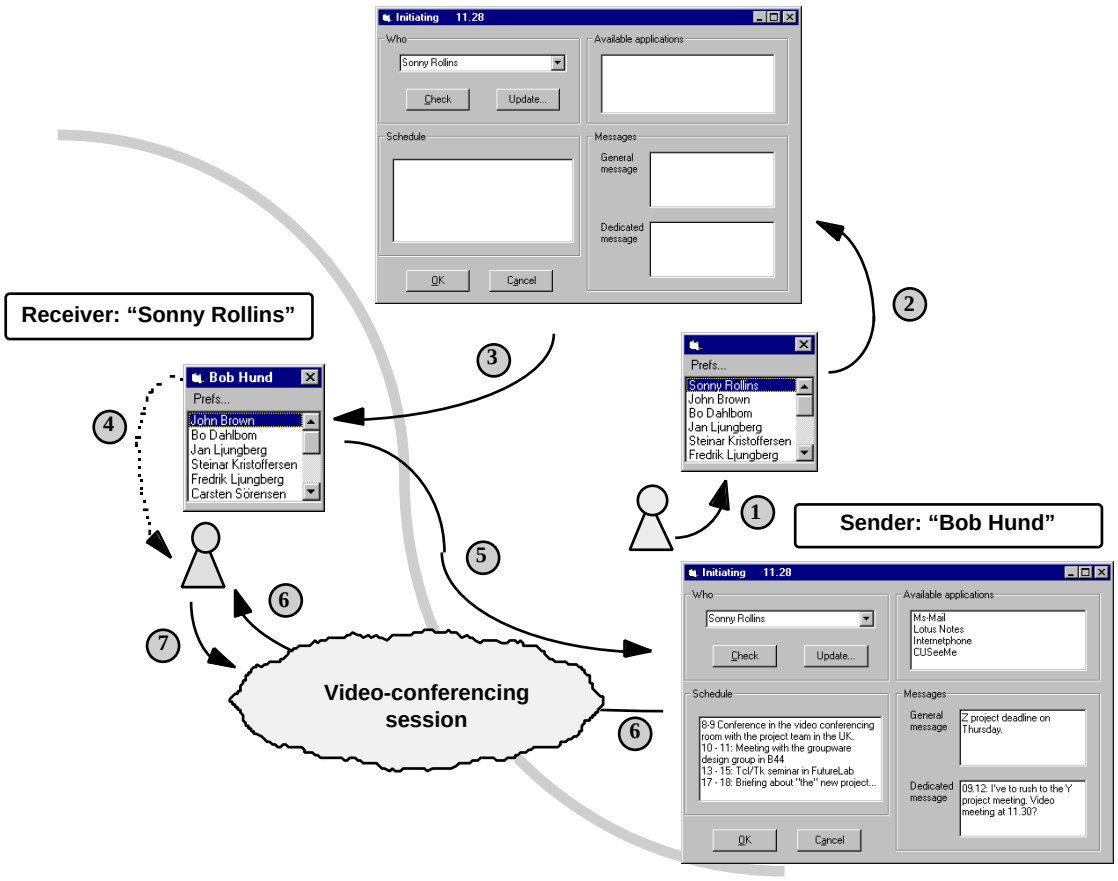

Figure 4. Setting up a session

Discussion

This section discusses the use of the Collaboration Interface and how the work relates to existing research.

Using the Collaboration Interface

This section first discusses how a fully implemented version of the Collaboration Interface actually would facilitate participants in decreasing the problem addressed here. Because the problem that the prototype seeks to decrease is experienced by receivers, while it is senders who have to do most of its operations, the second part of the section explores: why we would expect senders to use the system?

How would the prototype decrease the problem?

How would the accessibility and awareness mechanisms facilitate participants in coping more effectively with the problem explored in this paper?

Inasmuch as user-implemented plans reflect which sessions participants actually wish to join, then the accessibility mechanism promises to facilitate people in screening the amount of unfortunate sessions. Despite the inherent problem with plans, filtering has been successfully used in other areas, such as message filtering (Mackay 1989), and its potential to reduce the problem addressed in this paper seems difficult to deny. Used the other way around, the accessibility mechanism could reduce the amount of missed fortunate sessions by enabling participants to extend their accessibility to situations where they currently cannot be accessible without running the risk of being spawned with unfortunate disruptions. One example is to be accessible for a particular, and presumably very important awaiting session while hosting a meeting at one's office, i.e., a situation where people currently cannot be accessible at all without running the risk of disrupting the entire meeting — at least not without taking organisational measures.

The schedule and the two messages offered by the awareness mechanism would expose more or less explicitly participants' preferences of certain sessions. Exposing this information would aim to avoid unfortunate sessions but also to find opportunity for interaction. Information about people's work could be very informative even if it does not state their preferences explicitly. For example, if one person's schedule says: "9 - 10: Meeting with senior management at the office," then her preferences for that particular hour are quite clear. The messages offered by the awareness mechanism could be used to more explicitly invite people to behave in certain ways.

The notification of requests seeks to make participants aware of others who probably want to join together with them in a CSCW session. In terms of resolving the overall problem, its main benefit seems to be making participants aware of potentially relevant sessions that they had failed to notice otherwise, primarily because: (1) the sessions had been screened by the accessibility mechanism, or; (2) the receiver was out of her office and thus not accessible for most CSCW systems. If participants, in becoming aware of such sessions, assess them as desirable, and in doing so, contact the sender to set up a session, then the notification feature has in a sense facilitated people in reducing the amount of missed fortunate sessions. Used the opposite way, the notification message could, hypothetically, be used for screening: if the receiver is notified that an unfortunate person is trying to set up a sessions and realises that this person has access to some of her systems, then she could shut down these systems immediately to screen the unfortunate session.

Table 1 summarises how we believe the accessibility and awareness mechanisms would facilitate participants in coping more effectively with their current problem.

Why would senders use it?

The problem that the Collaboration Interface tries to decrease is experienced by receivers, but it is senders who have to do most of its

operations. The question that then occurs is: why would senders use the system?

Mecha-nism	**Function**	**Unfortunate sessions**	**Missed fortunate sessions**
Accessibility mechanism	Filtering	Screening.	Extend accessibility.
Awareness mechanism	Exposing preferences	Make others aware to avoid.	Make others aware to find opportunity.
Awareness mechanism	Notifying requests	Disconnect when being notified.	Requesting a session when being notified.

Table 1. How the mechanisms in the Collaboration Interface would facilitate people.

We would like to maintain that the system would *not* bring much extra-work for the sender, in fact only selecting the name of the receiver (two "enters" or "clicks" if the person is registered in the address book) and waiting until the request is replied. Then the user would only select the desired system to set up a session. These additional operations would however facilitate the sender in exactly what she is trying to do, i.e., set up a session together with a certain person:

- The awareness features would give her valuable information about when (etc.) to set up a session with the receiver.
- The notification features would make the receiver aware that the sender is trying to set up a session: (1) requests could be notified *both* on the PC and the cellular phone; (2) the system that the sender wants to use does *not* have to be running to notify the receiver.
- The sender would fail to activate the receiver's "start on request" if she does not use the system.

Based on these observations, and others, we maintain that the sender, first, would not have to do many additional operations to use the Collaboration Interface, and second, actually would be facilitated in what she is trying to do: set up a session with the receiver.

Related work

This section describes how the research presented here relates to existing CSCW research.

The topic

Some recent empirical studies of collaboration argue for *the importance of interruptions* in work (Whittaker *et al*. 1994, Bowers *et al*. 1995, Rouncefield *et al*. 1995). These studies imply that much work actually becomes triggered and done through interruptions. This observation is indeed important, amongst others, because it eventually dissolves the old notion of communication as something that inevitably "interrupts work" in a negative sense (Conradson 1988). At the same time, we want to maintain, the observation *cannot* be generalised to all situations, which the authors cited above probably would not claim. Our observations of work suggest to us, as do participants in interviews: even though communication is one of the foundations of work at the company, any communication is not inherently good in any situation.

Indirectly related to the problem and approach taken in this paper are research on awareness among people to facilitate their collaboration (see, Kraut *et al.* 1990, Heath and Luff 1992), resumption of interrupted and not yet completed activities (see, Dix *et al*. 1996b, Dix *et al*. 1996a), and information filtering (see, Malone *et al*. 1987b, Belkin and Croft 1992).

CSCW models

The manner in which people can join together in CSCW sessions is defined by the session management model used by the system (Patterson *et al*. 1990). Edwards (Edwards 1994) makes a distinction between explicit and implicit session management models, where explicit models, opposed to implicit, require participants to take dedicated actions additional to the work itself to initiate a CSCW session. Implicit session management models that are described in the literature are based on artifact (see, Edwards 1994), activity

(Edwards 1994, Isaacs *et al.* 1996) and the place metaphor (see, Mantei *et al*. 1991, Sohlenkamp and Chewlos 1994, Fitzpatrick *et al*. 1995, Roseman and Greenberg 1996b), assuming that participants wish to join together in sessions when they use the same artifact, e.g., a document, when they are involved in the same activity, e.g., using the same system, or when they are at the same gathering point in a place based groupware. The difficulties associated with setting up sessions automatically based on activity and artifact (Isaacs *et al*. 1996) could be one reason why few systems use these models. Workflow systems, which often use some kind of activity based model, is one exception. Place based models, e.g., collaborative virtual environments (see, Greenhalgh and Benford 1995b, Nakanishi *et al.* 1996), continuous connections between physical places (e.g., Fish *et al*. 1990), and virtual collaboration rooms (see, Roseman and Greenberg 1996b), are based on how people meet each others in the real world and the problem addressed in this paper does not seem to emerge in such environments.

Even though systems that use an explicit session management model would be most natural to combine with the Collaboration Interface, the prototype could have been used together with virtually all systems that do not automatically *set up* collaboration sessions. Systems that only *notify* participants about others doings, such as "Piazza" (Isaacs *et al.* 1996) and "@Work" (Tollmar *et al.* 1996), could be used together with the prototype. CSCW systems based on explicit session management, such as many so called "videophones"(e.g., RAVE's "vphone" operation (Dourish 1993, p. 128)) require participants to explicitly negotiate about setting up a session.

Conclusions

The work presented in this paper started out from the empirical observation that people currently experience problems in incorporating CSCW technology use within their overall working context, as they cannot effectively manage the process of setting up

sessions. We therefore asked the question: *How could we provide participants with technological means to cope more effectively with the process of setting up CSCW sessions*? Inspired by empirical investigations, we argued that the problem could be decreased by *accessibility* and *awareness* mechanisms. Accessibility mechanisms would offer participants to implement plans for *who* they wish to be accessible for using *what* CSCW system, while awareness mechanisms would enable remote participants' to make their work and intentions visible for each others, thereby affecting each others' behaviour, to increase the chance for appropriate sessions. The mechanisms were implemented in the Collaboration Interface prototype system, which was based on the notion of a unified entrance point for participants to interface with their co-operative work in computing environments.

Below we summarise what we believe are the main novelties of the research project presented in this paper.

- The notion of a "Collaboration Interface" as representing a unified entrance point for participants to interface with their collaboration in computer environments, seems to be novel.

- The features offered by the prototype are general in the sense that they can be used along with all CSCW systems that do not automatically set up sessions. As far as we are concerned, the general support for accessibility and awareness is novel.

- The combination of features for filtering and achieving awareness extends the support for implementing plans to manage CSCW sessions with services that reflect the actual action. Combining these seemingly contradictory features require the use of textual representation of work, as video does not seem to sit well with filtering — for example, what if the sender after the short audio-video glance interaction, realises that the other part, who was seemingly out of work, does not want to interact with her? This combination would facilitate the process of setting up CSCW sessions.

- The awareness and notification features would extend the support for "pre-interaction co-ordination" of CSCW (Tang *et al.* 1994) in novel ways: from the single system to all systems, and from the office to all environments where people can use a cellular phone — which agrees with the current trend of mobility in work (e.g., Bellotti and Bly 1996). This is important because empirical research on the topic reports low rates of requests leading to collaborative sessions (see, Fish *et al.* 1990, p. 7, Fish *et al*. 1993, p. 52, Tang and Rua 1994, p. 41).

We plan to implement the Collaboration Interface fully and evaluate it at the pharmaceutical company. Further work also concerns experimenting with implementations on other platforms.

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Appendix A

The research presented in the thesis has primarily been done within two projects: the Co-operative technology project (1994 - 1997) and the Internet project (1995 - 1999). Other publications in these projects with which some of the papers in the thesis partly overlap with, are:

- Kristoffersen, S., and F. Ljungberg (1996) "Practice makes perfect. Discerning theories on computing," In *Proceedings of the 19th Information Systems Research Seminar in Scandinavia*, edited by B. Dahlbom *et al.*, pp. 29-53, Gothenburg Studies in Informatics, No. 8.

- Kristoffersen, S., and F. Ljungberg (1996) "DARWIN and NEWTON: Basic infrastructural information technologies for group work?," in *The BIITs project*, edited by E. Beck, Oslo: Department of Informatics, University of Oslo.

- Kristoffersen, S., and F. Ljungberg (1997) "MobiCom: Networking dispersed groups," To appear in *Interacting with Computers*.

- Kristoffersen, S., and F. Ljungberg (1997) "CSCW in distributed, mobile and networking groups," Poster presented at *The Fifth European Conference on Computer-Supported Cooperative Work,* Lancaster University, UK.

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· Kämmerer, F., and F. Ljungberg (1997) "How VCW makes money on the net," In *Proceedings of the 20th Information Systems Research Seminar in Scandinavia*, edited by K. Braa and E. Monteiro, pp. 835-848, Department of Informatics, University of Oslo.

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· Ljungberg, F., and C. Sørensen (1996) "The push & pull profession. Practitioner perspectives on Lotus Notes initiation," In *Proceedings of Information Resource Management Association International Conference*, edited by M. Khosrowpour, pp. 223-232, Washington: IDEA Group Publishing.

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